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DECOMPOSITION OF LIGNIN AND CELLULOSE COMPONENTS OF SAW-DUST OF *SWIETENIA MAHOGANI, TECTONA GRANDIS* AND *SHOREA ROBUSTA* BY WHITE-ROT AND BROWN-ROT FUNGI

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Quantitative changes in lignin and cellulose during decay of *Sweitenia mahogani, Tectona grandis* and *Shorea robusta* wood meal by white-rot and brown-rot fungi were determined. The white-rot fungus removed all the major wood components progressively during decay ; the brown-rot fungus removed the polysaccharides but not lignin.

INTRODUCTION

From the standpoint of chemical deterioration, the white-rot types of wood-decaying fungi cause successive decomposition of all the cell wall components starting initially with lignin and hemicelluloses at later stages and also cellulose fractions. On the otherhand, the brown-rot ones utilize only polysaccharides of the cell wall living lignin matrix nearly undigested. Many of the wood-rotting besidiomycetes are known to be very efficient in utilizing cellulose (Siu, 1951 ; Scheffer and Cowling, 1966) and lignin (Pelczar *et al.*, 1950 ; Van Vliet, 1954) of wood but they vary considerably in their capacities to decompose lignin and cellulose of wood in storage, in service or in living trees (Lindeberg, 1946 ; Kirk, 1971 ; 1975).

In India, general information about deterioration of economic timbers by wood-decaying fungi is known, but works on decay of economic timbers by wood-rotting fungi are very limited. With this end in view, the present investigation has been undertaken to study the biochemical changes of economic timbers of *Swietenia mahogani* Linn., *Tectona grandis* L.f. and *Shorea*

robusta Gaertn. f. due to decay caused by *Trametes gibbosa* (Pers.) Fr. and *Polyporus ostreiformis* Berk. on the basis of quantitative estimation of lignin and cellulose components of sound and decayed saw-dust.

MATERIALS AND METHODS

Pure cultures from tissues of fresh fructifications of the test-fungi grown on malt agar medium were used. Wood powders of *S. mahogani, T. grandis* and *S. robusta* were dried to constant weight, soaked in distilled water, sterilized and then subjected to decay by the mycelia of *T. gibbosa* (Pers,) Fr. and *P. ostreiformis* Berk. in conical flasks (500 ml) for a period of four and eight months at 28°C under controlled laboratory conditions. After removing the superficial mycelia the wood powders were dried to constant weight and used for quantitative estimation.

The quantitative estimation of lignin was made following mainly Saeman *et al.* (1954) which is still considered to be largely satisfactory (Kirk, 1971). The total carbohydrates of the wood meal were dissolved by hydrolysis in sulphuric acid. The lignin was condensed to an insoluble residue which was determined gravimetrically.

For isolation and quantitative estimation of different cellulose components of wood the procedure used was following mainly Tappi standard (1954) and Cowling (1961). Holocellulose is taken as the residue remaining upon successive pre-extraction of woodmeal with ethanol benzene, ethanol and hot water to remove extraneous substances, followed by a succession of chlorination and monoethanolamine extraction treatments to remove lignin.

The isolated holocellulose was treated with 17.5% aqueous sodium hydroxide when hemicellulose was dissolved while alpha-cellulose fraction remained insoluble and was separated. The betacellulose was precipitated on acidification of the alkaline hemicellulose solution while gammacellulose remained soluble in the acidified solution. The percentage yield of alpha-and beta-cellulose was determined by subtracting the percentage of alpha-and beta-cellulose from the percentage of holocellulose in the original moisture free sample.

RESULTS

From Table 1, it is evident that lignin content in sound woodmeal of all the three timber species are between 30-32%. *Shorea robusta* shows maximum

Table 1. *Percentage of lignin loss from decayed saw-dust of* Sweitenia mahogani, Tectona grandis *and* Shorea robusta *by* Trametes gibbosa *and* Polyporus ostreiformis

Wood	Lignin in Sound wood (%)	Loss in lignin from wood decayed by			
		Trametes gibbosa		Polyporus ostreiformis	
		4 months	8 months	4 months	8 months
S. mahogani	30.5	16.0	36.0	2.0	4.9
T. grandis	30.0	20.5	45.0	3.0	6.8
S. robusta	31.0	24.0	50.0	2.0	5.0

Table 2. *Percentage of different cellulose components of sound saw-dust of* Swietenia mahogani, Tectona grandis *and* Shorea robusta

Wood	Holo-cellulose	Alpha-cellulose	Beta-cellulose	Gamma-cellulose
S. mahogani	70.5	40.5	20.5	9.5
T. grandis	65.0	40.0	15.5	9.5
S. robusta	68.5	42.0	17.5	9.0

lignin contents followed by the other two having more or less identical values. Loss of lignin in decayed wood meal shows considerable variations among the different timber species, Though lignin was removed progressively from all the timber species by *Trametes gibbosa* (white-rot fungus), the rate of removal was not usually linear. With the brown-rot fungus, *P. ostreiformis,* lignin was generally only slightly depleted. The percentage of loss also increased considerably with increase in period of exposure of the woodmeal from 4 months to 8 months.

Table 3. *Loss of different cellulose components of saw-dust of* Sweitenia mahogani, Tectona grandis *and* Shorea robusta *by* Trametes gibbosa *and* Polyporus ostreiformis

Wood	Fungus	Period of incubation	Loss (%) of different cellulose components			
			Ho'o cellulose	Alpha cellulose	Beta cellulose	Gamma cellulose
Swietenia mahogani	T. gibbosa	4 months	3.1	3.5	1·3	5.1
		8 months	6·5	7.0	2.7	10.0
	P. ostreiformis	4 months	3.0	2.9	2.5	5.0
		8 months	5 9	6.5	5.5	9.5
Tectona grandis	T. gibbosa	4 months	5.5	4.5	5.5	4.8
		8 months	11.5	4.7	11.9	9.8
	P. ostreiformis	4 months	4.9	4.0	2.9	3.5
		8 months	9.5	8.0	5 5	7.9
Shorea robusta	T. gibbosa	4 months	4.0	4.5	2.5	1.5
		8 months	9.0	9.5	5.0	3.6
	P. ostreiformis	4 months	3.9	2.5	1.9	7.1
		8 months	7.5	5.0	3.5	14.5

From Table 2, it appears that the percentage of cellulose in sound wood of all the three timber species is between 60-70% of the total dry weights, being maximum in *S. mahogani* followed by *S. robusta* and *T. grandis*. In decayed wood meal (Table 3) the amount of cellulose decreases to some extent by both white-rot and brown-rot fungi and the loss being increased with time of incubation. The white-rot fungus, *T. gibbosa* causes maximum degradation of cellulose from all the timber species than that of the brown-rot fungus, *Polyporus ostreiformis*.

DISCUSSION

From the results, it becomes evident that *T. gibbosa* is of white-rot type as exhibited by the capacity to cause considerable decay primarily of the lignin portion in all the timber species. Proportionately less cellulose than lignin is removed by the fungus. The relatively small amounts of cellulose utilized simultaneously with lignin proves the 'white-rot' nature of the test-fungus. Although the cellulose contents of the woodmeal of all the three timber species are fairly high, the activities of cellulolytic enzymes seem to be quite low.

Thus, from the point of view of chemical degradation of woodmeal, the white-rot fungus proves to be very important and play very active roles in the bioconversion of complex lignin in nature.

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