LIGNINOLYTIC PROPERTIES OF DIFFERENT WHITE-ROT FUNGI

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SUMMARY

Seven white-rot fungi were examined for the production of ligninase, manganese peroxidase and laccase. All these enzymes were found in Trametes gibbosa and Trametes hirsuta. Only manganese peroxidase and laccase were produced by Pycnoporus cinnabarinus, Coriolopsis polyzona, Stereum hirsutum, Dichomitus squalens and Ganoderma valesiacum. All fungi decolorized Poly B-411 and Indulin AT plates with low-N medium. The differences in enzyme pattern indicate that different species of fungi may employ different modes of lignin metabolism.

INTRODUCTION

Fungal peroxidases, ligninase and manganese peroxidase, together with laccase have been implicated in the biodegradation of lignin. Both peroxidases were discovered in Phanerochaete chrysosporium (Tien and Kirk, 1983; Glenn and Gold, 1983). Laccase is not produced by P. chrysosporium but was demonstrated in various white-rot fungi. Many white-rot fungi are lignin degraders but the production of lignin peroxidases has been observed only in a few species (Dodson et al., 1987; Hatakka and Tervilä-Wilo, 1985; Waldner et al., 1988; Nerud and Mišurcová, 1989; Bommmare and Jeffries, 1990).

In this study we examined several white-rot fungi to find possible new producers of so far known ligninolytic enzymes and to establish if these enzymes are widespread amongst the fungi.

MATERIALS AND METHODS

Organisms and culture conditions. The fungi were obtained from the Culture collection of Basidiomycetes, Institute
of Microbiology, Prague, Ganoderma valesiacum 223, 48 and Coriolopsis polyzona 319, 36 were from CBS, Baarn. All fungi were cultivated under static conditions at growth temperature optimal for each fungus in the medium described by Kirk and Nakatsubo (1983).

Analytical methods. Ligninase activity was measured according to Tien and Kirk (1984). Measurement of manganese peroxidase was based on the oxidation of ABTS or syringaldazine by the method of Paszczynski et al. (1986). Laccase activity was measured by monitoring the oxidation of ABTS in the absence of H₂O₂ (Niku-Paavola et al., 1988). Ligninolytic activity was assayed by the agar plate method using Poly B-411 (Glenn and Gold, 1983) and by a modified method of Sundman and Näs (1971) using Indulin AT in low-N medium, pH 4.4. The aromatic compounds extracted from the culture fluid with ethyl acetate were analysed by HPLC according to Waldner et al. (1988).

RESULTS AND DISCUSSION

The organisms and extracellular enzymes found during a 14-d cultivation are surveyed in Table 1. Ligninase was found only in Trametes hirsuta and Trametes gibbosa and its appearance was strongly dependent on the presence of veratryl alcohol (1mM) in the culture medium. Without addition of this metabolite no activity was detected. Veratryl alcohol had a positive effect also on the activity of laccase in T. hirsuta and D. squalens, and manganese peroxidase in T. hirsuta. The activity of ligninase varied according to growth conditions. T. gibbosa produced this enzyme only in N-limited (2,4mM) culture while in T. hirsuta the same activity level was found in a C-limited culture and under nitrogen sufficiency (24mM). The activities of enzymes excreted by these two fungi are summarized in Table 2.

Veratryl alcohol, which is thought to be a common secondary metabolite of white-rot fungi and which plays a role in lignin biodegradation (Kirk and Farrell, 1987), was not found during the whole cultivation time in T. hirsuta, being replaced by veratraldehyde. T. gibbosa produced both these metabolites.

P. cinnabarinus and D. squalens produced peroxidases that oxidize ABTS but are different from manganese peroxidase because the substrate oxidation rate was lower in the presence of manganese.

658