Chitosan-Coated Biodegradable Containers for Extending Food Shelf Life

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Food spoilage causes over 1.3 billion tons of global waste annually, largely due to microbial growth. This project investigated whether a chitosan-based antimicrobial coating applied to 3D-printed polylactic acid (PLA) containers could extend the freshness of produce. Chitosan, derived from crustacean shells, possesses antibacterial properties, making it a promising sustainable alternative to synthetic preservatives. Three PLA containers were 3D-printed and tested: uncoated, acid-soluble-chitosan-coated, and water-soluble-chitosan-coated. A commercial plastic container served as a control. Chitosan coatings were prepared as 1.5% solutions and applied to containers before drying. Four strawberries were placed in each container, with three used for daily mass measurements and one for spoilage monitoring. Spoilage progression was tracked via mass loss, visual appearance, pH, microscopic observations, nutrient agar cultures, and days until visible mold formation. Strawberries in chitosan-coated PLA containers showed delayed spoilage compared to uncoated PLA and plastic. Visible mold appeared on control samples by Day 9, while coated samples remained mold-free until Day 12, extending freshness by 33%. Coated samples maintained slightly higher pH values (0.5 increase), and agar tests showed smaller microbial colonies. While coated containers allowed slightly greater moisture loss due to their semi-permeable design, microbial growth was slowed overall. The water-soluble chitosan formed a thicker coating, while the acid-soluble coating showed fewer bacterial colonies in agar tests. These findings demonstrate that chitosan-coated PLA containers can delay spoilage and may serve as biodegradable food-contact materials to reduce food waste while repurposing seafood byproducts.

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