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SHORT COMMUNICATION

Bio-softening of mature coconut husk for facile coir recovery

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Abstract Bio-softening of the mature coconut husk using Basidiomyceteous fungi was attempted to recover the soft and whiter fibers. The process was faster and more efficient in degrading lignin and toxic phenolics. *Phanerochaete chrysosporium*, *Pleurotus eryngii* and *Ceriporiopsis subvermispora* were found to degrade lignin efficiently without any appreciable loss of cellulose, yielding good quality fiber ideal for dyeing.

Keywords Biosoftening · Coconut husk · Basidomycetes · Lignin degradation

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Introduction

Coir is a coarse fiber obtained from the mesocarp of coconut. The fiber cell walls are thick and made up of cellulose and lignin. Lignin is a complex chemical responsible for its stiffness and dark colour. Retting is a traditional fiber recovery process carried out in the backwater lagoons. This is an environmentally hazardous process due to the release of the toxic compounds such as polyphenols[1]. Bio-softening is an ecofriendly method to extract fiber by selective removal of lignin using specific microorganisms[2,3]. This also results in the reduction of retting time and is safe for the environment[4].

We used the white rot fungi for depolymerization of lignin and remove resins and parenchyma cells (pith) to obtain bleached coconut fibre.

Materials and Methods

Lignin degrading white rot fungi namely *Phanerochaete chrysosporium*[5], *Ceriporiopsis subvermispora*[6], *Pleurotus eringii*[7] and *Ganoderma lucidum*[8] were used in this study. *P. chrysosporium* (BKM-F-1767) and *C. subvermispora* cultures (FP-105752-Sp) were obtained from the United States Department of Agriculture, Wisconsin. *G. lucidum* culture was obtained from the Tamil Nadu Agricultural University, Coimbatore. *P. eryngii* (NBIMCC 2199) was obtained from the culture collection of Bulgaria, Sofia. *P. chrysosporium* and *C. subvermispora* were maintained on Potato dextrose broth[9] whereas *P. eryngii* and *G. lucidum* were grown in glucose peptone broth[9] and malt extract broth[9] respectively.

Homogenized fungal cultures (100 ml of 10 d old) were added separately to 10g husk samples in conical flasks, each with three replications and incubated at 30^{o}C. Lignin and cellulose contents in fiber, and extracellular enzymes and tannin in the spent medium were analyzed after 30, 60 and 90d of incubation. Husk and medium without any fungus served as the control.

Cellulose and lignin contents were estimated by the standard procedure[5]. Lignin peroxidase (Lip) was measured by monitoring the oxidation of 2 mM veratryl alcohol to veratraldehyde in 0.1M sodium tartrate (pH 3) supplemented with 0.4 mM H_2O_2[8]. Laccase (Lac) activity was assayed by the rate of oxidation of guaiacol in 0.1 M sodium phosphate buffer (pH 6)[8]. Manganese peroxidase (Mnp) activity was assayed by monitoring the formation of the Mn^{3+}-tartrate complex from 0.1 mM $MnSO_4$ in 0.1 M sodium tartrate (pH 5) supplemented with 0.1 mM H_2O_2[8]. Cellulase content was assayed by the standard procedure[8]. One unit of enzyme activity is defined as the amount of enzyme required for the transformation of 1μmol of substrate per minute. Tannin content was estimated by Lowenthal permanganate titration method[10]. Dye uptake percentage of the coir samples was calculated by determining the reduction in absorbance of malachite green solution at 660 nm before and after the treatment of the fibre.

Results

Lignin and cellulose contents of the coconut husk before biosoftening were 45.84 and 43.44% respectively. Reduction in the lignin content of the treated coir (Table 1) clearly indicated that lignin was degraded by the fungi. *P. chrysosporium* enhanced the reduction in lignin content from 24.3 % after 30d to 44.74% after 90d accompanied by 8.4–13.9% reduction in cellulose content. Reduction in the lignin content by *G. lucidum* was only 26.24% after 90d and was adjudged as a poor degrader of lignin.

P. eryngii reduced the lignin content from 16.7% after 30d to 36.36% after 90d accompanied by 7.7–14.8% reduction in cellulose content. *C. subvermispora* brought about a reduction in the lignin content from 19.87% after 30d to 34.99% after 90d accompanied by 5.7–9.9% reduction in the cellulose content. The observations are supported by earlier reports[2,11] on lignin degradation by the white rot fungi causing fiber individualization and decolourization in paper and pulp industry. Gradual increase in the Lip, Mnp and Lac activities in the spent medium implied more lignin degradation in coir (Table 2). The observations suggested that Lip, Mnp and Lac activities could contribute more for lignin deg-

Table 1 Effect of white rot fungi on lignin and cellulose contents[a] of coir.

Treatments	Lignin Incubation (d)			Cellulose Incubation (d)		
	30	60	90	30	60	90
Control[1]	45.51 ± 0.16	42.43 ± 0.13	41.42 ± 0.31	43.03 ± 0.13	42.00 ± 0.08	39.23 ± 0.21
P. chrysosporium	34.67 ± 1.70	30.37 ± 0.82	25.33 ± 0.50	39.78 ± 0.26	38.80 ± 0.22	37.38 ± 0.49
C. subvermispora	36.73 ± 0.79	34.51 ± 0.59	29.80 ± 0.40	40.93 ± 0.68	39.67 ± 1.25	39.13 ± 1.18
Control[2]	43.65 ± 0.19	39.52 ± 0.23	35.25 ± 0.55	41.10 ± 0.08	40.09 ± 0.07	39.97 ± 0.05
P. eryngii	38.17 ± 0.79	37.25 ± 0.18	29.17 ± 0.67	40.07 ± 0.05	39.26 ± 0.57	37.00 ± 0.82
Control[3]	42.64 ± 0.09	38.56 ± 0.05	35.21 ± 0.03	42.17 ± 0.05	41.30 ± 0.16	39.80 ± 0.25
G. lucidum	39.58 ± 0.10	37.43 ± 0.26	33.81 ± 0.20	42.03 ± 0.47	40.99 ± 0.08	39.20 ± 0.63
CD ($P < 0.01$)						
[1]Treatments x incubation period			2.16		1.99	
[2]Treatments x incubation period			1.52		1.25	
[3]Treatments x incubation period			0.45		1.05	

[a]Mean of 3 replicated values in % w/w.

Table 2 Extracellular enzyme activity[a] in *P. chrysosporium*, *P. eryngii* and *C. subvermispora.*

Sampling days	*P. chrysosporium*			*P. eryngii*			*C. subvermispora*		
	Lip	Mnp	Lac	Lip	Mnp	Lac	Lip	Mnp	Lac
30	0.052	0.030	0.057	0.050	0.025	0.020	0.037	0.014	0.050
60	0.059	0.051	0.090	0.052	0.030	0.021	0.041	0.018	0.114
90	0.067	0.062	0.100	0.064	0.041	0.024	0.050	0.021	0.131

[a] Values in Unit/mg of protein.

Table 3 Tannin reduction and dye uptake of bio-softened (90 d duriation) coir[a].

Treatments	Tanin (%)	Dye uptake (%)
Control	0.073	88.20
P. chrysosporium	0.030	97.44
P. eryngii	0.030	97.38
C. subvermispora	0.032	97.84

[a]10 g husk + 100 ml water as retting mix.

radation in softening and bleaching of the husk. Role of Lip in lignin degradation has been reported earlier[7,12].

The tannin, a biofouling compound[1], was reduced to 57.14% in treated sample (Table 3), suggesting that biosoftening can also reduce biofouling to a extent greater than the conventional retting process. Further, dye uptake in the biosoftened coir increased to 97% over 88% in the control. Our study showed that *P. chrysosporium, C. subvermispora* and *P. eryngii* are suitable for biosoftening and biobleaching of coconut husk in an ecofriendly manner.

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