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STUDIES ON THE DEGRADATION OF SAW DUST WASTE BY *PLEUROTUS DJAMOR*

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Abstract

Pleurotus djamor, a basidiomycetes known as a white rot fungi was tested for the effectiveness to degrade wood saw dust (WSD). In our study the white rot fungi *i.e.*, *Pleurotus djamor* showed a slow and gradual fibre degradation upto 14th day and 21th day respectively followed by steeper decline till the 28th day of degradation. The highest cellulose and hemicellulose degradation (56.2 and 48.5%) in saw dust were found to be caused by *Pleurotus djamor* monoculture and there was an gradual decrease in the cellulose and hemicellulose content ranged from 31.06% to 56.4% and 10.7% to 48.5% in 28 days of degradation respectively as compared to their controls. Simultaneously, there was an gradual increase in reducing sugars from 11.3% to 16.9% as compared to their initial value (7.7%) during 28 days of fermentation period.

Key words: *Pleurotus djamor*, Saw dust waste, Degradation, Monoculture,

INTRODUCTION

Sawdust a by product of wood processing is generally regarded as a waste. It is often heaped near carpenters' shades, burnt or dumped into rivers. Consequently, they block the water ways and if burnt, produce very thick smoke with high environmental consequences. Wastes and their disposal is a subject of environmental concern worldwide especially when they are non biodegradable to useful goods and services (Banjo and Kubuoye , 2000).

Sawdust is made up of 3 major components; cellulose, hemicellulose and lignin (Alexander, 1997; Erikson et al., 1990). Lignin is the most recalcitrant and protects the cellulose and hemicellulose from enzymatic attack by some microorganisms (Bonnarme and Jeffries, 1998). Cellulose constitutes one-third to one-half of the approximately 150 billion tones of organic matter synthesized annually (Bayer and Moray, 1994). Hemicellulose is an ill-defined group of carbohydrate and is of the major plants constituents, second in quantity to cellulose.

Wood sawdust have been reported (Shide *et al*., 2004) to be degradable by ***Lentinus squarrosolus*** (Mont) singer, basidiomycete also known as a white rot fungi to form protein, glucose and ethanol. Fungi of the classes hyphomycetes ,zycomycetes, pyrenomycetes, hymenomycetes and the actinomycetes and bacteria of the groups *Cytophaga, Erwinia, Pseudomonas, Sporoiytophaga,Xanthomonas* and *Streptomonas* degrade hemicelluloses (Durrant, 1996; Bonnarme and Jeffries, 1998).

The biological pretreatment by microorganisms and their enzyme systems can degrade lignin and hemicellulose that are already in existence in the lignocellulosic materials at low energy consumption and under mild environmental conditions (Sun and Cheng 2002, Yu *et al.* 2009, Bari *et al.* 2018). White rot fungi are a group of basidiomycetes with unique ability to degrade the structure of lignin and carbohydrates (Yu *et al.* 2010, Salvachúa *et al.* 2011, Nazarpour *et al.* 2013, Camarero *et al.* 2014).

Keeping these views in our mind, we attempt an work on the biodegradation of Sawdust waste by using white rot fungi. The objectives were as follows to study the efficiency of solid state fermentation and lignocellulose degradation in sawdust waste by *Pleurotus djamor.*

MATERIALS AND METHODS

Collection of substrate

Saw dust waste was procured from saw mills in and around Tenkasi, Tirunelveli (Dt.), Tamil Nadu. The waste was collected in the gunny bags and dried under shade. Further the waste was used for the biodegradation studies.

Organism used

Pure culture of oyster mushroom *viz.*, *Pleurotus djamor* [Fr] Singer (CO 1) variety was obtained from the Agricultural Research station, T. Kallikulam, Tirunelveli (Dt.), Tamil Nadu. The culture was maintained on Potato Dextrose Agar (PDA) slants and stored at 4ºC and the slant was sub cultured once in a month.

Biodegradation studies

Ten grams of saw dust substrate was taken in Erlenmeyer flasks (250ml) contained 70% of moisture content (w/v) in individually. The mouth of the flasks were plugged with cotton plug and autoclaved at 121° C for 15-20 minutes. After sterilization, the flasks were cooled and the fungal mycelium (7mm diameter) was inoculated using a sterile cork borer was taken from the 7-days old culture of *Pleurotus djamor* using a sterile scalpel. After 7 days of intervals, the substrates were withdrawn and dried biodegraded samples were analysed for change in cellulose (Updegaff, 1969)), Hemicellulose (Lin *et al*.,2010), lignin (Chesson 1978), reducing sugars (Miller, 1959). All the experiments were carried out in triplicates.

RESULTS AND DISCUSSION

Sawdust a by product of wood processing is generally,regarded as a waste. It is often heaped near carpenters' shades, burnt or dumped into rivers. Consequently, they block the water ways and if burnt, produce very thick smoke with high environmental consequences. Wastes and their disposal is a subject of environmental concern worldwide especially when they are non biodegradable to useful goods and services (Banjo and Kubuoye, 2000).

Saw dust contained cellulose as the major carbohydrate component (32 % by dry weight). It contained 10.3% of hemicellulose and 7.7 % reducing sugars on a dry weight basis. Fibre amounted to 48.3% dry weight of sawdust, while the content of protein in sawdust was 2.70% dry weight (Table 1).

pH of uninoculated sawdust was 7.2. Colonization of the sawdust substrate by the white rot, in monoculture resulted in continous lowering of pH, during the experimental period of 28 days. Sawdust contained 48.3% fibre by dry weight. There was a gradual loss in fibre content of the substrate during the course of degradation by the selected fungal

monoculture. The extent of fibre loss caused by the monoculture on the 28th day varied between 9.84% and 27.2%. White rot fungi were the most efficient sawdust degraders in terms of fibre loss. White rot fungal culture *i.e., Pleurotus djamor* showed a slow and gradual fibre degradation upto the 14th day and 21th day respectively, followed by steeper decline till the 28th day of degradation.

The highest cellulose and hemicellulose degradation (56.2 and 48.5 %) in sawdust were found to be caused by *Pleurotus djamor* monoculture and there was an gradual decrease in the cellulose and hemicellulose content ranged from 31.06% to 56.4 % and 10.7% to 48.5 % in 28 days of degradation respectively as compared to their controls (Table 2).

Similarly, the fast degradation of lignin and slow depletion of cellulose and hemicellulose during mycelial growth and slow degradation of lignin and fast depletion of cellulose and hemicellulose during fruit body formation in the present investigation revealed the differential requirement of the fungus *Pleurotus djamor* during different phase of its growth. Same pattern of biodegradation of lignocellulosic wastes by various species of *Pleurotus* have been reported by Singh *et.al.*2011. These observations suggested that the cellulose and hemicellulose serve as energy source for the formation of fruit bodies.

Simultaneously, there was gradual increase in reducing sugar from 11.3 % to 16.9% in 28 days of fermentation respectively as compared to their initial value (7.7%) (Table 3). Among the sugar polymers, hemicellulose was highly degraded by *P. tuberregium* and *P. pulmonarius* (4.1% - 4.6%), while cellulose (3.3% - 4.3%) was mainly degraded by *F. gilva* and *B. adusta*. Glucose was the dominant sugar released by all the fungi tested, with the highest concentration of 1.25 mg/mL produced by *B.adusta* at day 14 of incubation. Results indicate that selected white rot fungi can achieve significant delignification of CPB within 14 days of solid state fermentation. White rot basidiomycetes under solid state fermentation (SSF) for their potentials to secrete oxidative and hydrolytic enzymes to biodegrade canola plant biomass (CPB), and release sugars.

The white rot fungus *Pleurotus djamor* is an edible mushroom, which confers advantages over other mushrooms for its capability to grow on non-fermented lignocellulosic wastes and produce in turn fruit bodies with higher nitrogen content (Velazquez-Cedeno *et al., 2002*).

There are many reports on studies of EPS production by white rot fungi in submerged fermentation (Burns *et al.,* 1994) and (Elisashvili, *et al.*,2009). Their application is in nutraceuticals, especia β-glucans (Perera and Li, 2011) and environmental remediation (Lin,

et al 2010). However, studies on exopolysaccharide production in lignocellulosic substrates under SSF have been few (Isikhuemhen *et al.*,2012).

There was an gradual increase of reducing sugars and protein content in lignocellulosic substrate and mycelial protein in the solid state fermentation flasks till the end of the 28 days of experimental period respectively. One of the goals of biological delignification of agricultural wastes using white rot fungi is to make as much possible of the digestible substrate carbohydrate and reduce environmental hazard.

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S.NO	Components	Dry weight (%)
1.	Cellulose	32 ± 0.2
2.	Hemicellulose	10.3 ± 0.1
3.	Fibre	48.3 ± 0.4
4.	Reducing sugar	7.7 ± 0.03
5.	Protein	2.7 ± 0.01

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Table: 1. Composition of saw dust waste

Table 2: Percent degradation of Cellulose, Hemicellulose and Fibre in saw dust waste during solid state fermentation of *Pleurotus djamor*

Days	Cellulose	Hemicellulose	Fibre
7	31.06	10.7	4.1
14	37.5	26.2	9.84
21	43.7	34.9	18.0
28	56 .2	48.5	27.2

Table 3: Percent increase / decrease (%) of Reducing sugars and Protein in saw dust waste during solid state biodegradation of *Pleurotus djamor*

Days	Reducing sugar	Protein
7	11.3	3.2
14	14.7	3.6
21	16.9	4.8
28	16.6	4.3