Available online at www.sciencedirect.com
ScienceDirect
Industrial Crops and Products 26 (2007) 185–194
INDUSTRIAL CROPS AND PRODUCTS
AN INTERNATIONAL JOURNAL
www.elsevier.com/locate/indcrop

Physical properties of thin particleboard made from saline eucalyptus

Zhongli Pan [a,b,*], Yi Zheng [b], Ruihong Zhang [b], Bryan M. Jenkins [b]

[a] *Processed Foods Research Unit, USDA-ARS-WRRC, 800 Buchanan Street, Albany, CA 94710, USA*
[b] *Department of Biological and Agricultural Engineering, University of California at Davis, One Shields Avenue, CA 95616, USA*

Received 5 April 2006; accepted 14 March 2007

Abstract

Eucalyptus tree, *Eucalyptus cinerea*, has the potential to be used as a biomass crop to help manage saline subsurface drainage water in arid land where irrigated agriculture is practiced. In this research, saline eucalyptus was used to manufacture medium-density particleboard in an attempt to develop value-added application for the saline wood. This study investigated the effects of wood species (non-saline and saline), particle size, adhesive, bark content (BC), resin content (RC), and hot water treatment on the mechanical and water resistant properties of the medium-density particleboards made with eucalyptus woods. The measured mechanical properties included tensile strength (TS), modulus of rupture (MOR), modulus of elasticity (MOE), and internal bond strength (IB) of the finished particleboards. Water absorption and thickness swelling were tested to evaluate the water resistance properties. The particleboard made with 4% polymeric methane diphenyl diisocyanate (PMDI) resin had better qualities except for MOR than the particleboard made with 7% urea formaldehyde (UF). The particles of medium size (20–40 mesh) gave higher particleboard qualities, except for TS, than the smaller size (40–60 mesh) and larger size (10–20 mesh) particles. The qualities of particleboard were improved as the content of UF resin increased from 7% to 16%. The mechanical properties deteriorated as BC increased from 0% to 15.4%, but the water resistance was improved. The particleboard made from hot water treated wood particles had better qualities than the particleboard made from untreated particles. The particleboard made from saline wood had much better qualities than the particleboard made from non-saline wood. Saline eucalyptus is an appropriate material for manufacturing particleboards.

Keywords: Saline wood; Eucalyptus; Particleboard; Urea formaldehyde; Polymeric methane diphenyl diisocyanate; Mechanical properties; Water resistance

1. Introduction

Reuse of drainage water for irrigation is one of several options that farmers in California's San Joaquin Valley (SJV) are pursuing for managing subsurface drainage to alleviate problems with soil salinity and perched water tables. Environmental regulations restrict the discharge of agricultural drainage water into local water body. An innovative farm management system called integrated on-farm drainage management (IFDM) has been tested on a farm in the SJV. The IFDM uses drainage water to irrigate some salt tolerant crops, including Eucalyptus, Athel, Jose Tall Wheatgrass, and Creeping Wild Rye. The saline crops capture solar energy through photosynthesis and play an important role in transpiration of water

* Corresponding author at: Processed Foods Research Unit, USDA-ARS-WRRC, 800 Buchanan Street, Albany, CA 94710, USA. Tel.: +1 510 559 5861; fax: +1 510 559 5851.
E-mail address: zpan@pw.usda.gov (Z. Pan).

0926-6690/$ – see front matter © 2007 Elsevier B.V. All rights reserved.
doi:10.1016/j.indcrop.2007.03.006

and concentration of salts. However, in order to assure the sustainability of growing the saline crops, effective utilization of biomass from the crops is important. In this study, the feasibility of using saline eucalyptus as a suitable raw material for manufacturing particleboard was investigated.

Particleboard has been widely used throughout the world for furniture manufacture and house construction, including flooring systems, stair treads, and underlayment, etc. (Youngquist, 1999; Sellers, 2000). Recently, the demand for particleboard has continued to increase for housing construction and furniture manufacturing (Sellers, 2000). In 1998, 56.2 Mm^3 of particleboard was consumed worldwide (Youngquist and Hamilton, 2000). In 1999, approximately 85% of interior type particleboard was used as core stock for various furniture and cabinet application. Particleboard products are also commonly used for home decking and floor underlayment (Youngquist, 1999). The 76 particleboard mills in North America produced about 11 Mm^3 particleboards, accounting for 19% of the total wood composites manufactured in North America (Sellers, 2000, 2001).

Much research has been done on the use of various woods for particleboard manufacture. A summary of the selected studies is provided in this paper. Hiziroglu et al. (2002) investigated the use of Eastern Redcedar (*Juniperus virginiana* L.) to manufacture a commercial single-layer particleboard and reported that the Eastern Redcedar could be a suitable raw material to manufacture particleboards for commercial use. Oh et al. (2003) evaluated the strength properties and water resistance of wood composites from four Korean thinning logs, including *Pinus rigida* Miller, *Pinus densiflora* Sieb. et Zucc, *Larix leptolepis* Gordon and *Quercus acutissims* Carruthers. They reported that even though particleboards had significantly different physical strength and water resistance properties due to the different wood species, all of the thinning logs were suitable raw materials for particleboard manufacture. Nemli et al. (2004) manufactured medium-density particleboard from black locust (*Robibia pseudoacacia* L.) and noted that the tannin contents of black locust had significant effects on the properties of particleboards. Silica, phenol, and some oxidants, including CuO, CrO_3 and As_2O_5, have been reported to have significant effects on improving the mechanical properties, water resistance, and decay resistance of particleboards (Huang and Cooper, 2000; Clausen et al., 2001; Zhou and Kamden, 2002; Nemli et al., 2004).

The literature on using saline biomass for particleboard manufacture is scarce. In a recently study at the University of California at Davis, Zheng et al. (2006) found that the particleboard made from saline Athel, *Tamarix aphylla* L. possessed high mechanical properties and water resistance, which may have been due to the presence of some salts. Therefore, saline eucalyptus may also be used as raw material for manufacturing particleboard, which is the focus of this study.

The objectives of this study were to (1) compare the qualities of saline and non-saline eucalyptus particleboards, (2) characterize the mechanical properties and water resistance of medium-density particleboards made from saline eucalyptus as affected by wood particle size, adhesive type, bark content (BC), resin content (RC), and hot water treatment, and (3) study the effect of moisture content (MC) and BC on the pH values of wood particles.

2. Materials and methods

2.1. Materials

Polymeric methane diphenyl diisocyanate (PMDI) (100% solid content) and urea formaldehyde (UF) (C-TH39, 65.6% solid content) were used as the adhesives for making the particleboards. The UF and PMDI were obtained from Borden Chemical Company (Hope, AR) and Bayer Polymers LLC (Pittsburgh, PA), respectively. Ammonium sulfate was purchased from Fisher Scientific Chemical Co. (Fair Lawn, NJ) and used as curing catalyst for the UF resin.

Saline eucalyptus from 8-year-old trees was collected from the farm located near Five Points, California and then cut into approximately 40 cm long logs. The logs used in this study were from 16 trees with diameters ranging from 3 to 22 cm with harvest MC of 16.6–23.6%, which was measured according to the ASTM standard method (D4442-92, ASTM, 1997a). The average density and bark fraction of the logs were 0.77 g/cm^3 and 17.1%, respectively. All reported MC values are on oven-dry basis (db) unless specified otherwise. The logs were further reduced into 5–10 cm long chips with a Dosko Brush Chipper (Model 1400-12) before the chips were air-dried to about 7.5% MC at the Biomass Laboratory at the University of California at Davis. A 0.5 m long non-saline eucalyptus log (*Eucalyptus camaldulensis*) from an 8-year-old tree planted with fresh water was obtained from another farm near Davis, California. The average diameter, density, and bark fraction of the non-saline eucalyptus were 10 cm, 0.76 g/cm^3 and 17.4%, respectively. The chips were prepared using the same procedure for the saline eucalyptus.