Enhancing Tea-Waste Based Biopolymer Nanocomposite Performance Through a Biomimetic Cuticular Hydrocarbon Coating: A Sustainable Packaging Alternative

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Detrimental environmental effects of packaging waste have given rise to a shift towards eco-friendly packaging materials. A recent alternative employed are biopolymer nanocomposites, due to their feasible and biodegradable nature. The biopolymer nanocomposite under investigation is PVA@WTR-CDs, which incorporates carbon-dots derived from waste-tea-residue (WTR-CDs) as nanocomposites with the biopolymer 5wt% polyvinyl alcohol. A criticism of biopolymer nanocomposites is reduced tensile strength and decreased hydrophobicity. To address this, our investigation synthesizes a surface coating similar to cuticular hydrocarbons, a protective layer on social insects. Novel synthetic cuticular hydrocarbons were developed through the transesterification of carnauba wax, utilizing tert-butanol as an alkylating-agent and p-toluenesulfonic acid as a catalyst. The ratio of wax to alkylating-agent varied (1:0.25, 1:0.5, 1:0.75, and 1:1) with a control film containing no hydrocarbon-bilayer. Characterization of the films included testing tensile strength (N), hydrophobicity (contact-angle of water droplets), and UV absorption (Abs). Testing revealed that as the ratio increases, there is a concurrent rise in tensile strength, hydrophobicity, and UV absorption, with the 1:1 ratio obtaining the highest average tensile strength recorded at 25 newtons and a contact angle of 100.6° indicating immense hydrophobicity. Additionally, the 1:1 film also had the greatest UV absorption, with its highest absorbance occurring during the 350-400nm range. Thus, testing has revealed that the integration of a hydrocarbon bilayer with a 1:1 ratio of wax-base to alkylating-agent elevates the usage of biopolymer nanocomposites as a sustainable and effective packaging alternative.