Innovation From Nature: Production of Antibacterial, Antifungal, and pH-sensitive Smart Nano-Enhanced Smart Food Bio-Packing From Hazelnut Husk, Licorice Root, and Onion Peel

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This project aims to develop antibacterial, antifungal, and pH-sensitive bioactive smart food packaging using agricultural waste and by-products like hazelnut husk, onion peel, and licorice root. Lignocellulosic fibers from hazelnut husk, quercetin from onion peel, glycyrrhizic acid from licorice root, and agar-based bioplastic films from marine algae were developed as packaging materials. Halloysite Nanotubes (HNT) were added to enhance mechanical and thermal properties, while lignocellulosic fibers (LS) and glycyrrhizic acid (GA) provided antibacterial and antifungal effects. Quercetin (KR) pigment was included for pH-sensitive color change. Mechanical testing of the bioplastic films showed that adding HNT significantly increased maximum tensile stress and Young's modulus values. Characterization was done using Fourier Transform Infrared (FTIR) spectroscopy, opacity, color, water contact angle, mechanical durability, thermogravimetric analysis (TGA), water vapor permeability, UV-Vis spectroscopy, and food application tests. Antibacterial activity was tested against Escherichia coli (Gram-negative) and Staphylococcus aureus (Gram-positive), while Aspergillus parasiticus was used for antifungal testing. The packaging’s pH-responsive color change was observed using poultry meat, which turned from red-pink to purple-blue due to volatile amines released during spoilage. Results show that the Agar-HNT-LS Fiber-GA-KR composite films are cost-effective, eco-friendly, biodegradable, and have high potential in food packaging. This bioactive material promotes waste management, resource conservation, and sustainable production, offering an innovative solution to environmental challenges in the packaging industry.

Awards Won: