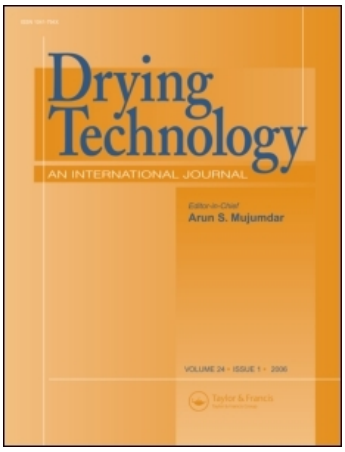

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Some Physical Properties of Heat-Treated Paulownia (*Paulownia elongata*) Wood

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The aim of this study was to determine the changes in physical properties of Paulownia (*Paulownia elongata*) wood, a fast-growing species, during heat treatment at three different temperatures (160, 180, and 200°C) and durations (3, 5, and 7 h). After heat treatment, changes in swelling, density, color, and equilibrium moisture content at 35, 65, and 85% RH were investigated. The results indicated that the minimum and maximum decrease swelling ratios were 6–46% for tangential, 4–32% for radial, and 12–64% for longitudinal. The equilibrium moisture contents were 1–26% for 35% RH, 1–33% for 65% RH, and 1–38% for 85 RH, respectively; the density of air-dried and oven-dried samples decreased by 1–16% and 1.5–15%, respectively, and color changes values (L^*) were 10–40%.

Keywords Heat treatment; Paulownia; *Paulownia elongata*; Physical properties; Wood

INTRODUCTION

Paulownia elongata is a species of plant in the Paulowniaceae family. It is used as a forestry tree in North America and China. It is reportedly the fastest growing hardwood tree and is known to grow up to 15 feet or more in the first year. Paulownia wood also resists splitting and warping in the drying process and can hold nails and screws without splitting.

Heat treatment of wood has an important effect on its chemical composition and its physical and mechanical properties. In addition to better durability, the advantages of heat-treated wood include reduced hygroscopicity, improved dimensional stability, and color changes.

The characteristic properties of heat-treated wood are generally different from those of untreated wood. After thermal treatment, wood is less hygroscopic than kiln-dried wood.[1–4] This can be noted as reduced swelling and shrinkage, which can be as much as 50% for higher temperatures (>200°C) and longer times. In that context, the sorption and desorption characteristics are also changed.

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The water uptake by heat-treated wood is slower, and the water release is faster than it is from kiln-dried wood.[5–7] It is furthermore clear that the equilibrium moisture content (EMC) is reduced by up to 40% compared with untreated wood.[5,8–10] Strongly associated with the reduction of the hygroscopicity, dimensional stability and durability are improved as a result of the improvement of the product's essential properties. However, the loss of strength has always been one of the main drawbacks for the commercial utilization of heat-treated wood.

Heat-treated wood is often appreciated for its light-brown to dark-brown appearance.[9] Therefore, heat-treated wood has been suggested as a substitute for some tropical hardwoods. Both treatment time and temperature can be varied to produce a specific, brownish color.

Prolonged treatment time and/or raised temperature usually give the wood a darker color. Furthermore, darker heat-treated wood is generally more converted than lighter heat-treated wood and, therefore, it has been suggested that the color can be used as an indicator of the degree of conversion[11] and that color can be related to losses in mechanical properties.[12] However, the brownish color attained is not stable against light exposure.[13–15]

The colored substances in the wood are eventually degraded and washed out if the wood is exposed outdoors, leaving a bleached and grayish appearance. No cost-effective and easy method to prevent this fading has been described. Distinct from other chemical modification methods,[16] in most thermal treatment processes, no reacting chemicals are added to the treatment of wood. In the thermal treatment of wood, transformations of the chemical structure of the wood are caused principally by autocatalytic reactions of the cell wall constituents.

In this study, changes in the physical properties as a result of the heat treatment of Paulownia wood, which is a fast-growing wood, were investigated. Although many species have been subjected to heat treatment, this is the first such study for Paulownia wood. After heat treatment of the wood, the effects on its physical properties were determined.