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Safe Implementation of Sustainable Insect Proteins: Allergenic Protein Characterisation and Risk Assessment

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Abstract

Edible insects are increasingly promoted and implemented as sustainable alternative protein sources for food and feed applications due to their favourable environmental footprint and nutritional value. However, their phylogenetic relatedness to crustaceans raises important food allergy safety concerns for shellfish-allergic consumers. While tropomyosin is recognised as a major cross-reactive allergenic protein (allergen), the broader diversity of insect allergens contributing to potential allergic risk remains insufficiently characterised. This study investigated allergenic proteins in commercially available edible insects using integrated immunological and proteomic approaches to support evidence-based risk assessment of sustainable insect proteins.

Protein extracts from commercial products derived from *Acheta domesticus* (cricket) and *Hermetia illucens* (black soldier fly; BSF) larvae were analysed using SDS-PAGE and immunoblotting. IgE-binding profiles were assessed using sera from 42 individuals with confirmed crustacean allergy. IgE-reactive proteins were identified by liquid chromatography-mass spectrometry (LC-MS/MS) and supported by whole-extract proteomic profiling. Cross-reactivity was further evaluated using allergen-specific antibodies raised against shrimp allergens from *Penaeus monodon* and *Penaeus vannamei*, alongside sequence conservation and putative IgE epitope analyses.

Patient sera identified both shared and species-specific IgE-reactive proteins in cricket and BSF larvae, including tropomyosin, hemocyanin, myosin light chain, vitellogenin, heat shock proteins, apolipophorin, and chitin-binding proteins. Tropomyosin demonstrated the highest IgE reactivity in cricket products (40%, n=42). Immunoblotting using shrimp allergen-specific antibodies further supported cross-reactivity between insect and shellfish proteins. Proteomic profiling identified tropomyosin as a dominant allergen in cricket and hemocyanin in BSF larvae, with several other allergen homologues demonstrating >60% sequence similarity to crustacean proteins.

These findings demonstrate that edible insects contain multiple IgE-reactive proteins beyond tropomyosin, with heterogeneous recognition patterns among crustacean-allergic individuals. Comprehensive allergenic protein profiling of sustainable insect proteins is therefore essential to support food safety assessment, food allergy risk management, and the responsible integration of insect-derived protein into future food systems.

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