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Improving some of applied properties of oriented strand board (OSB) made from underutilized low quality paulownia (*Paulownia fortunie*) wood employing nano-SiO_2

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ABSTRACT

In this study, effect of nano-SiO_2 on some applied properties of oriented strand board (OSB) made from underutilized low quality paulownia wood employing was investigated. Nano-SiO_2 at four levels (0, 1, 3 and 5 phc) was added to urea formaldehyde (UF) resin and since nano-SiO_2 has effect on the curing of UF resin, the press cycle time (7 and 10 min) was also selected as variable. Some chemical properties of paulownia wood (holocellulose, cellulose, lignin and ash contents, pH value, hot and cold water solubility), mechanical (modulus of rupture, modulus of elasticity, internal bond strength, screw and nail withdrawal strengths), physical (thickness swelling and water absorption) properties and formaldehyde emission of the strand boards were evaluated. Mechanical properties of all panels were found to comply with general-purpose OSB minimum value requirements of EN 300 Type 1 (1997) for use in dry conditions. With incorporation of nano-SiO_2 up to 3 phc into UF resin mechanical and physical properties of the resulting panels improved and formaldehyde emission decreased. However, none of the panels did satisfy the WA and TS requirement of EN Standard for general purpose usage. The results of X-ray diffraction (XRD) and transmission electron microscope (TEM) analysis confirmed the good dispersion of nano-SiO_2 in the resulting OSBs. Using paulownia as a fast growing underutilized species not only can sustain the forests but also can supply raw material shortage in wood short countries.

1. Introduction

The social and economical developments of human beings are depending on better utilization of available resources (Ndazi et al., 2006). Forests, the major sources of wood supply, are declining at the alarming rate of 13.0 million ha each year in developing countries (Pirayesh et al., 2012). The demand for composite wood products such as oriented strand board, plywood, medium density fiberboard, hardboard and veneer products has recently increased distinguishably throughout the world (Ashori and Nourbakhsh, 2008). Environmental pressure managed to prohibit forest harvesting; as a consequence, wood shortage-shut down of wood industries, unemployment, etc. can be seen in some countries including Iran. For instance, after closure of largest plywood plants in Germany and France (Papadopoulos and Traboulay, 2002); Iran's plywood plants discontinued their production either.

Natural fiber composites are also claimed to offer environmental advantages such as reduced dependence on non-renewable energy/material sources, low density, low cost, nonabrasive nature, easiness of processing, lower pollutant emissions, lower greenhouse gas emissions, enhanced energy recovery, and end of life biodegradability of components (Joshi et al., 2004; Ndazi et al., 2006; Ashori and Nourbakhsh, 2008; Pirayesh et al., 2012). Alternative fibers such as underutilized species, fast-growing species, agricultural crops, and other plant fibers will play an important role in providing balance between supply and demand (Ashori and Nourbakhsh, 2008).

Iran as a developing country does not have sufficient raw material to supply its forest industry demands. Consequently, several authors in Iran have investigated the suitability of some underutilized species as well as bio-based residues; date palm, mesquite, salt cedar and eucalyptus wood (Ashori and Nourbakhsh, 2008), almond shell (Pirayesh et al., 2012), straw (Tabarsa et al., 2010) and walnut shell (Pirayesh et al., 2012) in the production of wood-based composites.

Paulownia is a fast-growing shade tree indigenous to China and South-East Asia (Bergmann, 1998). It is soft, lightweight (0.26 g/cm^3), ring porous, straight-grained, and mostly knot-free with a satiny luster. The use of short rotation forestry plantations is a promising tool for reducing atmospheric carbon dioxide concentration through fossil fuel substitution (Martinez et al., 2010). Under the appropriate conditions, a 5–7-year-old tree can reach

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