Ecology and Evolutionary Biology
2021; 6(4): 120-124
http://www.sciencepublishinggroup.com/j/eeb
doi: 10.11648/j.eeb.20210604.14
ISSN: 2575-3789 (Print); ISSN: 2575-3762 (Online)

Comparative Study of the Influence of Straws of *Imperata cylindrica* and *Andropogon gayanus* on the Fruiting of *Pleurotus abalonus* in Benin

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To cite this article:

Séraphin Mouzoun, Toussaint Olou Lougbégnon, Boris Agonse, Pierre-Fourier Dossou. Comparative Study of the Influence of Straws of *Imperata cylindrica* and *Andropogon gayanus* on the Fruiting of *Pleurotus abalonus* in Benin. *Ecology and Evolutionary Biology.* Vol. 6, No. 4, 2021, pp. 120-124. doi: 10.11648/j.eeb.20210604.14

Received: June 29, 2021; **Accepted**: July 16, 2021; **Published**: November 23, 2021

Abstract: *Pleurotus abalonus* is an edible mushroom of interest for its nutritional and medicinal properties. Its commercial production has developed in tropical countries using local materials. The objective of the work is to contribute to the establishment of mycicultural practices likely to increase the productivity of oyster mushrooms using locally available materials. In the present study, the cultivation of *P. abalonus* is tested on two types of fruiting substrates: straws of *Imperata cylindrica* and *Andropogon gayanus*. The harvested straws were cut and pasteurised at boiling point for 60 minutes, then drained for 4 hours before being inoculated with the mother culture. The bags, filled with 1 kg of substrate, were incubated in a mushroom farm for 4 weeks. The best results in terms of weight, pileus diameter and average number of carpophores were obtained on *A. gayanus* straws compared to *I. cylindrica* straws. The highest average carpophore yield (6.56%) by fresh weight was obtained with *P. abalonus* on *A. gayanus* straw. For *I. cylindrica* straws, the average yield is close to 1%. Indeed, *A. gayanus* straws produced an average amount of 32.8 g of fresh carpophores from 500 g of substrate in dry mass against 4.6 g for *I. cylindrica* dry. The results show that production is better on *A. gayanus* straws compared to *I. cylindrica* straws.

Keywords: *Pleurotus abalonus*, Oyster Mushroom, Local Substrates, Edible Mushroom, Dogbo, Benin

1. Introduction

Only about 100 of the more than 3,000 mushrooms that are determined to be major edible species are or have been cultivated [1]. Global production of cultivated edible mushrooms was 24,000 thousand tons in 2009 [2], and has been steadily increasing for the last twenty years. The fundamental reason for the increase in consumption is related to their nutritional value as food on the one hand, and their medicinal properties and use as nutraceuticals (food supplements) on the other hand [1]. For many years, humans have been cultivating edible mushrooms [3], reported that the cultivation of edible mushrooms is practiced worldwide. However, [4] mentions that the strains cultivated in Africa are mainly of the genera Pleurotus (*Pleurotus* spp), Auricularia (*Auricula* spp), Volvariella (*Volvariella volvacea*) and Ganoderma (*Ganoderma lucidum*). The oyster mushroom (*Pleurotus* spp), is an edible saprophytic mushroom growing in clumps. Edible mushrooms, especially oyster mushroom species, are cultivated on various substrates. [5] Showed that edible mushroom species are grown on a variety of organic substrates: sawdust, rice straw, bagasse (sugarcane residue), maize essences, spent cotton, banana stalks and leaves, etc. Moreover, mushrooms are great decomposers of organic matter, growing on the most diverse materials, as soon as the humidity and temperature are favourable to them.

From a dietary point of view, edible mushrooms are a food of very high nutritional value [6]. Oyster mushroom species are considered to be a healthy food, rich in protein, fibre,

minerals and vitamins, mainly vitamins B1, B2, C and D; with unique flavour and aromatic properties [7-9].

Ideas for mushroom improvement are primarily addressed to the demands of producers, for whom criteria such as yield, post-harvest preservation and disease resistance are among the most important. Similarly, high productivity, which is linked to good substrate efficiency, is a priority interest for mushroom growers. In Benin, palm stalks have since been the preferred substrate for growing edible mushrooms. The cultivation and dissemination of new edible mushroom production technology, including *Pleurotus abalonus*, can be an efficient strategy to fight malnutrition and food insecurity, which threaten most countries in the world, especially Benin. This work aims at evaluating the biological efficiency of different substrates based on *Imperata cylindrica* and *Andropogon gayanus* straws, and the determination of the substrate that allowed the best yield of carpophores. The present study, which tests the fruiting of *Pleurotus abalonus* on various substrates, will contribute to the implementation of mycicultural practices likely to increase the productivity of the mushroom by using locally accessible culture substrates.

2. Materials and Methods

2.1. Materials and Experiments

2.1.1. Experimental Site

The experiments were carried out in Dogbo, located in the southwest of the Republic of Benin, in the Mialébouni compound, located between 6°42′25" and 6°45′75" north latitude, and 1°35′08" and 1°55′45 "east longitude and at an average altitude of 80 m. This study was conducted in a single trial, inside a mushroom farm. Mialébouni is an association of rural women who process agricultural products.

2.1.2. Fungal and Plant Materials

Pleurotus abalonus was used as mycicultural material. This species was chosen because of its ability to adapt to environmental conditions and its suitability for consumers. Mushrooms of the genus Pleurotus belong to the phylum of Basidiomycetes, the order of Agaricales and the family Pleurotaceae [10, 11]. *Pleurotus* is grown on a variety of solid culture media that enable the development of the mycelium. Many substrates such as wood shavings or sawdust, wheat straw, peanut shells and different types of straw can be used as basic substrate materials for growing oyster mushrooms. In the present study, two growing substrates were used for the fruiting of *P. abalonus*. These were *Andropogon gayanus* and *Imperata cylindrica* straws, chosen because of their accessibility in the vicinity of the town of Dogbo.

2.2. Data Collection Methods

Samples of *Andropogon gayanus* and *Imperata cylindrica* harvested in the fields were packed in polypropylene bags of about 110 cm height and 45 cm diameter and transported to the experimental site (Mialébouni headquarters). After harvesting, the straws of *A. gayanus* and *I. cylindrica* were exposed to the sun for about one month.

The different substrates, the dry *A. gayanus* and *I. cylindrica* straws were cut and pasteurised with boiling water in a large pot for 60 minutes and then drained (cooled) for 4 hours. The substrates consisting of *A. gayanus* and *I. cylindrica* straws were packed in polyethylene plastic bags. Five samples (bags) were taken per substrate type. No special additives were added to the different substrates.

The substrates were seeded under more or less aseptic conditions. It should be noted that the bags were capped with a cotton wool pad and tightened with a plastic ring to allow the passage of oxygen, while minimising the risk of contamination. Incubation of the seeded substrates took place in a mushroom farm for 4 weeks. The incubation conditions were made uniform by randomly moving the culture bags within the mushroom farm once a week.

After incubation, the method [12], was applied in order to enable good fruiting. This method was followed using the shelf culture technique. The bags are perforated to allow the passage of the primordia and then placed on wooden shelves. Watering of the mushroom house was done twice a day to keep the humidity level high in the farm. For each substrate there were 5 replicates.

The parameters observed and measured were: pileus diameter (carpophore, cap), stipe height, average weight in grams of mushrooms, number of plants per clump and number of clumps per substrate. Determination of the carpophore diameter was done by simple measurement with a ruler (double decimetre). The weight of the harvested mushrooms was determined by weighing with a weight scale.

2.3. Statistical Analysis of Results

The Excel 2010 spreadsheet and the XLSTAT 2020.4.1.1038 software were used for the statistical analysis of the data. Arithmetic means were determined for each measured parameter (weight, diameter, number of carpophores) according to the tested substrates. The yield of fungal production was calculated by considering the fresh weights of the harvested products and the starting substrate. Then, the fungus growth performance on the different substrates was evaluated by estimating ″Biological efficiency (Be)″ according to the relationship proposed [13-15]:

$$Be = \frac{FM}{DM}\ x\ 100$$

With Be=Biological efficiency; FM=Fresh Mass of carpophores produced; DM=Dry Mass of the base substrate.

Analysis of variance (ANOVA) at the 5% significance level was used as a statistical tool to detect significant differences between the mean values of production, yield and biological efficiency of the different substrates. This analysis enabled to compare the behaviour of the oyster mushroom strain (*P. abalonus*) on the different substrates tested at the end of the experiment. If the probability (P) is: $P \geq 0.05$ the variables show a non-significant difference; $P \leq 0.05$ the

variables show a significant difference; P ≤ 0.01 the variables show a highly significant difference; P ≤ 0.001 the variables show a very highly significant difference.

3. Results

The effects of substrate types on yield were analysed through the different measurements made (diameter, weight and number of carpophore).

3.1. Mean Weight of Harvested Mushrooms

Figure 1 shows the average weights of mushrooms grown on the two substrates.

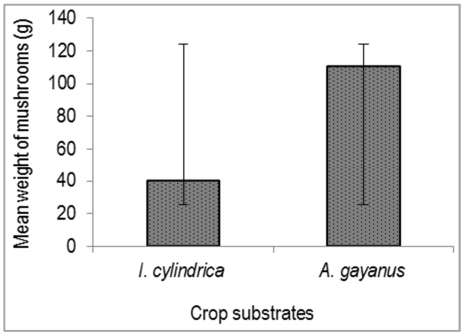

Figure 1. *Mean weights (± standard deviation) of harvested mushrooms according to substrates.*

The analysis of figure 1 shows a significant difference for the substrate factor. Indeed, the standard deviations are large, which means that the weight of the mushrooms is very variable and are respectively 40 and 110 grams. The largest mushrooms were obtained on *Andropogon gayanus* straw and the smallest on *Imperata cylindrica* straw. From the results presented in the figure above, it can be seen that the harvest from the straw of *A. gayanus* yields a total of 110 g and that 40 g of *I. cylindrica*. It can be concluded that the straw of *A. gayanus* is the best fruiting substrate for the *P. abalonus* mushroom.

3.2. Mean Diameter of the Caps

The average diameters of the caps are summarised in Figure 2.

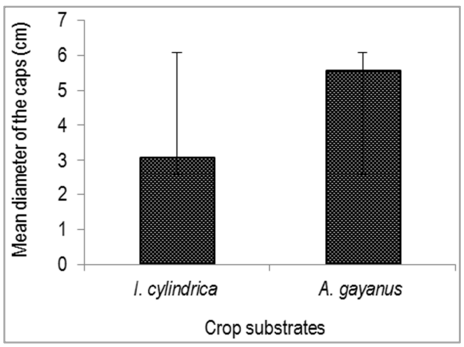

Figure 2. *Mean diameter of mushroom caps (± standard deviation) on the tested substrates.*

According to this figure, the average cap diameter is larger on the substrate *Andropogon gayanus* (5.57 cm). It is smaller on *Imperata cylindrica* (3.1 cm). The results of the variance test (ANOVA) are presented in Table 1.

Table 1. *Analysis of variance at the 5% threshold for the average diameter of mushroom caps according to the substrates tested.*

Source	DDL	Sum of squares	Average of squares	F	Pr > F
Model	1	2410,810	2410,810	1,337	0,367
Error	2	3606,500	1803,250		
Corrected total	3	6017,310			

Analysis of the above table reveals that there is no significant difference (pr=0,367 > 0,05).

Table 2. *Analysis of variance for mean yields according to the substrates tested.*

Source	DDL	Sum of squares	Average of squares	F	Pr > F
Modele	1	1312,975	1312,975	0,428	0,580
error	2	6133,617	3066,809		
Corrected total	3	7446,593			

3.3. Outputs

Figure 3 shows the average yields of the mushrooms according to the substrates considered.

Figure 3 shows that the highest mushroom yield is observed on the *A. gayanus* substrate (32.8±22.49) while on *I. cylindrica* the yield is the lowest (4.6±2.55). The analysis of variance (Table 2) shows that there is no significant difference between the substrates tested (Pr=0.580 > 0.05).

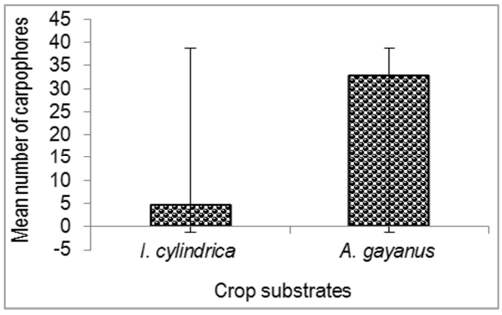

Figure 3. *Mean mushroom yield of Pleurotus abalonus as a function of substrates.*

4. Discussion

The straws of *Andropogon gayanus* and *Imperata cylindrica* considered as weeds and whose management poses serious problems to farmers in the commune of Dogbo can constitute a raw material for the production of edible mushrooms. However, the operation needs to be improved in order to increase the various crop parameters that were monitored, including yield. According to [16], the operation of cultivating oyster mushroom mycelia on a lignocellulosic substrate is economically profitable if the yields of edible carpophores produced represent at least 20% of the fresh mass of the substrates used. In the case of the present study,

the substrates used are the straws of *A. gayanus* and *I. cylindrica*.

The *A. gayanus* substrate produced an average of 32.8 g of fresh carpophore from 500 g of substrate in dry mass. In other words, 6.56 g of fresh carpophores were produced from 100 g of dry substrate and this corresponds to a yield of 6.56%. The *I. cylindrica* substrate produced an average of 4.6 g of fresh carpophore from 500 g of dry substrate. This is equivalent to 0.92% yield.

Therefore, according to the work [17] on the production of fresh carpophores of *P. cystidiosus* from two types of substrates (mixture of fermented sawdust with wheat bran, slaked lime and sucrose on the one hand, and mixture of *Cyperus papyrus* stems with wheat bran, slaked lime and sucrose on the other hand), yields obtained varied between 9.7% and 21.8%. Similarly, [15] using three fresh substrates obtained fresh weights of carpophores that varied between 31.4 g (substrate B1), 18.3 (substrate B3) and 5.9 g (substrate B2). The substrates consisted of a mixture of rice husks, wheat bran, sawdust and slaked lime (B1); a mixture of rice husks and slaked lime (B2) and a mixture of rice husks, sawdust and slaked lime (B3). Our results are somewhat different from their results. [18], obtained yields of *P. ostreatus* carpophores from a substrate of wild grasses, without any particular additive, ranging from 85.36 g to 149.42 g of fresh carpophores per 100 g (in dry mass) of wild grasses. Yields obtained by these authors are significantly higher than those obtained in the case of this study.

The difference observed in these yields seems to be due to the cultivation methods used. Indeed, unlike the present research, in the case [17], the proportions of fungal inoculum are 5 and 3% of the fresh masses of the base substrates. [18] The inoculated proportion is 20% of the fungal mycelia and 5% for the studies [16]. It appears from the various studies that the cultivation method, particularly the proportion of inoculum in relation to the basic substrate, can contribute significantly to the increase in yield. Thus, it can be deduced that production (yield), as well as other parameters (carpohore diameters, stem length, weight,...) depend on the composition of the base substrate as well as on the cultivation method applied.

5. Conclusion

The present study focused on the multiplication of oyster mushroom (*Pleurotus abalonus*) on two types of cellulosic substrates composed of *Andropogon gayanus* and *Imperata cylindrica* straws. The results obtained show that the substrate based on *A. gayanus* straws gave the best yield of carpophores compared to the straws of *I. cylindrica*. Based on the results obtained in the present work, cultivation on *A. gayanus* straws is recommended as a substrate for myciculture. The results of this research corroborate that the straws of *A. gayanus* and *I. cylindrica* can constitute a source of material with added value. Oyster mushrooms are known for their good nutritional and medicinal values. In addition, this research reveals that malnutrition and food security can be solved in Benin, in part by valuing *A. gayanus* and *I. cylindrica* straws for the production of edible carpophores. However, further studies should be carried out on the combination of substrates and additives in order to further improve the productivity of oyster mushrooms and thus counteract the food insecurity threatening countries, especially in Africa.

Acknowledgements

It is a pleasure for the authors to thank the people who generously shared their time and knowledge with them. Special thanks go to the reviewers/referents for making themselves available to review the manuscript. Our thanks to the Mialébouni Association for providing the necessary material means to conduct this study.

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