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# Biomechanical Pulping of Loblolly Pine Chips with Selected White-Rot Fungi[1]

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**Summary:**

Loblolly pine chips were treated with several white-rot fungi in two different bioreactor configurations for four weeks prior to refiner mechanical pulping. Irrespective of the bioreactor configuration, all fungal treatments caused some chip weight loss and saved electrical energy during fiberization and refining as compared to the untreated control. Some of the fungal treatments improved strength properties of the handsheets, whereas brightness and light scattering coefficient of the handsheets were decreased after all of the fungal treatments. Opacity of the handsheets after the fungal treatments remained unchanged. Based on energy savings and improvements in the strength properties, regardless of bioreactor type, the white-rot fungus *Ceriporiopsis subvermispora* appeared to be superior to the other white-rot fungi tested. When incubated in stationary tray bioreactors, *C. subvermispora* caused only 6% weight loss, saved 42% energy during fiberization and refining, improved burst index by 32% and tear index by 67%, as compared to the control.

## Introduction

Mechanical pulping operations consume large quantities of electrical energy to produce high yield but relatively weak pulps with useful optical properties (Kano *et al.* 1982; Kurdin 1979; Leask and Kocurek 1987; Pulp and Paper 1989; West 1979). Such pulps are desirable for printing papers because of their optical properties. Groundwood process produces the weakest mechanical pulp with the best optical properties, and is the least energy intensive. Refiner mechanical pulping processes produce stronger pulps with reduced optical properties, but require more energy. Adding steam pressure to the refining operation (thermomechanical pulp) (TMP), and chemicals together with steam pressurization (chemithermomechanical pulp) (CTMP), retains more of the basic fiber length and improves paper strength (Beath and Mihelich 1977; Higgins *et al.* 1978; Kurdin 1979; Mokvist *et al.* 1985; Wegner 1982, 1987). However, the increased strength properties are offset by reduced optical properties, and the TMP and CTMP processes may actually increase energy consumption (Kurdin 1979; Beath and Mihelich 1977). The CTMP process also generates a troublesome dilute waste liquor stream. Mechanical pulp production is increasing (Atack 1985; Jackson 1985), although growth has recently been slowed by an increased use of recycled fibers (Leask 1991).

The disadvantages of mechanical pulping processes are the primary reasons for evaluating the potential of using fungal treatments prior to mechanical pulping (biomechanical pulping) (Akamatsu *et al.* 1984; Ander and Eriksson 1975; Setliff *et al.* 1990). We have achieved promising results with a nonoptimized bench-scale process that uses selected white-rot fungi to treat wood chips prior to refiner mechanical pulping (Leatham *et al.* 1990 a,b; Myers *et al.* 1988). With the aspen chips, the process reduces refiner energy consumption, and improves strength properties of handsheets made from the biomechanical pulps.

Here we report the results of bench-scale studies of biomechanical pulping of loblolly pine chips treated by selected white-rot fungi in two different bioreactor types. A preliminary report was presented at an international conference (Leatham *et al.* 1990b).

## Material and Methods

*Fungal selection*

Seven different white-rot fungi were selected for this study, based upon their ability to selectively remove lignin from small loblolly pine blocks (Leatham *et al.* 1990 c). Fungi selected were *Phlebia (Merulius) tremellosa* (PRL-2845), *Phanerochaete chrysosporium* (BKM-F-1767), *Dichomitus squalens* (TON-429), *Hypodontia setulosa* (FP-106976-sp), *Phlebia brevispora* (HHB-7099-sp), *Ceriporiopsis subvermispora* (FP-90031-sp), and *Phlebia subserialis* (RLG-6074-sp). They were maintained on potato dextrose agar (PDA) (Difco Laboratories, Detroit, MI) slants and kept refriger-

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