

***Hermetia illucens* larvae can exploit substrates with different nutritional quality thanks to the morphological and functional adaptability of the midgut**

Marco Bonelli¹, Daniele Bruno¹, Matteo Brilli¹, Simone Pitton¹, Novella Gianfranceschi¹, Gianluca Tettamanti², Morena Casartelli¹

¹ University of Milan, Italy; ² University of Insubria, Italy

The use of insects as a primary agent for organic waste reduction and bioconversion can contribute to the management of organic waste and, at the same time, represent a source of valuable products, such as proteins for feed production, biodiesel, bioplastic and bioactive molecules. In this setting, the larvae of black soldier fly (BSF), *Hermetia illucens* (Diptera: Stratiomyidae), have captured great attention because of their capacity to grow on a variety of waste organic matter and bioconvert this material into valuable products. Even though composition, moisture, and nutrient concentrations of the rearing substrate can significantly affect insect performances and biotransformation processes, the astonishing adaptability of this insect to dietary substrates without any dramatic impact on its development strongly suggests that BSF larvae can finely and profitably regulate nutrient intake and post-ingestion processes to match their nutritional requirement.

Here we address this issue by investigating if and how the midgut of BSF larvae, the organ involved in the digestion and absorption of nutrients, sets in motion post-ingestion responses to compensate variations in nutrient composition of the diet. We chose two rearing substrates: a nutritionally balanced diet for dipteran larvae and a nutritionally poor diet that mimics fruit and vegetable waste composition. Our data show that larval growth performance was affected only moderately by the unbalanced substrate because a diet-dependent adaptation process of the midgut ensured its exploitation; in particular, differences in cell morphology, activity of digestive enzymes, and accumulation of long-term storage molecules were observed. Moreover, transcriptome analysis of midgut samples from larvae reared on the two substrates showed that genes encoding proteins with important roles in midgut function were differentially expressed, confirming the functional adaptation of this organ. Our data demonstrate that the functional plasticity of the midgut has a key role in the ability of BSF larvae to grow and develop on substrates with low nutrient content.

KEY WORDS: *Hermetia illucens*, larval midgut, functional adaptability.