Effects of Citric Acid and Calcium Carbonate to Mechanical & Flammability Properties of Corn Dust Waste Particleboard Using Polyvinyl Alcohol as Binder

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ABSTRACT

This research, the utilization of corn dust waste from corn processing plants was studied. The corn dust waste particleboards for application of fire-retardant wall panels were prepared. Polyvinyl alcohol (PVA) was used as a free formaldehyde binder, while citric acid crosslinker and calcium carbonate fire-retardant additive were used to enhance physical properties, mechanical properties, and fire retardancy, respectively. The particleboards were fabricated using a hot-pressing method at 150 °C and 1,500 psi for 30 minutes. The influences of citric acid and calcium carbonate contents on the physical properties, thermal properties, mechanical properties (flexural strength), and fire retardancy of the corn dust waste particleboards were investigated. The results showed that the corn dust particleboards containing 10% citric acid exhibited highest flexural strength of 1.16 ± 0.01 MPa. In addition, the particleboards demonstrated better water and moisture resistance in which water absorption and thickness swelling reduced, thereby enhancing the material's overall stability. Moreover, the addition of calcium carbonate in the range of 20 to 30 percent by weight of corn dust waste in the particleboard resulted in a reduction of flammability rate indicating that the addition of calcium carbonate increased the fire resistance of the particleboard.

OBJECTIVES

- To utilize & upcycling of industrial corn dust waste for use as formaldehyde-free flame-retardant wall panel application.
- To study effects of citric acid and calcium carbonate contents to the properties and flammability of corn dust waste particleboards.

KEY PROBLEM

Abundant corn dust waste → **Environmental Issues**

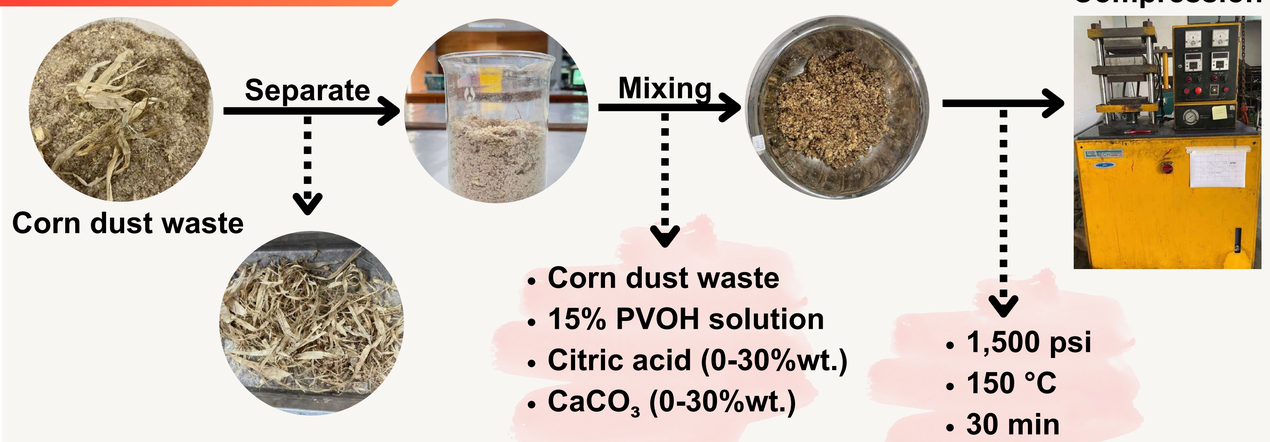
- From processing of corn products

- Air pollution
- Smoke & PM 2.5
- Greenhouse gases

GREEN SOLUTION

Decorative wall panel manufactured under pressure and heat with the addition of an adhesive.

EXPERIMENTAL



CHARACTERIZATION

- Morphology
- Bulk density
- Water content
- Water absorption
- Thickness swelling
- Thermal stability
- Bending test
- Flammability test

Reference : N.A Ramlee, M. Jawaid, S.A.K. Yamani, E.S. Zainudin, and S. Alamery (2021), Construction and building Materials, 276,122239.

RESULTS & DISCUSSION

Effect of citric acid content

Dimensional stability

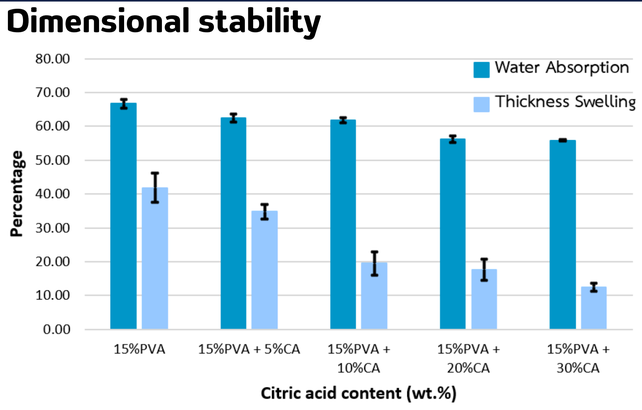


Fig. 1 Water absorption & thickness swelling of particleboards with various %CA.

Flexural strength (Bending)

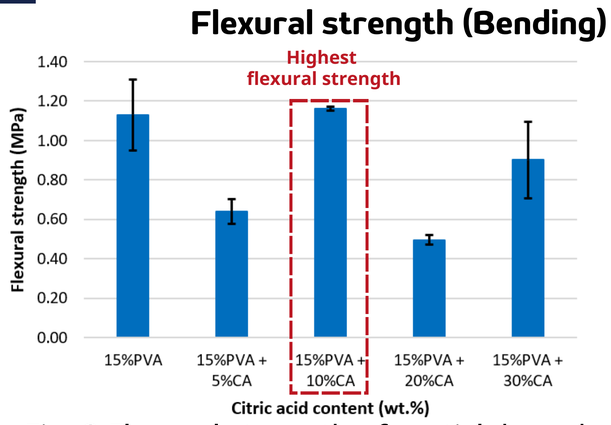


Fig. 2 Flexural strength of particleboards with various %CA.

CA ↑ Water absorp. & Swelling ↓

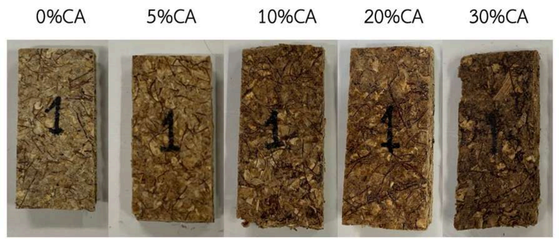


Fig. 3 Appearance of particleboards with various %CA.

CA ↑ Water absorp. & Swelling ↓

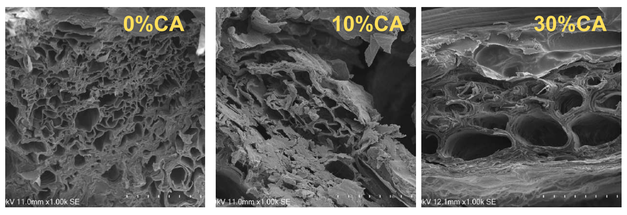


Fig. 4 SEM images of particleboards with various %CA.

Effect of calcium carbonate content

Dimensional stability

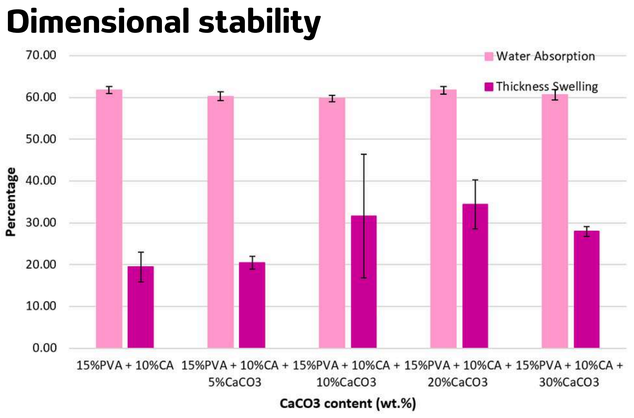


Fig. 5 Water absorption & thickness swelling of particleboards with various %$CaCO_3$.

Flexural strength (Bending)

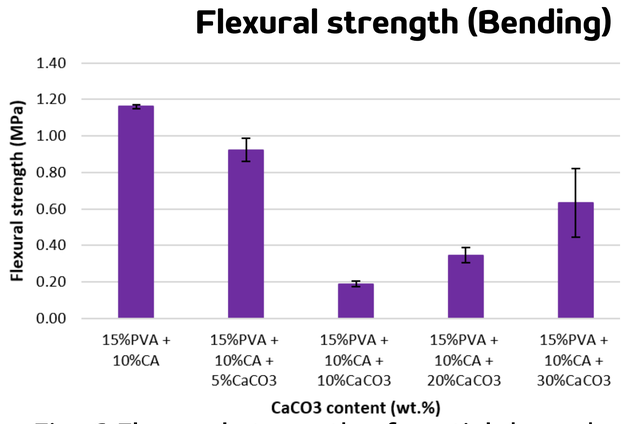


Fig. 6 Flexural strength of particleboards with various %$CaCO_3$.

$CaCO_3$ ↑ Thickness swelling ↑

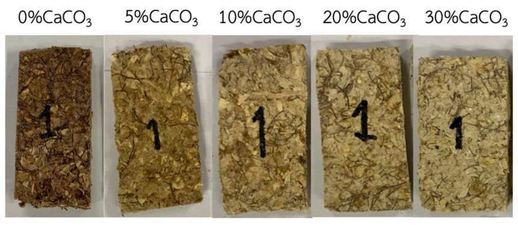


Fig. 7 Appearance of particleboards with various %$CaCO_3$.

$CaCO_3$ ↑ caused aggromeration

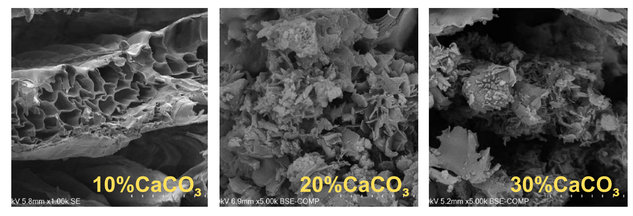
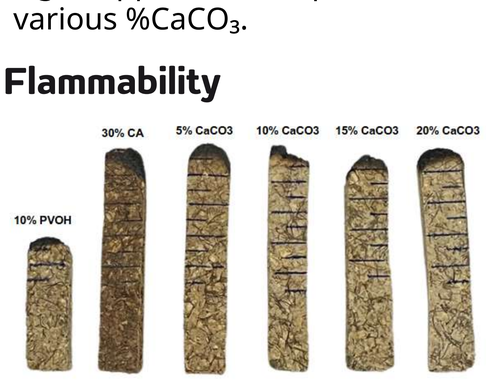


Fig. 8 SEM images of particleboards with various %$CaCO_3$.

Flammability



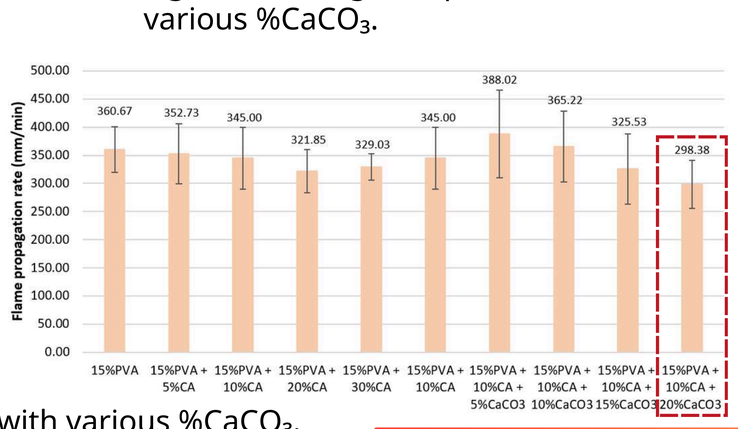


Fig. 9 Appearance of particleboards with various %$CaCO_3$.

CONCLUSIONS

- The corn dust waste particleboards containing 10% citric acid exhibited highest flexural strength.
- The corn dust waste particleboards showed improvement of water and moisture resistance which reducing water absorption and swelling for greater stability.
- Adding of 20–30% calcium carbonate reduced the flammability rate, enhancing the fire resistance of the particleboard.