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Development of Bio-based Water-repellent Wood Treatment**Bhagya, W.K.P. *, Senevirathne, G.V.D.P., Udayakumara, S.V.***Department of Materials Science and Engineering, University of Moratuwa,**Katubedda, Sri Lanka***piyushani.b.wanigasinghe@gmail.com***Abstract**

The significance of effective water-repellent treatments is crucial for withstanding moisture induced degradation, which compromises the durability and longevity of exterior hardwood applications. Conventional synthetic coatings such as polyurethane, varnishes, lacquers, and chemical preservatives offer effective protection against moisture degradation. However, they raise environmental-health concerns, emphasizing the importance of sustainable and non-toxic bio-based substitutions. This study focused on developing a bio-based water-repellent wood treatment employing local natural oils and waxes. This material selection was based on their major fatty acid components, which provide hydrophobic properties. Accordingly, bitter-melon seed oil with α -eleostearic acid was extracted using the Soxhlet apparatus. Castor oil with ricinoleic acid was dehydrated (280 °C) to improve its hydrophobicity by converting hydroxyl groups into unsaturated bonds. Beeswax was chosen due to its high myricyl-palmitate ester content hydrocarbon-rich structure, which enables water repellency by filling pores and forming a continuous protective film on wood substrate. The melted beeswax was combined with the two oils (wax-to-oil 1:3) at 60 °C and the coated samples were allowed to reach a dry-to-touch level for 72 hours under controlled environmental conditions. Then the formulation was evaluated through an extensive set of characterization techniques, including static water contact angle, liquid and vapor water absorption, dimensional stability and Scanning Electron Microscope (SEM) imaging for both treated and untreated mahogany wood samples. Results showed that treated samples exhibited $58\pm 0.8\%$ and $55\pm 1.2\%$ reductions in liquid and vapor water absorption, respectively, compared to untreated samples, with static water contact angles ranging from 148° to 159°. Moreover, the treatment also reduced volumetric swelling of samples by $58\pm 0.55\%$, compared to untreated samples, demonstrating a substantial enhancement in the dimensional stability. Obtained SEM images revealed that the untreated wood surfaces were highly porous with open cell lumens, while treated samples displayed a continuous, uniform film that filled and sealed these pores indicating an effective surface coverage. Thermal stability was assessed by cooling the coating solution from 85 °C to 35 °C. According to the results, the coating solution remained stable up to 50 °C, despite the melting point of beeswax being 65 °C, demonstrating improved stability of the oil-based coating formulation. All these characterization techniques were performed multiple times under steady controlled conditions for intensified reliability and validity of the results. The developed bio-based wood treatment offers strong practical potential as a safe, locally sourced, and eco-friendly alternative for protecting exterior hardwoods in construction, furniture, and outdoor structures.

Keywords: *Water-repellent, Wood treatment, Bio-based, Castor oil, Bitter-melon seed oil, Beeswax*