Sustainable Development of Microfibrillated Cellulose and Biochar Composites for Horticultural Containers

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Horticultural containers are crucial in plant propagation, growth, and transport. However, existing containers often fall short in terms of sustainability, durability, and environmental impact as they are manufactured with non-biodegradable fossil-derived resins, thus, more sustainable options are warranted. The development of sustainable composites seeks to combine the properties of various bio-based materials to improve performance and sustainability. Therefore, this study focuses on the formulation of composites of lignin-containing microfibers (LCMF), and biochar made from down timber, using polyvinyl alcohol (PVA) as a binder, and evaluate their performance for potential adoption by the horticultural industry as plant containers. To this end, the impact of different compositions of LCMF, biochar, and PVA on the mechanical properties and water absorption capacity of the composite materials was studied. The different polymers were mixed with a laboratory blender to obtain a homogenous mixture and compression molded at a temperature of 130°C at a pressure of 500 psi for six minutes. The mechanical properties and dimensional stability in wet conditions were key metrics to evaluate the performance of each formulation. Each specimen was mechanically tested using an Instron machine to determine tensile strength, elongation at break, and modulus of elasticity to provide information on the durability and robustness of the material under tension. Water absorption tests were performed to evaluate moisture resistance which is crucial for horticultural container applications where exposure to water is frequent. Preliminary results indicated that PVA served as a binder that facilitated the integration of LCMF and biochar, resulting in a more uniform composite structure compared to formulations without PVA. The findings of this study suggest that the strategic combination of LCMF, PVA, and biochar can produce biomaterial composites with desirable properties for horticultural applications. Future research includes studies of the biodegradability and environmental benefits of these composites in horticulture, laying the foundation for the development of advanced biomaterials that contribute to more sustainable agricultural practices.