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Growth performance of the black soldier fly (*Hermetia illucens*) on by-products from brewing production

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Hermetia illucens (Diptera: Stratiomyidae), also known as the black soldier fly, is considered an interesting candidate as alternative source of protein for livestock. Larvae of this species are able to efficiently bio-convert organic waste material into insect biomass. In addition, larvae can consume twice of their weight per day of waste, accumulating high amounts of protein and fat. The choice of the correct rearing substrate is essential in order to contribute to the disposal of waste or by-products obtained from the various stages of the industrial food production, that could hardly find other utilization, and to maximize the production of black soldier fly prepupae. Moreover, it is important to identify a low-cost diet with no competition with animal or human consumption. Among numerous by-products of vegetal origin, in this study black soldier fly larvae were reared on the following substrates originating from the brewing production: brewer's spent grain, trub, and a mix of the two by-products (50 and 50%). The influence of the rearing substrates of the different life-history traits was observed. In particular, we considered the survivorship of the different developmental stages, the larval final weight, the duration of the larval period and the emergence of adults. Larvae could complete their development on the three substrates tested. Nevertheless, some differences were observed on the different parameters. In particular, the mixture of the two by-products resulted in a faster growth of the larvae that took less days to reach prepupal stage than the ones grown on the single by-product. The same trend was noticed on the final larval weight. The mortality of the larvae was significantly higher on those grown on brewer's spent grain, while no differences were noticed among the other substrates. This study showed the possibility to rear the black soldier fly on different by-products coming from the brewing production industry, that can therefore represent an interesting rearing substrate for the insect. More research is needed to optimize the diet for a possible use in mass rearing system.

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The influence of diet on the morphofunctional properties of *Hermetia illucens* (Diptera: Stratiomyidae) larval midgut

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Hermetia illucens (Diptera: Stratiomyidae) is among the most promising organisms for the bioconversion of organic waste in proteins for feed production, because the larvae are able to grow on a wide variety of organic substrates and the dry-matter of the prepupae contains a very high percentage of protein with high nutritional value. One of the potential substrates for bioconversion by *H. illucens* is Fruit and Vegetable Waste (FVW), which could be provided in large amounts by large-scale retail trade and wholesale markets. However, in view of a possible application of this system, it is fundamental to evaluate the biological performance and the morphological, physiological, and molecular responses of *H. illucens* reared on this food substrate. In the present study we compared larvae reared on a standard diet for dipteran larvae and on FVW. In particular, after evaluating the growth performances, we focused our attention on the midgut, which is responsible for nutrient digestion and absorption. The morphological changes occurring in this organ after the ingestion of the two diets were investigated by optical microscopy. Moreover, an evaluation of midgut functionality was performed. An analysis based on enzymatic histochemistry was carried out to evaluate specific differences in lipids and glycogen accumulation in midgut cells. Finally, we assessed the activity and the mRNA expression levels of enzymes involved in digestion, focusing on proteolytic and amylolytic ones. Our results demonstrate that the extraordinary feeding plasticity of this insect corresponds to an extraordinary biological, morphological, physiological and molecular plasticity, that allows larvae to perform an effective bioconversion of FVW, opening up interesting application perspectives. This work was supported by Fondazione Cariplo (Insect bioconversion: from vegetable waste to protein production for fish feed, ID 2014-0550).