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# A new biobleaching sequence for kenaf pulp: Influence of the chemical nature of the mediator and thermogravimetric analysis of the pulp

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## HIGHLIGHTS

- We report a novel laccase-mediator treatment for kenaf pulp biobleaching.
- Relevance of phenoxy radicals formed in the enzymatic stage.
- Kenaf increases oxidative efficiency of laccase.
- Thermogravimetric analysis realizes cellulose surface changes.

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## ABSTRACT

This paper evaluates five phenolic compounds as mediators for kenaf pulp biobleaching by laccase. The results have been compared with the treatment using a non-phenolic mediator, 1-hydroxybenzotriole and laccase alone. The influence of the nature of the chemical mediators used on various pulp properties is discussed. In addition to oxidizing lignin, the phenolic radicals formed in the process take part in condensation and grafting reactions in enzymatic stage. After biobleaching sequence (LP), syringaldehyde was shown to be the best phenolic mediator, allowing a delignification of 43% and 72% ISO brightness. These results were similar to the use of laccase alone due to the role as mediators of syringyl units resulting from oxidative lignin degradation. As a novelty, the study was supplemented with thermogravimetric analysis, with emphasis on the crystallinity degree of the cellulose surface and the aim of elucidating the action mechanisms of laccase-mediator systems on fiber.



## 1. Introduction

Kenaf (*Hibiscus cannabinus*) is an annual dicotyledonous plant which grows in temperate and tropical areas. Kenaf adapts easily to various types of soil and requires only minimal chemical treatment to grow effectively (Elsaid et al., 2011). Kenaf plants can adsorb approximately 1.5 times their weight in carbon dioxide, which is an increased level of adsorption relative to other plants (Mohanty et al., 2005). This fact, its rapid growth and its high yield makes kenaf one of the most promising nonwood plants. In the developed world, fiber from nonwood plants has a growing market for producing paper with high added value (Moore, 1996). The contents in long (bast) and short (core) fibers of kenaf are in fact suitable for manufacturing paper and various other products (Ahmed et al., 1998); however, kenaf bast fibers are especially suitable for producing high-quality paper.

The use of laccases in combination with various natural phenolic compounds is receiving increasing attention for various purposes including pulp delignification, wood fiber modification, dye or stain bleaching, contaminated water purification and soil remediation (Widsten and Kandelbauer, 2007). Laccases hold much promise for the paper and pulp industry in its search for ways to avoid the environmental impact of the chlorine-based oxidants currently in use in delignification and bleaching processes (Cañas and Camarero, 2010).

Laccases are multi-copper oxidases catalyzing the oxidation of phenolic substrates with the concomitant reduction of oxygen (Leonowicz et al., 2001). However, these enzymes have a moderate oxidizing power and can only attack phenolic moieties in lignin polymers (Xu et al., 1996), so they require the assistance of a natural or synthetic mediator to efficiently degrade nonphenolic lignin (Morozova et al., 2007). Mediators are low-molecular weight compounds that form radicals upon oxidation by laccase; such radicals are indeed capable of oxidizing lignin linkages. Laccase-mediator systems (LMS) have been successfully used to oxidize lignin in sisal

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