**RETASTE Conference Abstracts**
RETASTE-NOV-1427-In-person Poster
Rethymno, September 16-18, 2026
© Author(s) 2026 CC BY 4.0 License
DOI:10.5281/zenodo.23678198

# Upcycling Black Soldier Fly Farming by Products into Bio Fillers for Sustainable Biopackaging Materials

Eleftherios G. Andriotis[1,2,*], Anthia Matsakidou[3], Sotiria Krani[2], Agni D. Migkou[2], Maria-Apostolia Pissia[3], Dimitris S. Achilias[2], Maria-Teresa Capucchio[4] and Adamantini Paraskevopoulou[3]

[1]*Department of Creative Design and Clothing, School of Design Sciences, International Hellenic University, 61100, Kilkis, Greece*
[2]*Laboratory of Polymer and Dyes Chemistry and Technology, School of Chemistry, Aristotle University of Thessaloniki, 54124 Thessaloníki, Greece*
[3]*Laboratory of Food Chemistry and Technology, School of Chemistry, Aristotle University of Thessaloniki, 54124 Thessaloníki, Greece*
[4]*Department of Veterinary Sciences – Pathology Unit, University of Torino, 10095, Grugliasco (TO), Italy*

ACCEPTED

## Abstract

The global food industry faces significant challenges regarding the management of organic waste and processing side-streams. In recent years, the black soldier fly (Hermetia illucens) has emerged as a highly efficient driver of food repurposing and upcycling, capable of rapidly bioconverting low-value organic waste into valuable nutritional biomass. However, the expanding industrial-scale rearing of BSF inherently generates immense volumes of secondary by-products, including frass and residual exoskeletons. Identifying high-value, non-feed applications for these residual streams is critical for fully closing the loop in a circular bioeconomy and transforming remaining agricultural waste into advanced, sustainable resources. This study explores the valorization of black soldier fly (BSF) by-products as functional bio-fillers for the development of sustainable film materials derived from food-related resources. BSF by-products—comprising dehydrated larvae (protein and lipid fractions), frass (excrement, shed exoskeletons, and undigested feed), and larval exoskeleton residues (moults and pupae)—were processed into a dry powdered mixture and incorporated into two distinct film matrices. In the first approach, the BSF powder was physically blended with sodium alginate and glycerol in the absence of water to produce dry alginate-based composite films. In the second approach, tannic acid was incorporated with the BSF powder and blended with water, using polyethylene glycol (PEG) as a plasticizer, to facilitate the formation of uniform, cohesive films. Both composite systems were characterized using FTIR, DSC, TGA, optical microscopy, water resistance testing, sessile drop contact angle measurements, thickness determination, gas barrier evaluation, and water vapor permeability (WVP) assessment. The results demonstrate that insect-derived biomass can be effectively transformed into value-added materials, offering a promising route for upcycling food production side-streams into biodegradable packaging films with tailored barrier and mechanical properties. The objectives and findings of this research are part of the OLIWA project (Repurposing OLIve WAste in circular economy solutions for feeds, additives, packaging, and biogas), an international initiative focused on establishing sustainable, zero-waste value chains across the Mediterranean. A key pillar of the OLIWA framework involves

utilizing localized agricultural waste—such as olive industry by-products—for insect rearing and subsequently developing eco-friendly bio-packaging materials from the resulting insect-derived biomass. By demonstrating the technical feasibility and functional efficacy of black soldier fly by-products as bio-fillers in composite film matrices, this study provides critical scientific validation for OLIWA's circular model. Ultimately, the successful development of these insect-fortified biopolymers directly supports the project's mission to extend food preservation, reduce reliance on conventional plastics, and transform integrated agricultural waste streams into high-value, sustainable packaging solutions.

**Keywords:** Bio-fillers, Biopackaging, Upcycling, Circular Valorization

ACCEPTED