Nutrient flows and associated gaseous emissions of the production of black soldier flies

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Black soldier fly larvae (BSFL) production is on the rise. BSFL can grow on a wide range of organic streams making them ideal candidates to turn organic streams into biomass that can be upcycled in the food system, as either animal feed or human food. Even though previous studies have reported the efficiency with which BSFL convert dry matter and nitrogen in different organic streams into larval biomass, little is known about when and how nutrient losses occur. Here we aimed to quantify the flows of dry matter, carbon, energy, nitrogen, phosphorus and potassium between a diet currently used for large-scale BSFL production, and the larval biomass, residues, and gaseous emissions during BSFL rearing in a climate respiration chamber. Larval conversion efficiencies ranged from 14% (potassium) to 38% (nitrogen). The proportion of dietary inputs found in the residues ranged from 53% (energy) to 87% (potassium), while the proportion of dietary inputs lost via gaseous emissions ranged from 0.7% (nitrogen) to 23% (carbon). We found high concentrations of starch in the residues, indicating that BSFL did not use all the feed provided. Correcting carbon and energy efficiencies for unconsumed starch increased BSFL carbon and energy conversion efficiencies slightly. Even though gaseous nitrogen losses were minimal, ammonia-nitrogen was produced with a defined temporal pattern, starting on the fifth rearing day right after the peak of carbon dioxide was reached. Direct emissions of methane and nitrous oxide during the rearing were 14.9 ± 2.3 g CO_2-equivalents per kg of dry BSFL. Our results are relevant for the improvement of BSFL conversion efficiencies and for understanding the dynamics of gaseous emissions during BSFL rearing.