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Characteristics of Particleboard Fabricated from Waste Wood Particles with Gingko Tree Leaves

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ABSTRACT

This study was performed to find potentialities of the leaves of gingko tree (*Gingko biloba* L.) as a raw material for particleboard (PB) manufacturing. Various amounts of the leaves were mixed with wasted wood particles to manufacture PB. Physical and mechanical properties, such as density, internal bond (IB) strength, and modulus of rupture (MOR) of manufactured PB were not much different from those of the control board. Formaldehyde emission values decreased with increasing the amount of leaves. Especially, the formaldehyde emission of PB made with 5 percent of leaves was decreased to 1.31 ㎎/ℓ, which is about 36% lower emission than that of the control. From these results, the leaves of gingko tree may be considered as an additive of lowering formaldehyde emission in a functional PB manufacturing process.

Key words: Gingko tree leaf, Particleboard, Physical & mechanical properties, Formaldehyde emission.

INTRODUCTION

The implementation of 'Indoor Air Quality Act' by The Ministry of Environment of the Republic of Korea (2004) requires the measurement of the formaldehyde emission levels as well as other 6 volatile organic compounds (VOCs) of new apartments to post the results for more than six months. In addition, the Ministry of Education and Human Resources has also announced that the guidelines and required levels of VOCs for school class room in May 2005.

Recycling of waste wood is important in Korea in terms of raw material supply for wood-based panel industry. The use of such recycled wood particles could make formaldehyde emission problem worse than sound materials. Therefore, it needed to solve those formaldehyde emission problem. One way of recycling waste wood is using it as mixture with other materials for wood composites. Park et al. (2004) reported formaldehyde reduction method with bamboo charcoal. Formaldehyde emission values of particleboard (PB) prepared with 3 percent of leaves was decreased to 1.66 ㎎/ℓ in formaldehyde emission, which is about 40% lower emission than that of the control. The author also examined a feasibility of using the cypress leaves as a partial raw material for the manufacture of PB to reduce formaldehyde emission (2005). Gwak et al. (2005) investigated the deodorant components of the essential oil of *Cryptomeria japonica* against benzene, toluene, xylene and formaldehyde. In this study, we investigated the potentialities of the leaves of gingko tree (*Gingko biloba* L.) as another raw material for lowering the formaldehyde emission.

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MATERIALS AND METHODS

Preparation of PB

The leaves of gingko tree (*Gingko biloba* L.) were collected from roadside in Korea Forest Research Institute (KFRI). The leaves were dried for 48 hours at 60℃ (MC, 5%), and then ground to obtain 4~5 mm in sizes for particleboard. The recycled wood particles (4~5mm) were dried about 1% of MC. The leaves of gingko were added to the recycled wood particles for PB at 1, 5, and 10wt%.

Urea-formaldehyde resin (60% solids content) used was obtained from a PB company. The mixture of gingko leaves and wood particles was thoroughly blended with UF resin adhesives at 10 wt% based on the oven-dry weight of recycled wood particles. The resin-blended particles were mat-formed in a forming box (300 ㎜ x 350 ㎜), and then hot-pressed at 210℃ for 300 seconds. As a control, recycled wood particles were also used to prepare particleboard. The target density was 0.65g/㎤ and the target thickness was 15 ㎜.

Measurement of particleboard's properties

Hot-pressed particleboard were conditioned for 1 week at 20℃, 65%RH before cutting for test specimens. Properties of particleboard, such as density, moisture content (MC), thickness swelling (TS), water absorption (WA), internal bond (IB) strength, modulus of rupture (MOR), modulus of elasticity (MOE), and formaldehyde emission, were measured by the procedures of KS F 3104 standard (2006).

RESULTS AND DISCUSSION

Physical properties

Fig.1 shows density and MC levels of particleboard prepared with different amount of the leaves of gingko tree. The density and the MC of PBs were 0.64~0.65g/cm^3 and 8.8~9.0%, respectively, which met the requirement (0.50~0.80) of the KS F 3104 standard.

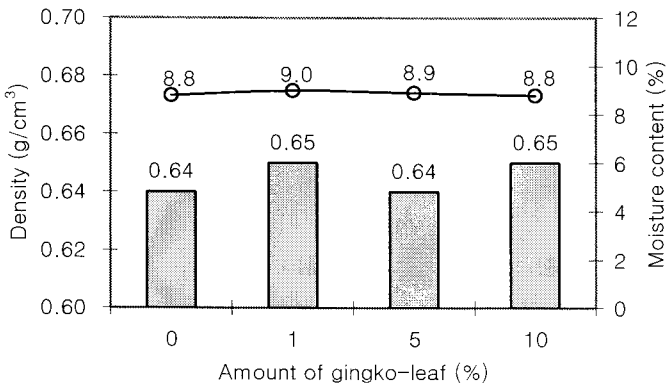

Fig.1. Density and moisture contents of the leaves of gingko tree added particleboards.

Fig.2 shows thickness swelling of particleboard after soaking in water for 24 hours. Thickness swelling of particleboard ranged from about 12.03% to 15.72%. The addition of gingko leaves

increased thickness swelling of particleboard increased compared to that of the control particleboard. Due to the relative weakness of the leaves of gingko tree, added leaves influenced the bond strength negatively.

Water absorption of particleboard was not much changed with the addition of gingko leaves. Water absorption ranged from about 49.7% to 53.5% for particleboard added gingko leaves.

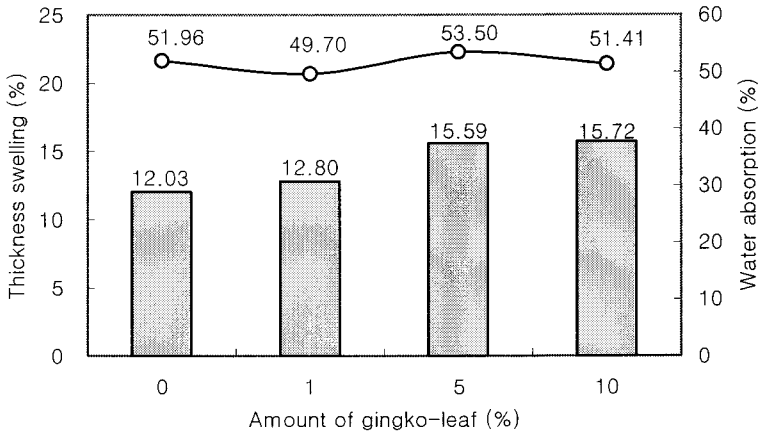

Fig.2. Thickness swelling and water absorption of particleboards mixed with the leaves of gingko tree.

Mechanical properties

Fig. 3 shows internal bond (IB) strength of particleboard, depending on the contents of gingko leaves. The IB strength was ranged from 6.60 kgf/cm^2 to 8.54 kgf/cm^2, which was lower than that of the control particleboard (9.33 kgf/cm^2). This result revealed that the urea adhesive which used in this research was the most effective for the bonding between particles. In addition, the relative strength of wood particles were stronger than that of gingko leaves, therefore, the stronger IB strength. IB strengths of all tested boards met the requirement (0.24N/mm^2(6.5kgf/cm^2) for type 15.0) of the KS F 3104 standard.

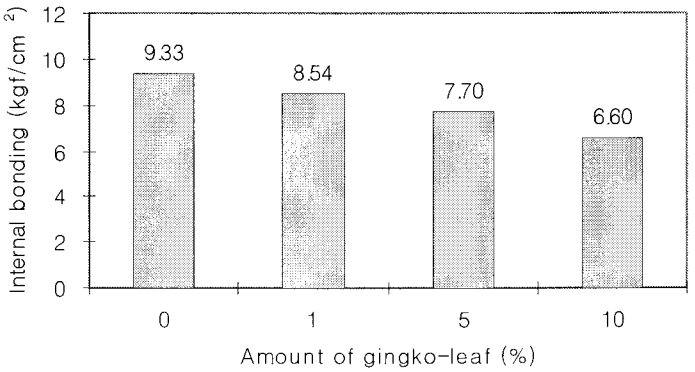

Fig.3. Internal bond strength of gingko-leaf added particleboard.

MOR values of particleboards added gingko leaves were ranged from 85.9 kgf/cm^2 to 113.7 kgf/cm^2. MOR values tended to decrease when gingko leaves amount increased.

MOE values of particleboards tended to decreased when the amount of gingko leaves increased, which was the same trend as MOR results. Both maximum MOR and maximum MOE values were obtained at 1% of gingko leaves addition level.

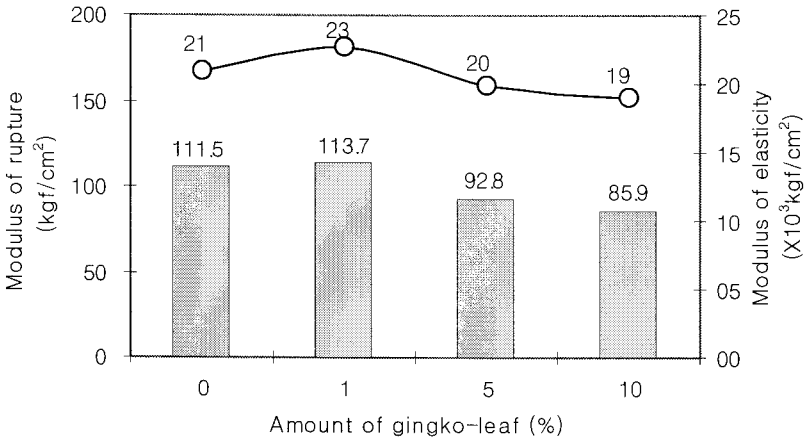

Fig.4. Modulus of rupture and modulus of elasticity of gingko-leaf added particleboards.

Fig. 5 shows the resistance of a nail withdrawal for particleboards. The nail withdrawal resistance of all prepared particleboards met the requirement (600N (61kgf) for type 15.0) of the KS F 3104 standard.

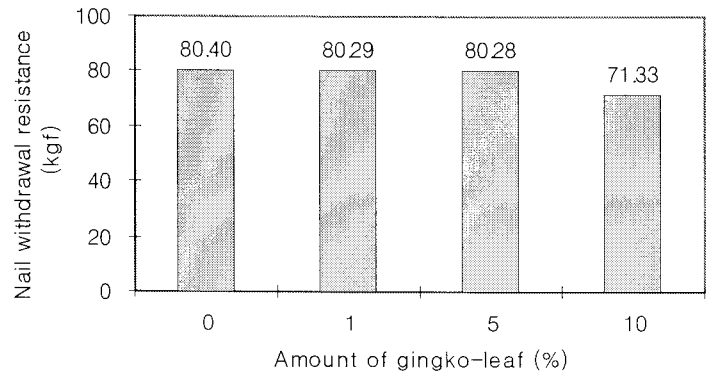

Fig.5. The resistance of nail withdrawal of gingko-leaf added particleboards.

Formaldehyde emission

Fig. 6 shows formaldehyde emission of particleboards prepared. Formaldehyde emission of the control particleboard without adding gingko leaves was about 2.06 mg/ℓ, which was lower than the E_1 grade (below 1.5 mg/ℓ with a maximum 2.1 mg/ℓ) specified by the standard (KS F 3104). Formaldehyde emission of particleboard gradually decreased as the content of gingko leaves

increased. When the gingko leaves added at 5%, formaldehyde emission decreased about 36%, compared to control board. In general, the addition of gingko leaves increased formaldehyde emission of particleboard decreased. It is assumed that flavonoid, a kind of polyphenol and one of major component of gingko-leaf, may form hydrogen bonding with formaldehyde molecules, thus formaldehyde emission may be decreased.

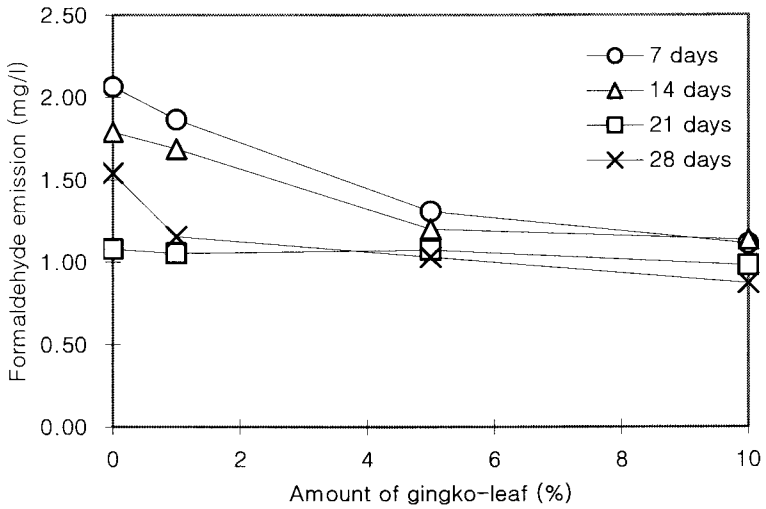

Fig.6. Formaldehyde emission of particleboards prepared with different contents of gingko leaves.

CONCLUSIONS

The results of this study showed that the addition of small amount of gingko-leaf did not harm physical and mechanical properties of particleboard while it reduced formaldehyde emission of particleboard. These results indicated that the gingko leaves could be effectively used for manufacturing particleboard.

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