ABSTRACT
The agricultural wastes are composed essentially of cellulotic or lignocellulosic matter. These are considered to be the cheapest source for the production of different utilizable products, throughout the world. Macrofungi from the genus Pleurotus, widely known as oyster mushrooms are preferred by many people for their delicate taste, mild chewy texture and unique aroma. Pleurotus is one of the important popular edible mushrooms due to their medicinal properties. It possess a number of properties like antitumor, immunomodulatory, antioxidant, hypocholesterolaemic, antihypertensive, anti-inflammatory, antiplatelet-aggregating , anti hyperglycaemic, antimicrobial and antiviral activities. Growing edible mushroom is the most efficient method of bioremediation in the process of converting the large quantity of lignocellulosic wastes into therapeutic value based products. This study showed that there is reduction in the lignin content of lignocellulosic waste after the cultivation of mushroom. To identify the lignin content, the paddy straw were analysed by FTIR.

Key words: Pleurotus spp, LCW, Medicinal properties.

INTRODUCTION
Edible mushrooms are commonly thought to have little nutritional value, of which many species are high in fibre and provide vitamins such as thiamine, riboflavin, niacin, biotin cobalamines, ascorbic acid and a significant source of vitamin D along with some minerals like selenium, potassium and phosphorus. Many species have medicinal value to inhibit tumour growth and enhance the immune system. Cultivation of the oyster mushroom,
Pleurotus spp has increased greatly throughout the world during last few decades (Chang, 1999; Royse, 2002). Its popularity has been increasing due its case of cultivation, increased yield potential and rich nutritional value (Banik and Nandi, 2004). Mushrooms (Pleurotus) are rich sources of natural antibiotics, where the cell wall glucans are well known for their immunomodulatory properties, and many of the externalized secondary metabolites combat bacteria, fungi and viruses (Benedict and Brady, 1972; Collins and Ng, 1997; Gao et al., 2005; Lindequist et al., 2005; Suzuki et al., 1990). The amount of lignocellulosic waste obtained from the agriculture industry is abundant in Tamilnadu but the utilization is still limited. In Tiruchirappalli, there are three major agriculture residues, such as paddy straw, sugarcane bagasse and saw dust. Various varieties of mushroom seem to convert lignocellulosic residues from agricultural fields, forests into protein rich biomass. Such processing of agro wastes not only reduces environmental pollution but the by product of mushroom is also a good source of manure, animal feeds and soil conditioner.

Annual world rice (Oryzae sativa) production was about 577 million tons for 1997-98. More than 50 countries contributed to this sum with the production of at least 100,000 tons of rice annually, among these large quantities of agricultural residues (rice straw) only a minor portion of the residues is reserved as animal feed. However a huge quantity of the remaining straws is not used and burnt in the fields.

MATERIALS AND METHODS

Collection of substrate
In the present study, paddy straw was used as a substrate for mushroom cultivation. It was collected from the agricultural field of Tiruchirappalli district.

Selection of mushroom variety
Mushroom variety used for the study were selected mainly based on its medicinal properties Pleurotus spp. (Oyster mushroom) was selected and obtained from Tamil Nadu agricultural university (TNAU), Tiruchirappalli.

Preparation of substrates for mushroom cultivation
Substrates were chopped into 2-3 inches in length and soaked in water for 9-12 hours, then the substrates were sterilized by autoclaving at 121°C for 15lbs for 15 minutes. Then the sterilized straws were allowed to cool at room temperature. Mushroom cultivation in high density polythene bags (60cmX40m) with layer spawning was done as described by Pani and
Das (1998). The spawned bags were incubated in dark for impregnation with the mushroom mycelia. After incubation, the bags were transferred into the cropping room for fruiting at 30-35°C temperature and 80-90% humidity. Sufficient light and controlled ventilation was allowed during cropping period. Water was sprayed regularly to keep the surface of the substrate moist. 20% potassium permanganate was prepared and sprayed over the gunny bags thrice a week in a mushroom cultivation room. When the substrate appeared completely white, holes were punched on the surface of bags to allow the pin-heads to come out. The average incubation period for fruiting body formation was about 21 to 30 days. Matured and fully appeared sporocarps were harvested. Those harvested mushrooms were subjected to FTIR analysis. The FTIR spectroscopy is an appropriate technique to establish the concentration of cellulose variations introduced by different treatments. Cellulose is a linear polymeric compound, which is built up by coupling β-D-glucose using 1, 4- glycosidic bonds. Hydrogen bonds, methyls, ethylenes, and C-O-C are some important functional groups of cellulose units.

RESULT AND DISCUSSION
Fig. 1 Cultivation of mushroom using paddy straw

Fig. 2 Spent substrate

Fig. 3 FTIR analysis of untreated straw powder (22µm)
Fig. 4 FTIR analysis of biological (*Pleurotus florida*) pretreated Paddy straw powder (22µm)
Mushroom cultivation is one of the most important methods of agro waste utilization. Mushroom cultivation is an eco friendly method of solid waste management. This resulted in selective degradation of the lignin rather than the cellulose component and increased the susceptibility of paddy straw to enzymatic hydrolysis.

FTIR analysis

In the FT-IR spectra of straw powder a broad stretching band is observed at 3416 cm\(^{-1}\) due to the presence of OH and NH groups. The change in wave number from 3415 to 3428 cm\(^{-1}\) during pre-treatment indicates the breakage of lignin and exposure of peptides and nucleotides.

The peak located at 2925 to 2921 cm\(^{-1}\) corresponds to CH vibrations. The intensity of the peaks is increased after alkali pre-treatment (2\% & 10\%), indicating the distinguished features of cellulose.

The peak located at 2361 cm\(^{-1}\) is absent in pure cellulose whereas it is present in rest of the spectra especially in biological treatment. It should be due to two different nitrogen base like

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Table 1: FT-IR Spectra of Paddy straw powder

<table>
<thead>
<tr>
<th>Substrate</th>
<th>3500-3000 cm(^{-1}) (OH,NH)</th>
<th>3000-2500 cm(^{-1}) (CH)</th>
<th>2500-2000 cm(^{-1}) (C=NH(_2), C=N(^+))</th>
<th>2000-1500 cm(^{-1}) (C=O)</th>
<th>1500-1200 cm(^{-1}) (CONH, C=C)</th>
<th>1200-1000 cm(^{-1}) (C=N,C- C Aromatic, C=C)</th>
<th>1000-800 cm(^{-1}) (C=N)</th>
<th>800-600 cm(^{-1}) (Bending modes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cellulose</td>
<td>3349</td>
<td>2902</td>
<td>2365 2123</td>
<td>1642</td>
<td>1433 1371 1283</td>
<td>1163 1114 1059</td>
<td>-</td>
<td>667 613 562 443</td>
</tr>
<tr>
<td>Straw powder</td>
<td>3416</td>
<td>2924</td>
<td>2364 1724 1632</td>
<td>1513 1372 1321</td>
<td>1097 792</td>
<td>663 566 466</td>
<td>664 612 453</td>
<td></td>
</tr>
<tr>
<td>2% NaOH</td>
<td>3421</td>
<td>2921</td>
<td>2367 1645 1600</td>
<td>1437 1430 1370</td>
<td>1044 778</td>
<td>681 620 449</td>
<td>668 572 467</td>
<td></td>
</tr>
<tr>
<td>10% NaOH</td>
<td>3403</td>
<td>2925</td>
<td>2365 2338</td>
<td>1601</td>
<td>1450 1030</td>
<td>868 776</td>
<td>681 620 449</td>
<td></td>
</tr>
<tr>
<td>Pleurotus florida</td>
<td>3429</td>
<td>2922</td>
<td>2362 1636</td>
<td>1380 1321</td>
<td>1094 792</td>
<td>668 572 467</td>
<td>664 612 453</td>
<td></td>
</tr>
</tbody>
</table>
N-terminal amino acids in peptides and also due to purines and pyrimidine bases in nucleotides. It may be an important constituent that is exposed when the lignin skeleton breaks down during the pre-treatment procedures adopted in this work.

The peak at 1724 cm$^{-1}$ represents C=0 groups in the FT-IR spectra of straw powder (Table 1). It disappears during the pre-treatment process with the release of monosaccharide into the aqueous solution. This peak is absent in pure cellulose. During pre-treatment of lignocellulosic substrates, hydrolysis of cellulose and other polymeric sugar units take place. Further it may be noted that monosaccharide like glucose may be released.

The absorption peak at 1631 cm$^{-1}$ is assigned to the stretching of CO-NH in peptides and quinoid vibrations in nucleotides. During pre-treatment, hydrolysis of protein present in the substrate may lead to the release of peptides. Free sugars present in untreated straw powder, are not observed in the spectra of the solid material recovered after pre-treatment.

Such observations are recorded by earlier workers. For example Viera et al (2007) have noted an absorption peak at 1639 cm$^{-1}$ in pre-treated samples which diminished in intensity in the spectrum of pre-treated rice straw. He has assigned this absorption to the functional group of lignin.

The peak located at 1513 cm$^{-1}$ is assigned to benzenoid rings in lignin. It is present only in the untreated rice straw. Since the band got disappeared after pre-treatment, it can be suggested that the deformation of lignin has occurred. Sun et al (2005) have reported that peaks at 1513 & 1433 cm$^{-1}$ can be assigned to C=C stretch in the aromatic rings in lignin in steam exploded wheat straw. Lin-Vein et al (1991) have located a peak at 1514 cm$^{-1}$ attributed to semicircle stretching-Para-substituted benzene rings (Budevska ,2002) showing the presence of lignin in corn kernel.

The absorption peaks at 1437, 1371 & 1320 cm$^{-1}$ are assigned to phosphates in nucleotides and bending modes of CO-NH groups in the exposed peptides. Yu et al (2007) & WetZel et al (1998) have reported a peak at 1370 cm$^{-1}$ attributed to C-O stretching in cellulose.

The peak at 1096, 1043, 1029 and 1093 cm$^{-1}$ indicate that the C-O-C stretch in cellulose has broadened (Fig). The blue shift of this FT-IR band in 2% & 10% NaOH by 53 & 67 cm$^{-1}$ denotes the presence of small molecules. During biological pre-treatment these peaks have not shifted much. Stewart et al (1995) has noted a peak at 1098 cm$^{-1}$ showing a region a weak
absorbance assigned to cellulose in barley straw. The peak located at 791,777,867 and 791 cm$^{-1}$ are absent in pure cellulose. Hence it should be due to N-bases that may be correlated to the presence of nucleic acids. New peaks are observed at 612,619 cm$^{-1}$ after pre-treatment with NaOH (Table 1). Further the bending vibrations at 442 cm$^{-1}$ in cellulosics found at higher wave numbers in all the samples these changes may be due to H- bonded smaller fragments arising during hydrolysis.

CONCLUSION

The study revealed that structural and functional changes of lignin occurred after the cultivation of mushroom on paddy straw. Biologically treated method seems to be more effective in terms of economy, ecofriendliness and beneficial in terms of treating lignocellulosic waste.

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REFERENCE


