Biopolymer Synergies from Waste: Production and Development of Compostable PHBV-Based Films for Sustainable Food Packaging

Vesna Ocelić Bulatović
Faculty of Chemical Engineering and Technology, University of Zagreb, Marulićev trg 19, 10000, Zagreb, Croatia

Dajana Kučić Grgić
Faculty of Chemical Engineering and Technology, University of Zagreb, Marulićev trg 19, 10000, Zagreb, Croatia

Stela Jokić
Faculty of Food Technology Osijek, Josip Juraj Strossmayer University of Osijek, Franje Kuhača 18, 31000 Osijek, Croatia

Krunoslav Aladić
Faculty of Food Technology Osijek, Josip Juraj Strossmayer University of Osijek, Franje Kuhača 18, 31000 Osijek, Croatia

Abstract

The increasing environmental impact of conventional plastic packaging, particularly in the food industry, has sparked global interest in biodegradable and compostable alternatives. Among the broad class of biopolymers, poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) has emerged as a particularly attractive candidate due to its biocompatibility, high biodegradability and promising barrier and mechanical properties. One of the focal points of this research is the utilisation of agro-industrial waste from the food industry for the production of PHA by microbial fermentation, followed by intracellular extraction and purification of the polymer. The utilisation of organic waste supports circular economy models while addressing sustainability challenges throughout the packaging value chain. In addition to the production of PHA biopolymers, research is also being conducted into the formulation and processing of PHBV in combination with other biodegradable polymers such as polylactic acid (PLA), thermoplastic starch (TPS), polybutylene adipate terephthalate (PBAT) and polybutylene succinate (PBS). These blends are processed into thin films and subjected to comprehensive physicochemical, mechanical, thermal, morphological, rheological and barrier property characterisation. Biodegradability and compostability are rigorously tested under controlled conditions according to international standards, with long-term tests lasting up to six months to determine the complete degradation profile. This research contributes to the further development of bio-based packaging systems tailored to food applications and emphasises the potential of PHBV-containing materials to meet both functional requirements and environmental goals. The results emphasise the role of integrative biotechnological and material engineering approaches in the transition to sustainable packaging solutions.

Keywords

poly(3-hydroxybutyrate-co-3-hydroxyvalerate), agro-industrial waste, biodegradable packaging, circular economy.

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