

## **Bio-Derived Polymer Coatings for Sustainable Food Packaging: A Technological Pathway Toward Climate-Conscious Waste Reduction**

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### **Abstract:**

The rapid increase in plastic waste from food packaging highlights the urgent need for environmentally responsible materials that align with global climate goals. This study presents a technology-driven approach to sustainable packaging through the design of bio-derived polymer coatings based on shellac, a naturally abundant resin. Essential oils were encapsulated within shellac microparticles fabricated via an electrospraying technique to achieve tailored monophasic, biphasic, and core-shell structures. This structural precision enhanced loading efficiency (up to 86.3%), improved storage stability, and enabled sustained release of active components. The optimized coating significantly reduced water vapor transmission ( $56 \text{ g m}^{-2} \text{ day}^{-1}$ ) and moisture absorption ( $\text{COBB 180s} \leq 20 \text{ g m}^{-2}$ ), demonstrating robust barrier performance. Biodegradation tests further revealed 90% mass loss within 15 days, confirming its environmental compatibility. By integrating material science innovation with sustainability objectives, this work presents a scalable strategy to reduce plastic dependency in food systems—bridging technology, education, and climate awareness to promote a circular economy.

### **Keywords:**

Biopolymer, Shellac, Sustainable packaging, Biodegradable.