EVALUATION OF GROWTH AND PERFORMANCE OF OYSTER MUSHROOM (*Pleurotus ostreatus*) ON DIFFERENT SUBRATES IN ANYIGBA, KOGI STATE

By

*Alfa, J.I., Sale, F.A., Agbaji, F., Musa V.H. and Umar, H.O.

Department of Forestry, Faculty of Agriculture, Kogi State University, P.M.B 1008,

Department of Crop Production, Faculty of Agriculture, Kogi State University, Anyigba

Anyigba, Kogi State, Nigeria

Correspondent Email: jerryalfa2015@gmail.com

The effect of substrate (medium) on growth, yield and nutritional composition of domestically grown oyster mushroom (Pleurotus ostreatus) was investigated. Five different substrates namely sawdust +rice bran (SDR), sawdust +banana leave (SDBL), wood shave + rice bran (WSR), sawdust + cassava peel (SDCP), oil palm fruit mesocarp + sawdust (SDOF) were used to evaluate their productivity and effects on mushroom quality and quantity of pleurotus ostreatus at Kogi state university, Anyingba, Nigeria. The substrates were pasteurized with hot water (90°C for 10 h) before spawns of oyster mushroom was inoculated to them. After inoculation, the substrate was kept in a controlled environment until fruiting took place. The principal objective of the study was to come up with the best substrate with highest productivity and mushroom quality recommendable for use by oyster mushroom growers. The experiment was laid in a randomize complete block design (RCBD), with each treatment replicated 4 times. Harvesting was done by hand and the harvest from each bag was weighed separately on each day of harvesting. Only 2 were considered, as the most productive ones. Substrate productivity was evaluated by determining the mean number of mushroom (MNM) and mean mushroom weight (MMW), while the quality was evaluated based on cap diameter groups. There were significant differences in MNM ($p<0.001$), MMW ($p<0.001$) and CD ($P<0.001$) among the substrates. The SDCP substrate gave the highest number (20) of fruiting body, highest yield (46.75 g/kg) and this was followed closely by the harvest from SDR substrate. This study has shown that some agricultural waste namely sawdust, wood shave, oil palm fruit mesocarp, cassava peel, banana leaves and rice bran can be used effectively for cultivation of Oyster mushroom and the nutritional value of the domestically grown Oyster mushroom were greatly affected by the substrate media

Keywords: Pleurotus ostreatus, sawdust, Ricebran, Wood shave, Cassava peel

INTRODUCTION

Widespread malnutrition with ever-increasing protein gap in the third world including Nigeria has necessitated the search for alternative protein. Mushroom is among the favoured alternatives. Mushrooms belong to the kingdom of fungi, a group, very distinct from plants, animals and bacteria. Chang (1991) defined mushroom as a macrofungus with a distinctive fruiting body, which can either be epigeous (growing on or close to the ground) or hypogenous (growing under the ground). Most mushroom species are either under the phylum *Basidiomycota* or the phylum *Ascomycota*, and both phyla belong to the kingdom Fungi (Cho, 2004). Generally, mushroom has a stem (stipe), a cap (pileus), and gills (lamellae) on the underside of the cap. According to Boa (2004), "mushroom" can also refer to a wide variety of gilled fungi, with or without stems, and the term is used even more generally to describe both the fleshy fruiting bodies of some Ascomycota and the woody or leathery fruiting bodies of some Basidiomycota, depending upon the context of the word. Unlike green plants, mushrooms are heterotrophs. They lack the ability to use energy from the sun directly through chlorophyll, because they do not have chlorophyll which is the most important features of plants. Thus, they cannot generate nutrients by photosynthesis but depend on other organisms for food; absorbing food from the organic materials in which they live (Oei, 2005; Ha *et al*., 2015). Hence, mushrooms exist as saprophytes on trees, and this is why forests are often generous to mushroom hunters.

Mushrooms breed by spores. Under the proper conditions, spores germinate into hyphae (collectively, mycelia). Mycelia are filamentous and generally unseen with the naked eye. Germinated hyphae form primary mycelia, and then secondary mycelia through plasmogamy (hyphal fusion). They accumulate nutrients from the substrate upon which they grow and colonies the substrate. When stimulated by temperature, humidity etc. the mycelia colony forms pins under certain conditions that grow into fruit bodies. Young fruit bodies are called pins. Pins differentiate into a pileus (cap) and stipe (stem) forming fruit bodies. Under the cap, spores are produced in the gills. Fruit bodies release the spores in order to produce the next generation (*Oei, 2003*). The life cycle of mushroom is divided into two phases: vegetative and reproductive growth. Vegetative growth indicates linear growth of fungal mycelium breaking down complex substrate components into simpler molecules and absorbing them as nutrients. When temperature is low, humidity high, oxygen tension high and light intensity high, the mycelia cease vegetative growth and begin to produce fruit bodies, which are called mushroom. This is the reproductive growth phase. Mushroom cultivation can be said to be the practice of obtaining fruit bodies artificially by repeating these growing stages (Cho, 2004).

According to Oei *(2003),* there is evidence of the use of mushrooms 13,000 years ago in Chile, although China has the first reliable evidence of wild fungi consumption, several hundred years BC (Aaronson 2000). The Chinese value mushrooms for medicinal properties as well as for food. Apart from the medicinal use, some mushrooms are useful in dyeing wool and other natural fibers as well as in the development of effective biological remediation and filtration technologies. Several mushrooms are especially tasty and many are rich in nutrients. Many species are high in fiber and provide vitamins such as thiamine, riboflavin, niacin, biotin, cobalamin and ascorbic acid. Chang (1991) confirmed that mushrooms are also a source of some minerals, including iron, selenium, potassium and phosphorus. However, mushroom should be harvested from hardwood only, as those growing on soft wood are poisonous (SOMA, 2017; Zhao, 2009). There are, of course, real dangers in collecting and consuming poisonous fungi, but these according to Boa (2004) should be seen against the wider background of millions of people collecting and eating wild fungi safely on a regular basis. He also stated that knowing the scientific name of a fungus provides a good indication of its edibility. The solutions to these potential risks include providing local advice on which species to collect and which ones to avoid and publicity campaigns that highlight potentially poisonous species on posters.

Although mushrooms have high nutritional, economic and medicinal value, its availability is the challenge faced by the society. It is mostly available during the rainy season and after the rainy season, it becomes a scares commodity. Therefore there is a need to discover the most suitable and appropriate substrate for maximum yield and growth all year round. Furthermore, the oyster mushroom (*Pleurotus ostreatus*) is a primary decomposer of wood that grows on a wider array of forest, industrial and agricultural wastes than species from any other group (Jadhau and Bagal, 1998). There is also need for research on the productivity of alternative substrates that can be used and be easily accessible to oyster mushroom farmers in the country. It is in this context that this research was designed to determine the growth and performance of oyster mushroom (*Pleurotus o.*) on different substrates.

MATERIALS AND METHODS

Experimental Site

The experiment was carried out in the Crop Production Department Laboratory, Faculty of Agriculture in Kogi State University, Anyigba which lies on latitude $7^0$15’ and $7^0$29’ of the equator and latitude $7^0$11 and $7^0$32 of the greenish meridian (Ifayimehin *et al*; 2009).

Experimental Materials

Pleurotus ostreatus commonly known as Oyster mushroom was select for this study because it is particularly common in the north central of Nigeria, where the mushrooms are commonly used in soup preparation (Akpaja *et al.,* 2011). The mushroom spores used for this study were obtained from a local Mushroom farmer in Lagos, Lagos state. Wood shave and Saw dust were obtained from Anyigba timber shade, Rice brawn was obtained from Ibaji rice milling site in Ibaji, Banana leaves and Cassava peel were obtained from Egume, Kogi state and oil palm fruit mesocarp was obtained from the Kogi State University Research Farm Anyigba

Preparation of Substrate

The Rice brawn, Oil palm fruit mesocarp and Banana leaves were air-dried. They were separately ground into powdered form, thoroughly mixed and soaked in clean and sterile water for 24 hours. After removing excess water from the substrates, they were fermented for 3 days by covering them with polythene sheets before bagging. After fermentation each substrate was filled into heat resistant plastic bag (100 gauze thickness), measuring 15 cm, and compressed to make bag logs weighing 1.0 kg (Plate 1). The openings of the bags were closed with a plastic ring and cotton wool plug. The substrates were pasteurized by partly immersing them in hot water (90°C for 10hour). After heat treatment, the bags were cooled to 30°C before inoculating with the spawn of oyster mushroom *(Pleurotus ostreatus*) at the rate of 20 g per 1.0 kg bag of substrate. The substrates (now bagged and inoculated) were incubated in a darkroom for 3 to 4 weeks on a shelf. During this period, daily temperatures of the incubation room were taken twice daily. The bags were fully colonized of the mushroom mycelia within 17 to 30 days. Next, the bags was moved to another room for fructification. The two ends of the bags were cut open with a blade and placed side by side on the shelf provided for this purpose. The humidity of the bags during the cropping (fructification) stage was accomplished by spraying of water in the form of fine mist from a nozzle three times a day.

Temperature and humidity of the cropping room was also monitored two times a day. Exhaust fans was used for exhaust of gases for cropping room to ensure adequate oxygen supply to the spawns. The first primordial (pinheads) appeared 17 to 28 days after opening the bags depending on the substrate. Matured mushroom was harvested by twisting gently to uproot from the base. The mushrooms generally mature in 7 to 10 days after the appearance of the pinheads.

TABLE 1: Substrates formation for the cultivation of oyster mushroom

Substrate Code	Substrate Composition
WSR	Wood shave (60%) + Rice bran (40%)
SDR	Sawdust (50%) + Rice bran (50%)
SDOPF	Sawdust (75%) + Oil palm mesocarp (25%)
SDCP	Sawdust (85%0 + Cassava peel (15%)
BLSD	Banana leave (50%) + sawdust (50%) SDCP

Analysis of Growth Rate of Oyster Mushroom

The yield of oyster mushroom was determined by recording the number and size of cap of the fruit bodies after sprouting. The following parameters of growth and yield were measured;

Mycelium running time: This is the number of days it took the mycelium to fully colonize the substrate bags.

Number of fruit bodies: This was done by directly counting the number of fruit bodies on each bag/ substrate.

Cap diameter: This was achieved by measuring the broadness of the cap after harvesting. This was carried out in the morning hours using a measuring ruler.

Cropping time: This is the time from the completion of mycelium running to the time when the pinheads were fully blossomed and ready for harvesting. It was measured in days.

Yield of mushroom: This is the quantity (weight) of mushroom produced per bag of substrate per harvest time. It was weighed using weighing balance. The crop of oyster mushroom was harvested in four flushes.

Biological efficiency: The biological yield (g/kg) was determined by weighing the whole cluster of the fruiting body divided by the initial weight of the substrate. The biological efficiency was calculated.

Statistical analysis: Data obtained will be subjected to statistical analysis using ANOVA on SASS (9.2) analytical tool on windows 2007. Means will be separate using the least significant difference (LSD) at a 95% confidence level.

4.0 RESULTS

4.1 Effect of substrate media on growth of Oyster mushroom

The substrates media were found to influence duration of mycelium running, pin head formation, number of fruit bodies produced, the cropping time, the pileus diameter (size of cap) and the biological efficiency of oyster mushroom (Tables 1 and 2). The mycelium growth took 3 to 4 weeks after inoculation (Table 2). On the sixteenth day of inoculation, whitish mycelia colonized all the substrates. The SDCP and SDR substrates took extra 5 and 7 days respectively before mycelium fully colonized their bags but the mushrooms obtained from these two substrates were larger in size. The broadest size of cap (5.53 cm) was obtained on SDCP and SDR substrates, while the lowest cap size of (2.40 cm) was obtained from WSR follow by OFSD (3.73CM). According to Daniel (1985) large mushroom are produce with longer spawn runs. SDCP substrate showed excellent mycelia growth as the bags was fully colonized in 13 days.

Plate 3: Mycelium Running and Pin Head Formation

4.2 Effect of substrate media on yield of oyster mushroom

The effect of substrate type on yield of Oyster mushroom is shown in the Table below. Generally the substrates had varying ($p<0.05$) effects on the yield of oyster mushroom. The maximum yield (46.75 g/kg) was obtained from SDCP substrate followed closely by SDR substrate (45.75 g/kg), while lowest (15.25 g/kg) yield was obtained from WSR substrate.

Mean estimate of different substrates on the Weight, Number and Cap diameter of Oyster mushroom

Treatment	Weight (g/kg)	Number	Cap diameter (cm)
SD + R	45.75a	19.75a	5.53a
WS +R	15.25c	8.25d	2.40d
BL + SD	31.25b	15.75b	4.47b
OF + SD	31.25b	15.75b	4.47b
SD + CP	46.75a	20.25a	5.57a
LOS	**	**	**
LSD	1.33	1.11	0.07

Mean with the same letter are not significantly different.

SD+R=sawdust +rice bran; WS+R=wood shave + rice bran; BL+SD=banana leaf + sawdust; OF+ SD=palm fruit mesocarp; SD+CP=sawdust +cassava peel; LOS=level of significant; LSD=least significant different

** =highly significant

The presence of the right proportion of alpha-cellulose, hemi-cellulose, pectin, lignin as well as suitable carbon to nitrogen ratio might be responsible for the higher rate of mycelium running in SDCP and SDR. This agrees with the work of Ahmed *et al*. (2009) who reported that, mycelia growth rate was greatly facilitated as aresult of abundance of alpha-cellulose and pectin present in mushroom growth media. The ability of mushroom to grow on lingo-cellulosic substrate is related to the vigor of its mycelium (Ashrafuzzaman et al., 2009).

The pinhead (the second stage of mycelia growth during cultivation of mushroom) was observed 6 to 13 days after the bags were opened. By the 6 to 9 days of opening the bags, SDBL, WSR and SDOF substrates had formation of primordial (pinheads) on them. Sawdust substrate and rice bran (SDR) brought forth primordial on the 13th day and SDCP substrates brought forth primordial on the 12th and 31th days respectively. These results agree with Oei (2003) and Chinda and Chinda (2007) who observed that oyster mushroom normally complete spawn running in 14 to 28 days depending on the substrates.

Oyster mushroom yield was highest in the Saw Dust + Cassava Peel substrate while the lowest yield was obtained from the Wood Shave+ Rice Bran substrate. The differences in yield from these two substrates is because of the differences in chemical and material compositions of these two substrates. Generally, the substrates had varying effects on the yield of oyster mushroom. This finding is in consonance with the report of Narayanasamy *et al.* (2009) who reported that different substrates used in culturing mushroom gave varying mushroom yields because of the biological and chemical differences in the substrates. Similarly, Rizki and Tamai, (2011) found that, suitable nitrogen ratio helps to produce optimum mushroom yield as nitrogen is required for vegetative growth of most plants and mushrooms. Oei (2003) in his work supplemented sawdust with rice bran (5-10%) to enrich his medium for optimum mushroom yield. Rice bran has shown to be a promising supplement to mushroom substrates as it contains high amount of nitrogen compared to most other lignified substrate material such as wood shave. This research finding corroborates this finding as sawdust supplemented with rice bran gave the best mushroom growth and weight. Mushroom samples harvested from SDCP showed the best biological efficiency (46.31%), followed by those from SDR (39.55%), while lowest biological efficiency (20.00%) was observed in WSR.

CONCLUSION

This study has shown that some agricultural waste namely sawdust, wood shave, oil palm fruit mesocarp, cassava peel, banana leaves and rice bran can be used effectively for cultivation of Oyster mushroom and that the nutritional value of the domestically grown Oyster mushroom were greatly affected by the substrate media. The implication of these findings is that substrates could be tailored to achieve desired mushroom yield and nutrient profile. Despite the differences in chemical composition of the mushrooms, the overall result indicated that fruit bodies of domestically cultivated mushroom had nutrient qualities similar to other exotic mushrooms. It is worthy of note also that the domestically cultivated mushrooms had higher mean weight than those that grow in the natural environment (bush and forest). This study has proven that commercial cultivation of mushrooms is feasible given the abundance of agricultural waste in Nigeria. Mushroom cultivation will create job opportunities in Nigeria and equally create avenue of utilizing agricultural waste materials.

REFERENCES

Ahmed S. (1998). Development of mushroom varieties suitable for rural level in Bangladesh Report presented in BARC Annual Review Programme. 72-73.

Ashraf J, Md Ali A, Ahmad W, MdAyyub C, Shafi J.(2013). Effect of different substrate supplements on oyster mushroom (Pleurotus spp.) production. Food Science and Technology. 1(3):44-51.

Ahmed SA, Kadam, JA, Mane, VP, Baig MM (2009). Biological efficiency and Nutritional contents of Pleurotusflorida cultivated on differentagro Wastes. Nat. Sci. 7(1):45-48.

Bano Z, Rajarathanam S. (1982). Studies on the cultivation of Pleurotussajor-caju, The Mushroom Journal. 115:243-245.

Bhatti MA, Mir FA, Siddiq M. (1987). Effect of different bedding materials on relative yield of oyster mushroom in the successive flushes. Pakistan J. Agri. Res. 8(3):256259.

Biswas KM, Biswas BS. (2015). Recycling of ligno-cellulosic waste materials through oyster mushroom cultivation for sustainable food production. International Quarterly Journal of Environmental Sciences.9 (3-4):655659.

Chang ST (1993). "Mushroom biology: the impact on mushroom production and mushroom products". In Chui S-W, Buswell J, Cang S-T (eds). Mushroom Biology and Mushroom Products. Hong Kong: Chinese University Press. Pp.3-20. ISBN 962-201-610-3

Chang ST, Miles P.G. 2004.mushroom cultivation, nutritional value, medicinal effect and environmental impact, 2nd Ed. Chemical Rubber Company Press. USA,Pp 35-45

Chang ST, Miles P.G. (1991). Recent trends in world production of cultivated mushroom. The Mushroom Journal. 503:15-18.

Chinda, MM, Chinda F (2007). Mushroom cultivation for health and wealth. Para, Lagos. Pp. 12-50.

EU onyeka, E Udeogu, C Umelo, MA Okehie .2018. African journal of Pant Science 12(7) 141-147

Elamastas M, Isildak O, Turkekul I, Temur N. 2007. Determination of antioxidant activity and antioxidant compounds in wild edible mushrooms. Journal of food composition. And Analysis. 20:337-345.

Fan L, Pandey A, Mohan R, Soccol CR. 2000. Use of various coffee industry residue for the cultivation of Pleurotusostreatus in solid-state fermentation. Acta Biotechnology, 20(1):41-52.

Food and agriculture organization (FAO) (2015). OECD-FAO Agricultural outlook 2015-2020 OECD.

Haque, A. B. M. A. 2004. Use of different substrates and methods on the mycelial growth, spawn. Journal of mushroom science Vol (5), Pp 122-128

Hong Kong. Gupta, R. S. 1986. Mushroom Cultivation. *Indian Hort*., 31(1): 11. Pp 135-156.

Jiskani MM. 1999. A brief outline "The Fungi" (cultivation of mushrooms). Izhar Pub, Tandojam, 94(56):220-235

IHAND project, GOB/UNDP/ FAO,Survase DM.2012. Bioconversion of agro waste into edible protein rich mushroom by P.sajor-caju (Fr.) singer. Trends in biotechnological research 50(6):334-338

Khan WW, Ali AM, Khan NA, Khan MA, Rehman A, Javed N. 1981. Effect of different level of lime and PH on mycelia growth and production efficiency of oyster mushroom (Pleurotus Spp.). Pakistan Journal of Botany. 45(1):297-302.

Khanna PK, Garcha HS. 1981. Nutritive value of mushroom Pleurotusflorida. Mushroom science. XI: 561-572 14.

Kuforiji O and Fasidi I.O (2008). Compositional studies and pleurotus tuber-regiumsclerotia. Advances in Food Sciences 30(1): 2-5

Kuforiji O.O and Fasidi I.O (2007). Factor affecting the yield of fruit body and sclerotia in pleurotus tuber-regium. Advances in Food Science. 29(4): 211-215

Lavi I, Levison D, Peri I, Hadar Y, Schwartz B. 2010. Orally administered glucan from edible mushroom (P. pulmonarius) reduce acute inflammation in dextran sulfatesodium induced experimental colitis. British Journal of Nutrition.Vol(6) Pp103-104

Lalithadevy V, Many JN. Yield performance of fruits and vegetables peel as substrates for cultivation of oyster. Journal of Pharmacognosy and Phytochemistry mushroom (Pleurotusflorida). Journal of Innovative Research and Solution. 2014; 1(1):220-226

Maniruzzaman, M. 2004. Influence of media composition and growth regulators on mycelial growth Journal of Biological Science 26(4), 433-447

Manpreet K, Giridhar S, Khanna PK. 2010. In vitro and in vivo antioxidant potentials of Pleurotusflorida in experimental animals. Mushroom Res.x 13:21-26.

Manzi P, Aguzzi A, Pizzoferrato L.2001; Nutritional value of mushrooms widely consumed in Italy. Food Chemistry. 73:321-325

Mshandete AM.2011. Cultivation of Pleurotus HK-37 and Pleurotussapidus (Oyster mushrooms) on cattail weed (Typhadomingensis) substrate in Tanzania. Inter. Journal. Research. Boil. Sci. 1:35-44.

Nayana J, Janardhanan KK.2000. Antioxidant and antitumour activity of Pleurotusflorida. Current. Science; 79:941943.

Narayanasamy, P, Suganthaval, P, Sarabai, P, Divya, D, Kumas, S (2009). Cultivation of mushroom (pleurotusflorida) by using two different agriculture wastes in Laboratory condition. International Journal. Microbiology. 7:2.

Oei P. 2003 Mushroom Cultivation: appropriate Technology for Mushroom Growers. The Netherlands Backhuys Publishing: Leidden.Pp 40-45

Oei .P (2005). Small Scale Cultivation of mushroom. AGRODOK series 40. Digigaf, Netherlands Pp 37-63

Osemwegie O.O, E.G. Eriyaremu and J. Abdulmahik (2006). A survey of macrofungi in Edo/Delta region of Nigeria, their morphology and uses. Global Journal of Pure and Applied Science. 12(2):149-157.

Onyeka, E.U., Udeogu, E., Umelo, C. and Okehie, M. A. July (2008). Yield of mushroom on different substrate. Journal of plant science. vol. 12(7), pp. 141- 147.

Patra AK, Pani BK.1995. Yield response of different species of oyster mushroom (Pleurotus) to paddy straw. Current Agriculture Research; 8:11-14. ISSN 1991-3031

Patil SS, Kadam RM, Shinde SL, Deshmukh SD.2008. Effect of different substrate on productivity and proximate composition of P. florida. International Journal of Plant Science; 3:151-153.

Ragunathan R, Swaminathan K. 2003. Nutritional status of Pleurotus spp. grown on various agro-wastes. Food Chemistry. 80:371-375.

Rashad M, Abdou HM, Mahmuoud AE, Nooman MU. 2009. Nutritional analysis and enzymes activities of Pleurotusostreatus cultivated on Citrus limonium and Carica papaya wastes. Aus. J. Basic App. Sci. 3(4):33523360.

Rizki M, Tamai Y (2011). Effects of different nitrogen rich substrates and their combination to the yield performance of oyster mushroom (Pleurotusostreatus) World Journal. Microbiology. Biotechnology. 27:1695-1702.

Sarhad Journal of Agriculture. 1997,SiddhantYadav S, Singh CS. Spawn and spawning strategies for the cultivation of Pleurotuseous. International Journal of Pharmacy and Chemical Sciences. 2013; 2(3):1494-1500

Shah ZA, Ashraf M, Ishtiaq M. 2004. Comparative study on cultivation and yield performance of oyster mushroom (Pleurotusostreatus) on different substrates (wheat straw, leaves, sawdust). Pakistan Journal of Nutrition. 3(3):158-160.

Shah H, Iqtidar AK, Shagufta J.2002. Nutritional composition and protein quality of Pleurotus mushroom. Siddiqui, A. B. Mushroom Production Technology. 26(4):1445-1450

Sivaprakasam, K. 1980. *Studies on Oyster mushroom* (*Pleurotussajor-caju)* Fr. Ph. D. Thesis, Sivaprakasam, K. 1986. Constituents of substrates in relation to sporophore yield of *Pleurotus*

Song, B. C. 2004. Oyster Mushroom Cultivation. Mushroom Growers' Handbook 1 www.banglajol.info. Progress.Agric. 19(1) :7-12. ISSN 1017-8139

Stamets, P. 1990. A discussion on the cultivation of *Ganodermalucidum*(Curtis: Fr.) Kar. The Tamil Nadu Agril. Coimbatore, India

Sonoma County Mycological Association (SOMA) (2017). Identification of poisonous mmushroom. (http:www.somamushrooms.org). Retrieved: 06/02/17

Tan KK. 1981. Cotton waste is a material for (Pleurotus). Good substrates for cultivation of Pleurotusostreatus the oyster mushroom. Mush. Sci. 11:705-710.

Vijay B, Sohi HS.2012. Cultivation of oyster mushroom Pleurotussajor-caju (Fr) Singer on chemically sterilized wheat straw. Mushroom Journal of Tropics. x (7):6775

Willard, T. 1990. *Reishi mushroom:* Herb of spiritual potency and medical wonder. SylvanPress, Issaquah, W.A. pp.238-249. 4556

Zhao.L.(2009).Mushroompoisoning:http://en.wikipedia.org/wiki/mushroom_poisoning.

Retrieved 11/12/09