WormSorter: An Innovation for Harvesting High-Quality Black Soldier Fly Larvae for Animal Feed by Using Aggregation Behavior

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Black soldier fly larvae (BSFL) are increasingly recognized as a promising alternative protein source that can help address solid waste issues amid rapid global population growth. However, harvesting high-quality larvae requires efficient separation from rearing substrates and classification of developmental stages to meet various livestock. Traditional sieving methods often cause high mortality, mechanical stress, microbial contamination and significant labor demands. This project aims to develop a novel method to harvest BSFL by leveraging their aggregation behavior for substrate separation. We investigated how larvae at different stages respond to stimuli such as light, gravity and airflow. The results showed that pre-pupae exhibited negative phototaxis and geotaxis, remaining on the substrate surface for airflow while other stages burrow. Notably, light and gravity stimuli accelerated pre-pupa aggregation by 2.1 and 1.6 times, respectively. Next, we developed WormSorter, an innovative separation method integrated with AI to detect complete aggregation behavior. To optimize efficiency, the system leverages phototaxis and geotaxis, facilitating the automated sorting of larvae based on developmental stage and size. This method achieved 100% separation of pre-pupae from the rearing substrate and effectively categorized larvae by size. The mortality rate during the separation process was only 2.4%, which is 4.8 times lower than that of traditional methods, and reduced the separation time up to 2.5 fold. Our innovation resulted in a higher concentration of essential amino acids (leucine, valine, lysine) for livestock and a reduction in stress-related markers in larvae. This method enables efficient, high-quality BSFL harvesting to support sustainable global food security.

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