

Assessment of venting styles on the rate of fruiting and incidence of contamination in *Pleurotus floridanus* Singer

Dede P., Okereke V.C. and Adedokun, O.M.*

Department of Crop and Soil Science, Faculty of Agriculture, University of Port-Harcourt
P.M.B. 5323, Choba.

Corresponding author (Email: olutayo.adedokun@gmail.com)

ABSTRACT

The study investigated possible yield increase due to venting styles of mushroom substrate bags and effect of contamination on mushroom production. Four venting styles at the fruiting stage (venting one, two, four, and six sides) were used as treatments with eight replications. Data were collected on wet weight of fruit, number of branches formed, number of fruiting, dry weight of fruit, moisture content of mushroom and contaminants. The results showed that number of flushes (periodic fruiting) had effect on wet and dry weight, number of fruiting, branches and moisture content of *Pleurotus floridanus*. Wet, dry weights and moisture content decreased with later flushes and were significantly ($P < 0.05$) different. However, the number of fruiting and number of branches did not significantly differ with flushes. Venting one side, two sides, four sides, and six sides led to mushroom wet weights of 58.21g, 57.67g, 70.25g, and 77.92g respectively. Yield increased with increasing number of vents. Moisture content for venting one side, two sides, four sides, and six sides were 51.63, 52.67, 65.17 and 71.46 respectively. It was observed that moisture content increased as number of vents increased, with venting 6 sides having the highest moisture content (71.46) and venting one side having the least moisture content (51.63). Venting four sides (2.58) had the highest number of branches. *Aspergillus flavus* and yeast (*Candida* spp.) were commonly isolated from the infected substrate only in six side venting. In conclusion, venting four sides could be recommended for improved branches and yield of *Pleurotus floridanus*.

Keywords: Venting style, yield, mushroom production, *Pleurotus floridanus*

INTRODUCTION

Mushrooms are widespread in nature and they remain the earliest form of fungi known to mankind. In Nigeria, so many people in both the urban and rural areas are conversant with mushroom growing around them. Mushrooms do not contain chlorophyll and therefore depend on other plants material (the substrate) for their food. Commonly cultured mushrooms are saprophytic organism that feed on dead plant materials. Some species of

mushroom can grow on a wide range of materials while others cannot. Mushrooms are products of biological origin and can be developed from biological and industrial wastes (Akinyele *et al.*, 2011). After the mycelium has grown throughout the substrate and when its specific requirements are met, the mushroom will fruit (Stamets, 2005). Traditionally mushrooms are used for nutritional, medicinal, and mythological benefits in Nigeria (Alabi, 1991; Akpaja *et al.*,

2005; Osemwegie *et al.*, 2006).

Multiplication of mushrooms in bags is limited by different factors such as temperature, aeration, relative humidity. High temperature in growing environment can reduce mushroom development in different ways, allowing the development of competitive micro-organism better adapted to high temperature (Rolim *et al.*, 2014). There are several pathogens that are of concern in mushroom production. Such pathogens include species of *Dactylium*, *Diehlomyces*, *Fusarium*, *Mycogone*, *Trichoderma*, *Verticillium* etc (Sang-Woo *et al.*, 2013). These pathogens get through by vectors of contamination such as: air, casing, insects, ventilation ducts, wind blow etc. Gaseous environment control in aerobic solid-state fermentation is an important factor in the development of pathogens and this depends on the flow of oxygen through the substrate and the speed of oxygen consumption by microorganism. Mushrooms require oxygen for their survival and development (fruiting). During fruiting stage, reduction of carbon-dioxide is required with an increase in oxygen. This is possible by opening mushroom substrate (ramified) bag in order to allow air exchange through ventilation within the bags thereby increasing the relative humidity (Oei and Nieuwenhuijzen, 2005). This encourages the growth of pathogenic organisms hence reducing the number of fruiting bodies or quality of fruits harvested (Oei and Nieuwenhuijzen, 2005). Sometimes, most cultivated mushroom in bags is opened on one side and this could reduce the rate of fruiting. Therefore, introducing different venting styles at the onset of fruiting may encourage the rate of fruiting and lower the relative humidity within the bags by increasing air circulation. However a balance needs to be maintained to avoid much exposure to contamination resulting from

different venting.

MATERIALS AND METHODS

Study Area and Source of Samples

The study was carried out at the Faculty of Agriculture Demonstration farm (mushroom unit), University of Port Harcourt, Choba, Rivers State (4.9018°N, 6.9205°E). The Oyster mushroom *Pleurotus floridanus* spawn used for the production was prepared at the mushroom farm of the University. The Sawdust was gathered from a sawmill industry at Rumuosi, Obio/Akpor LGA in Rivers State, Nigeria. Wheat bran and Calcium Carbonate (CaCO₃) were obtained from Agro-Allied Services in Port Harcourt, Rivers State, Nigeria.

Substrate preparation

Substrate preparation as described by Stamets, (2003) with modifications, (40 kg sawdust, 3 kg wheat bran, 200 g CaCO₃ and 30 litres of H₂O). One kilogram of mixed substrate were packed in a 21 X 36cm polyethylene bags and labeled for easy identification. The Design for the experiment was a Completely Randomized Design (CRD) with eight replicates, with venting one side, venting two sides, venting four sides, and venting six sides of the fully ramified substrate bags as treatments. Sterilization was done using a fabricated metal cylindrical container (drum) of 200 L at constant heat for four hours, to kill unwanted microbes or contaminants associated with the substrates. The sterile bags were inoculated with 10 g of *Pleurotus floridanus* spawn in aseptic condition in the inoculation chamber. Incubation took place inside the incubation room for one month at the temperature of 28±2°C. Fully mycelia-colonized bags were transferred into the fruiting room. The different venting treatments were made on the substrate bags in

other to aerate the bags and increase humidity for fruiting. These were arranged randomly in the fruiting room with maintained regular sprinkling of water until primordial emergence. Fruiting bodies were harvested by hand twisting, weighed immediately with electronic digital balance and oven dried separately at 60°C for 15 hours. The loss in weight after drying was regarded as the moisture content (Manzi et al., 1999). Infected mushroom substrates were taken to the laboratory for isolation and identification of the causal agent using standard procedures.

RESULTS

Mushroom grew and the different treatments were harvested appropriately. Yield however differed from one treatment to another.

Fruiting bodies yielded well on venting six sides, venting four sides, as well as venting one side which is often used (Table 1). Flushes had an effect on yield. Yield decrease with increasing number of flushes (Table 2). Venting six sides yielded more for wet weight followed by venting four sides and was significantly different. Venting one side gave the highest number of fruit. Number of branches was highest for venting four sides. For moisture content, venting six sides gave the highest moisture content, while venting one side gave the lowest. Moisture content increased with increasing number of vents. On acidified Potato Dextrose Agar (PDA) incubated at $28\pm 2^\circ\text{C}$, *Aspergillus flavus* and yeast (*Candida* spp.) were commonly implicated as the causal agents of the infection (Table 3).

Table 1: Effect of venting on wet weight, dry weight, number of fruiting, number of branches and moisture content of *Pleurotus floridanus*

Venting	Wet weight	Dry weight	Number of fruit	Number of branches	Moisture content
One side	58.21 ^b	6.58	11.33 ^a	2.29	51.63 ^b
Two sides	57.67 ^b	5.00	7.50 ^b	2.04	52.67 ^b
Four sides	70.25 ^{ab}	5.08	8.54 ^{ab}	2.58	65.17 ^{ab}
Six sides	77.92 ^a	6.46	9.88 ^{ab}	2.29	71.46 ^a

Mean values followed by different letters on the same column are significantly different ($P < 0.05$).

Table 2: Effect of flushes on wet weight, dry weight, number of fruiting, number of branches and moisture content of *Pleurotus floridanus*

Flushes	Wet weight	Dry weight	Number of fruit	Number of branches	Moisture content
1	104.84 ^a	8.09 ^a	10.16	2.16	96.75 ^a
2	62.84 ^b	5.69 ^b	9.22	2.34	57.16 ^b
3	30.34 ^c	3.56 ^c	8.56	2.41	26.78 ^c

Mean values followed by different letters on the same column are significantly different ($P < 0.05$).

Table 3: Pathogens isolated from mushroom substrates after the second flush harvest

Venting	<i>A. Flavus</i>	Yeast
One side	-	-
Two sides	-	-
Four sides	-	-
Six sides	+	+

+ present; - absent

DISCUSSION

Wet and dry weight decreased with increasing number of flushes. This result is supported by Ha *et al.*, (2015) who reported that the highest mushroom yield was obtained from the first flush and followed by the second flush and the trend gradually decreased at next flushes. Other researchers also supported this claim. According to Gaitan-Hernandez and Mata (2004), the first flushes of oyster mushroom production accounted for about 64% of total harvest, with 36% contributing towards the remaining three flushes. Choi (2003) also emphasized that the reason for the first flushes yielding higher in weight is because the spawn decreased with successive flushes. This is due to the release of the nutrient pattern: most of the nutrients are released in the first crop and thus, optimize yields, and this should be well managed. The higher the venting on the substrate bag, the higher the yield. This agrees with the observation of Seung *et al.*, (2004) who stated that mushrooms grow well at high humidity but are stunted under high carbon dioxide (CO₂) concentration. (Anonymous, 2018a) confirms that many vents should be created during fruiting. However, absence of adequate vents will increase the concentration of CO₂ which will lead to long stipe and small pileus. Since Oxygen is in high demand during the fruiting period of mushroom, the air permeability of the venting created on the bags greatly affects development of the mushroom (Lee *et al.*, 2007). Limited ventilation due to little venting

or clogged holes can result to poor growth and decreased mushroom production (Lee *et al.*, 2012). The venting of the bag allowed mushroom cultures good ventilation, though this exposed the mushroom substrates to contamination especially in six side venting. Manikandan *et al.*, (2012) isolated *Aspergillus* spp, *Penicillium* spp and *Rhizopus* spp from spent mushroom substrates. Sang-woo *et al.*, (2013) reported that strains of *Trichoderma*, *Phomopsis*, *Mucor* and *Cladosporium* cause severe damage to the commercial production of oyster mushroom. Under favourable environment, mushroom substrates could be contaminated by these pathogens, thus making the product unfit for human consumption and affecting yield.

Alexander (2017) had shown that excessively high level of temperature, high humidity, lack of fresh air and a high level of CO₂ causes growth abnormalities in mushroom production. He further added that very dry air, strong air movement with low relative humidity cause growth abnormalities in mushroom development. Anonymous (2018b) showed that well ventilation of mushroom bag is very important to good colonization as mycelial needs oxygen to breathe. Therefore, venting is recommended for free air exchange and at the same time helps filter out possible contaminants. The higher the venting on the substrate bags, the higher the moisture content. This confirms the observation of Bellettini *et*

al., (2016) that low moisture content results in the death of fruiting body. Water is one of the main factors that influence the success in mushroom growth as confirmed by Hyung-jong et al., (2004) who indicated mushrooms are 90% water. Oei and Nieuwenhuijzen (2005) confirmed that a frequent moisture flow is the source in which nutrients are transported from the mycelium to the fruiting body. However, Urben (2004) showed that high moisture content in the bag leads to difficulty breathing and this cause low development of fruiting even with high amounts of vents in the bag, leading to contamination. The normal moisture content for development and substrate utilization depends on the organism and the substrates for cultivation.

CONCLUSION

This study revealed that number of flushes of *Pleurotus floridanus* affected wet and dry weight significantly. Wet and dry weight decreased with increasing number of flushes. A significant relationship between venting and yield was observed. Venting of mushroom bags had an effect on incidence of contamination in mushroom cultivation, as too much venting could increase the level of contamination. A significant relationship between venting and moisture content was observed. The cultivation of *Pleurotus floridanus* using more than one venting sides is better to increase yield. Venting of substrate bags should be adopted. This is because the more the venting, the higher the aeration and consequently, the yield.

REFERENCES

- Akinyele B. J., Olaniyi O. O. & Arotupin D. J 2011. Bioconversion of selected agricultural wastes and associated enzymes by *volvariella volvacea*, an edible mushroom. *Research Journal of Microbiology* 6,63-70.
- Akpaja, E. O., Okhuoya, J. A. & Eliwer Heferere, B. A. 2005. Ethnomycology and indigenous uses of mushrooms among the Benin-speaking people of Nigeria. *International Journal of Medical Mushroom*, 7 (3), 373-374.
- Alexander, T. (2017). Growth abnormalities of *Agaricus*. Online: <http://en.agaricus.ru/cultivation/diseases/growth-abnormalities> [Accessed October 29, 2019]
- Alabi, R. O. 1991. Mycology and Nigeria culture: past, present and future. Proceedings of 1st conference on African mycology; Mauritius, June 10-15, 1990 P. 43-52.
- Anonymous 2018a. Cultivation of Oyster mushroom. Online: http://agridaksh.lasri.res.in/html-file/mushroom/15_mush_oyster_culi.html [Accessed November 20, 2019].
- Anonymous 2018b. Identifying contaminations. Online: <https://mushplanet.com/basic-cultivation/identifying-contaminations/> [Accessed October 29, 2019]
- Bellettini M.B., Fiorda, F.A. Maieves, H.A., Teixeira, G. L., Avila, S., Hornung, P. S., Junior, A. M. and Ribani, R. H. 2016. Factors affecting mushroom *pleurotus* species. *Saudi Journal of Biological Sciences*, 26 (4), 633-646.
- Choi, K.W 2003. Oyster cultivation. Shelf or bag? Internet: http://www.mushworld.com/tech/view.asp?cata_id=1110&vid=555 [Accessed November 20, 2019]
- Gaitan-Hernandez R. and Mata G. 2004. Cultivation of edible mushroom, *Lentinula edodes* (shiitake) in pasteurized wheat straw. Alternative use of geothermal energy in Mexico. *Engineering in Life Sciences*, 4, 363-367

- Ha Thi Hoa, Chun-Li Wang & Chong-Ho Wang 2015. The effects of different substrates on the growth yield and nutritional composition of two oyster mushrooms (*Pleurotus ostreatus* and *Pleurotus cystidiosus*) *Mycobiology* 43(4), 423. DOI: 10.5941/MYCO.2015.43.4.423
- Seung Woo Kang, Hyunjong kwon, Byung Sik Kim 2004. Illustrated guide to oyster mushroom cultivation. Online: <https://www.scribd.com/document/225929681/Mushroom-Growers-Handbook-1-Mushworld-Com-Chapter-3-1-2>. [Accessed October 29, 2019].
- Lee HU, Ahn MJ, Lee SW, Lee CH. 2007. Effects of various ventilation systems on the carbondioxide concentration and fruiting body formation of king oyster mushroom (*pleurotus eryngii*) grown in culture bottles. *Journal of Life Science*, 17: 82-90
- Lee, Hwa-Yong, Eun-Ju Ham, Young-Jin Yoo, Eui-Sung Kim, Kyu-Kwang Shim, Myung-Kon Kim, and Chang-Duck Koo. 2012. Effects of aeration of sawdust cultivation bags on Hyphal growth of *Lentinula edodes*. *Mycobiology* 40 (3), 164-167 Doi: 10.5941/MYCO.2012.40.3.164.
- Manikandan, N., Kuzhali, S.S., Kumuthakalavalli, R. 2012. Decolorisation of textile dye effluent using fungal microflora isolated from spent mushroom substrate (SMS). *Journal of Microbiology and Biotechnology Research*, 2(1), 57-62.
- Manzi, P., Gambelli L., Marconi S., Vivanti V. & Pizzoferrato, L. 1999. Nutrients in edible mushrooms: An interspecies comparative study. *Food Chemistry*, 65, 477-482.
- Oei, P. and Nieuwenhuijzen B. V 2005. Small scale mushroom cultivation: Oyster shiitake and wood ear mushrooms. Agromisa foundation and CTA, Wageningen, The Netherlands 89pp.
- Osemwegie, O. O., Eriyamremu, E. G & Abdulmalik, J. 2006. A survey of macrofungi in Edo/Delta region of Nigeria. Their morphology and uses. *Global Journal of Pure and Applied Sciences*, 12 (2), 149-157.
- Rolim, L.N., Sales-Campos C., Cavalcanti, Queiroz, M. A. and Urben, A.F. 2014. Application of Chinese Jun-Cao technique for the production of Brazilian Ganoderma lucidum strains. *Brazilian Archives of Biology and Technology*, 57 (3), 367-373.
- Sang-Woo Kim, Sinil Kim, Hyun-Jun Lee, Ju-Wan Park, and Hyeon-Su RO 2013. Isolation of fungal pathogens to an edible mushroom, *pleurotus eryngii*, and Development of specific ITS primers. *Mycobiology* 41(4),252-5. DOI: 10.5941/MYCO.2013.41.4.252
- Stamets, P. 2005. Mycelium Running: How mushroom can help save the world Ten Speed Press. California, 343pp.