Research Article

iMedPub Journals
http://www.imedpub.com/

European Journal of Experimental Biology
ISSN 2248-9215

2017
Vol.7 No.5:31

DOI: 10.21767/2248-9215.100031

Agricultural Wastes- Potential Substrates For Mushroom Cultivation

Ritika Kamthan* and Ishita Tiwari

Department of Biotechnology, Jaypee Institute of Information Technology, India

***Corresponding author:** Ritika Kamthan, Department of Biotechnology, Jaypee Institute of Information Technology, Noida, 201307, India, Tel: + 8601101800; E-mail: publication.cytogene@gmail.com

Received date: September 08, 2017; **Accepted date:** October 06, 2017; **Published date**: October 16, 2017

Citation: Kamthan R, Tiwari I (2017) Agricultural Wastes- Potential Substrates For Mushroom Cultivation. Eur Exp Biol. Vol. 7 No. 5:31.

Abstract

Agricultural wastes disposal is of primary concern in today's world as they are rich in nutrient and their disposal without pretreatment can cause leaching in field, which can cause environment pollution. To overcome this problem, mushroom cultivation on these agricultural wastes is the most ecofriendly method to reduce the level of nutrients at acceptable range to be used as manure. Besides overcoming this problem defined combination of agricultural wastes also gives high yield of mushroom in a cost effective manner.

Keywords: Mushroom; Agricultural wastes; Lignocellulosic; Protein; Cultivation

Introduction

Agricultural wastes are rich in various types of nutrients and their disposal is difficult to manage as excess of nutrients in them can cause leaching is left in field, as a compost. Mostly they are disposed by means of incineration which causes pollution [1]. Hence, there is always a high demand of discovering an agricultural waste management method which is cost effective and contribute less in environment pollution. Mushroom cultivation on agricultural wastes fulfills these requirements [2].

Agricultural wastes are rich in lignincellulosic components which are difficult to breakdown, but can effectively be done mushroom cultivation. Mushrooms are fleshly fungi, spore-bearing fruiting bodies which are produced above ground on soil. They often refer to fruiting body of the gill fungi, which do not contain chlorophyll like green plants and as a result cannot manufacture food by their own. They are very nutritious products that can be generated from lignocellulosic waste materials. The bioconversion of agricultural wastes into a value added products is a good mean of their use [3-6]. The property of edible mushroom fungi to convert complex organic compounds into simpler one's is used to transform the useless agricultural waste into valuable product [7]. Various edible mushroom strains are cultivated worldwide. Some of them are given below:

- Button -Agaricus
- Oyster -Pleurotous
- Shiitake -Lentinula Edodes
- Straw -Volvallella volvacea
- Chinese mushroom - Ganoderma

Besides having many nutrional values they are also useful in waste management. The choice of species to cultivate depends on the availability of growth media. Oyster mushroom is the third most cultivated edible mushroom in the world [8].Oyster mushrooms are easiest to grow as they can grow on many substrates but their cultivation has one drawback as some people are allergic to their spores. In these cases, air-cleaning equipment or respirators are necessary in order to safely work in the production facility. Because of the short shelf life this species offer a special advantage to the local grower who markets directly and can continuously deliver a fresh, high-quality product.

Two mycorrhizal mushrooms, morels and truffles are commercially cultivated. Mushroom cultivation offers benefits to market gardens when it is integrated into the existing production system. Mushrooms are rich in various nutrients such as:

- Protein- Protein content of dry weight is between 18% and 37%.
- Fat- Fat is present at low rate, content between 1-8%. The high content of linollic acids is one of the reasons why mushrooms are considered healthy food.
- Vitamins and minerals - Mushrooms are a good source of vitamins such as thiamine (Vitamin B), Riboflavin (vitamin B2) and ascorbic acid (vitamin C), folic acid. They also contain significant amounts of phosphorus, sodium, potassium, calcium, magnesium, iron and Zinc [9,10].

Protein content of mushroom in paddy was significantly higher than in wheat straw while lipid content of mushrooms was higher in wheat straw than paddy straw [11]. Mushrooms have medicinal values as they contain substances which lower the cholesterol level in serum and liver which in turn makes it good for those suffering from heart diseases. Some of them contain substances, which suppress the growth rate of tumors.

Free radicals can damage body cells and induce cancers. Free radicals are the result of specific transformation process. Many bio active compounds protect the body against these radicals. These substances are often called anti oxidants and are present in many mushrooms. In other words, the body immunity is boosted. This will be a relief to those suffering from HIV/AIDS.

History of Using Agricultural Wastes as a Substrate

Agaricus bisporus, was first observed growing in melon crop compost. Firstly, this mushroom was cultivated in open fields and later on moved underground into caves because of the presence of appropriate weather conditions over there.

By 1865, the mushroom cultivation started in United States. In Europe, the first cultivated fungi, the mushroom, was introduced in the 17th century and in Netherland its cultivation began in 19th century. Japan and China were the countries who firstly exploited its medicinal use. 80 years ago, Shittake mushroom (*Lentinula edodes*) was used to grow in China for medicinal purposes as it increases the immune response when given in addition to AIDS drugs.

Agricultural Wastes

Agricultural wastes are the good source for the cultivation of mushrooms. Some of them are most commonly used such as wheat straw, paddy straw, rice straw, rice bran, molasses, coffee straw, banana leaves, tea leaves, cotton straw, saw dust etc.

For the cultivation of Pleurotus rice straw, wheat straw and cotton straw are the substrates that are commonly used while for Agaricus, it is wheat straw which is usually used. A disadvantage of straw is that it should be prepared first, especially if mushrooms are to be grown indoors. Straw is laden with other microbes, and it is necessary to get rid of those tiny competitors, as there will be no scope of mushroom mycelium to grow in there presence.

Rice bran, coffee pulps are the main substrates used for the cultivation of Lentinula edodes. Banana leaves and tea leaves are used for Volvallella and Pleurotus respectively Sturion (1994) proposed using banana leaves for the cultivation of *Pleurotus spp*.

Ganoderma can be cultivated using sawdust [12]. Sawdust itself is often not nutritious enough and needs to be supplemented with a nitrogen source such as bran, urea, sunflower seed and horse manure.

Cultivation of oyster mushroom is of most concern as its spores are allergic to some people, so related preventive measures should be done in working facility. Besides this, oyster mushrooms have a short life span, so they are beneficial to those growers who can sell them fresh in market **(Tables 1-3)**.

Table 1: Various types of agricultural wastes used for mushroom cultivation.

S. No	Agricultural waste	Strains
1.	Rice straw Wheat straw Cotton straw Tea leaves Banana leaves	*Pleurotus sp.*
2.	Wheat straw	*Agaricus bisporus*
3.	Rice bran Coffee pulp	*Lentinula edodes*
4.	Tea leaves	Volvallella
5.	Sawdust	Ganoderma

Correlation of Agricultural Wastes Composition With Mushroom Cultivation

For high yield of mushroom cultivation, it is necessary that the entire nutritional requirement should be fulfilled in optimum concentration as various researches has reported low yield when nutrients in a medium are either in low or high concentration. Banana stalk and Bahia grass are used for the cultivation of Pleurotus sajor-caju with biological efficiency of 74.4% and 74.12% respectively but there is a low yield when they are supplemented with other components. This can be due to high nitrogen concentration which hinders its yield [13].

Growth of Pleurotus ostreaus resulted similar in paddy straw and wheat straw while in sugarcane bagasse it resulted in low yield. Reason behind this selective high yield must be appropriate concentration of lignin, hemicelluloses, cellulose in substrate [14].

Table 2: Composition of various types of substrate [14].

S. No	Substrate	Composition
1.	Wheat straw	1% protein 13% lignin 39% hemicelluloses 40% cellulose
2.	Rice straw	41% cellulose 14% lignin 0.8% total nitrogen 0.25% P_2O_5 0.3% K_2O 6% SiO_2 pH 6.9
3.	Sugarcane bagasse	Cellulose 35-40% Hemicellulose 20-25% Lignin 18-24% Ash 1-4% Waxes <1% Nitrogen 0.7%

There is a Positive correlation of cellulose: lignin with mycelia growth and high yield in Pleurotus ostreatus and carbon:

nitrogen ratio with mushroom yield in Pleurotus eryngii and Agaricus aegerita while in *V. volvacea* strains high yield is related to cellulose content [15].

Combination Of Agricultural Substrates Used For Cultivation

In addition to the use of supplements with agricultural wastes as a substrate, various combination of agricultural wastes are also used for the cultivation and are reported to be optimal substrate.

Vegetable waste when used in combination with paddy straw resulted in high yield of oyster mushroom [16]. To cultivate *P. ostreatus* sawdust in addition to rice husks is reported as an optimal substrate [17]. The quality of *P. eryngii* was significantly affected by substrate ingredients. On barley straw and sugar beet pulp substrate complemented with rice bran, highest mushroom fresh weight and moisture content were achieved [18].

For Pleurotus sajor-caju, combination of soybean straw, wheat straw showed significantly highest yield while soybean straw and saw dust combination showed significantly lesser yield [19].

Table 3: Combination of substrates reported on various strains and their effect.

S. No	Substrate (in combination)	Strain	Effect
1.	Barley straw+wheat bran and wood chips+soybean powder+rice bran treatments	*Pleurotus eryngii*	4.64% protein content
2.	Wheat straw+wheat bran+soybean powder treatment	*Pleurotus eryngii*	13.66% protein content
3.	soybean straw+wheat straw	*Pleurotus sajorcaju*	87.3% Biological efficiency
4.	soybean straw+saw dust	*Pleurotus sajorcaju*	43.8% Biological efficiency
5.	corncob (CC)+sugarcane bagasse	*Pleurotus ostreatus* *Pleurotus cystidiosus*	High content of protein, ash and mineral (Ca, K, Mg, Mn, and Zn)

Supplements Used With Agricultural Wastes

Agricultural wastes are used in addition to various supplements such as gypsum, lime and urea. Gypsum contributes as a calcium source and regulates the acidity level. Water holding capacity of gypsum is high which prevent excess wetting of the substrate. Lime is used to adjust pH. Mushroom cultivation needs appropriate nitrogen content for high yield, which can be fulfill by various components such as urea, bran, sunflower seed, molasses, horse manure [20].

Optimum Conditions For Cultivation

- Besides having appropriate composition for significantly high yield of mushroom, optimum conditions of the environment during cultivation should also be maintained. Given below are the usual optimum conditions that should be maintained during cultivation.
- Temperatures of 15-35°C
- pH of about 6.5
- Carbon dioxide (CO_2) level to be between15-20%
- Humidity to be between 86-90%
- CO_2 should be between 0-0.6%.
- Temperatures and humidity levels should be regulated at 86% and10-28°C respectively.

Future Aspects and Advantages

India, being a second major producer of vegetables in the world; contributes 14% of total world vegetable production. Taking estimated production of fruits and vegetables in India at 150 million tons, the total waste generation comes to about 50 million tons per annum. Due to their chemical composition fruits and vegetables wastes are more prone to spoilage than cereals, which create unhygienic condition leading to spread of diseases and loss of resources. The vegetable wastes are a rich in nitrogen and carbohydrate but are not fit for consumption. These wastes can be utilized for the production of various types of mushroom such as the oyster variety.

In the recent times the waste management is of most concern. Proper management and execution of waste disposal practices have become today's need. The inappropriate management of waste gives rise to many problems such as rapid spread of infectious diseases, development of new varieties of diseases. The exponential increase in the present amount of waste produced brings to notice an immediate requirement of solution to overcome this problem.

An agricultural waste consists of lignin and cellulose, which are difficult to breakdown. They are insoluble and bind to inert substances in soil and get out of reach of bacterial culture present in soil. While mushroom's mycelium releases extracellular enzymes, which are responsible for the lignin degradation. Pleurotus and Lentinus have their own enzymes systems based on endoglucanase, laccase and phenoloxidases. The large amount of agricultural wastes and appropriate climatic conditions provide massive scope for oyster mushroom cultivation in Sagar, M.P. [21].

An agricultural waste provides the opportunity for cost effective farming. Even after being used for mushroom cultivation, it can be used later on as manure for agricultural field as now the nutrient contents are at acceptable range. Cultivation of mushroom on these residual wastes is one of the

most eco-friendly practices to fight the malnutrition and environmental pollution caused by these wastes. Various researches is still going on to exploit the potential of agricultural wastes either by using them in combination or by giving them pretreatment.

References

1. Udayasimha L, Vijayalakshmi YC (2012) Sustainable Waste Management By Growing Mushroom (Pleurotusflorida) On Anaerobically Digested Waste And Agro Residues. Int J Eng Res Tech 1: 12.
2. Nicolcioiu MB, Popa G, Matei F (2016) Mushroom Mycelia Cultivation on Different Agricultural Waste Substrates. Romania Scientific Bulletin Series F. Biotechnologies Vol. Xx.
3. Bonatti M, Karnoppa P, Soaresb HM, Furlana SA (2004) Evaluation of Pleurotus Ostreatus and Pleurotus Sajor-Caju Nutritional Characteristics When Cultivated In Different Lignocellulosic Wastes. Food Chemistry 88: 425-428.
4. Tan YH, Wahab MN (1997) Extracellular Enzyme Production during Anamorphic Growth in the Edible Mushroom, Pleurotus Sajor-Caju. W Micro Biotech 13: 613-617.
5. Quimio TH (1978) Introducing Pleurotus Flabellatus for Your Dinner Table. Mushroom Journal 69: 282-283.
6. Bano Z, Rajarathanam S (1982) Studies on the Cultivation of Pleurotus Sajor-Caju. The Mushroom Journal 115: 243-245.
7. Jain AK, Vyas D (2003) Cultivation of Three Pleurotus Sp. On Different Substrates. J. Basic Appl. Mycol 2: 88-89.
8. Royse DJ (2003) Cultivation of Oyster Mushroom. College of Agricultural Sciences/The Pennsylvania State University Park University: Agricultural Research And Cooperative Extension. Cat Ul207 3m1/03acg4562.
9. Sonali DR (2012) Cultivation and Study Of Growth Of Oyster Mushroom On Different Agricultural Waste Substrate And Its Nutrient Analysis. Adv. Appl. Sci n b Res.
10. Sturion G (1994) Utilização Da Folha De Bananeira Como Substrato Para O Cultivo De Cogumelos Comestíveis (Pleurotus Spp.). Piracicaba: Esalq/Usp. 56p. (Tese Mestrado).
11. Peksen A, Yakupoglu G (2009) W Micro Biotech 25: 611-618.
12. Shashitha KN, Shlini P, Kavitha GS (2016) Vegetable Waste-A Potent Substrate for Cultivation of P. Ostreatus. Int Res Stud Biosci 6: 5-9.
13. Thongklang N, Luangharn T (2016) Testing agricultural wastes for the production of Pleurotus ostreatus. Mycosphere 7: 766-772.
14. Elahe KJ, Mehrdad J, Shahin E (2016) King oyster mushroom production using various sources of agricultural wastes in Iran. International J Rec Org Waste Agr 5: 17-24.
15. Poonam D, Deepak V (2013) Effect of different agro-waste substrates and their combinations on the yield and biological efficiency of Pleurotus sajor- caju. IOSR J Pharm Bio Sci 8: 60-64.
16. Ralph H, Kurtzman J (1994) Nutritional needs of mushroom and substrate supplements. In: Nair MC (editor), Advances in mushroom biotechnology: 106-110.
17. Singh MP, Singh VK (2012) Biodegradation of Vegetable and Agro Wastes by Pleurotus Sapidus: A Novel Strategy to Produce Mushroom with Enhanced Yield and Nutrition. Cell Mol Biology (Noisy-Le-Grand) 58: 1-7.
18. Zadrail F, Dube HC (1992) The Oyster Mushroom-Importance and Prospects. Mushroom Resource 1: 25-32.
19. Rani P, Kalyani N, Prathiba K (2008) Evaluation of Lignocellulosic Wastes for Production of Edible Mushrooms. Applied Biochemistry And Biotechnology 151: 151-159.
20. Reis FS, Barros L, Martins A, Ferreira I (2012) Chemical Composition And Nutritional Value Of The Most Widely Appreciated Cultivated Mushrooms: An Inter-Species Comparative Study. Food and Chemical Toxicology 50: 191-197.
21. Vyas D, Chaubey A, Dehariya P, Wagay AJ, Bajpai A, at al. (2009) Perspectives on Agripreneurship And Rural Development, ICARD. International Conference On Agripreneurship & Rural Development, BHU, Varanasi, India: 463-470.