

Effectiveness of *Hermetia illucens* (Diptera: Stratiomyidae) Larvae at Decomposing Household Food Products

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Abstract: Efforts to control and dispose of human food waste typically rely upon increasing public awareness of the problem and improving retail management practices to mitigate the amount of food thrown away. Food waste becomes an increasingly noticeable problem as the world population continues to grow, creating a host of environmental concerns. A recently executed experiment examined the ability of *Hermetia illucens* (Family Stratiomyidae and Order Diptera) to decompose household food waste. In previous studies, *Hermetia illucens* (Black Soldier Fly) has shown promising ability to decompose organic food waste. In our experiment, we intervened in the life cycles of *Hermetia illucens* larvae by feeding them five separate food groups over a two week timespan: grains, vegetables, fruits, meat, and dairy. By comparing the initial start weight of the larvae and the end weight after the larvae consumed their respective food groups, it was determined that *Hermetia illucens* larvae decompose fruit, meat, and vegetables most effectively. These findings suggest that *Hermetia illucens* larvae may be a viable alternative to decompose specific food groups in everyday household environments.

Keywords: food waste, black soldier fly, *Hermetia illucens*, decomposition, composting, larvae

Black soldier fly (*Hermetia illucens*) larvae are classified under Order Diptera and Family Stratiomyidae and have been increasingly researched for their composting and waste reduction potential (Nguyen et al 2015). These larvae can be used for forensic cases that involve decomposition over long periods of time, allowing investigators to determine post-mortem intervals with greater accuracy (Nguyen et al 2013). More recently, black soldier fly larvae have been studied for

composting purposes. In recent studies, black soldier fly larvae have exhibited effective ability to decompose biodegradable waste, successfully reducing organic food waste and fecal matter and providing a promising option for organic waste reduction in the future (Nguyen et al 2015, Banks et al 2013). In addition, black soldier fly larvae have been shown to reduce levels of *Escherichia coli* and *Salmonella enterica* in chicken manure, demonstrating their value and role in organic

waste reduction and sanitation (Erickson et al 2004). Furthermore, black soldier fly larvae have been shown to act as a biological control for house flies (*Musca domestica*) by outcompeting house flies for oviposition sites (Bradley and Sheppard 1984, Sheppard et al 1994). Therefore, the purpose of this experiment was to determine the effectiveness of black soldier fly larvae in decomposing various household food groups. As the global population steadily increases and the general public is becoming more environmentally conscious, organic waste is becoming a major concern that demands a more sustainable and effective waste management option. This experiment examined how effectively black soldier fly larvae decomposed some typical household foods consumed by the general public.

Materials and Methods

5,700 black soldier fly larvae in total were provided by Symton Black Soldier Fly (Symton™ Black Soldier Fly, College Station, TX). Five sets of 500 randomized small black soldier fly larvae were sifted and placed in each of five flat, plastic tubs of uniform dimensions. The larvae in each tub were fed 125 grams of a different item from each of the major food groups: white bread (grains), collard greens (vegetables), chopped peaches (fruit), rotisserie chicken (meat) or shredded cheese (dairy). Food was obtained from an everyday consumer supermarket. A positive control was taken by feeding a customized entomology grain food blend to 500 larvae in a plastic tub. This custom-made food is specifically made for black soldier fly larvae and contains the appropriate nutritional requirements and

moisture content necessary for larvae to grow. A negative control was taken by placing 200 larvae in a plastic tub with no food. A scale was used to weigh food groups and take pre- and post-weights of the fly larvae from each food group. Initial weights of the larvae were taken by weighing the larvae in their respective tubs after zeroing out the weight of the tubs. After 5 days, the larvae were sifted and weighed again. The remaining food waste was weighed and recorded. Two cohorts were performed. These methods were repeated exactly as written once more and the results were compared.

Results

On average, the larvae before feeding weighed 3.5 grams. The first cohort showed that most of the food types were decomposed at equal rates. The total weight of the larvae in each section was as follows: larvae in fruit weighed 5.06 grams, in meat weighed 4.75 grams, in vegetables weighed 5.11 grams, in grains weighed 5.04 grams, and in dairy weighed 5.03 grams. In this trial, the only remaining food substance left in the container, meaning that it was not fully decomposed, was white bread.

In the next cohort, all larvae were able to thrive in their environment. The total weight of the larvae in each section was as follows: larvae in fruit weighed 25.20 grams, in meat weighed 23.25 grams, in vegetables weighed 22.65 grams, in grains weighed 7.00 grams, and in dairy weighed 6.95 grams. In this cohort, the development of larvae and decomposition of food waste was more successful with fruit, meat, and vegetables.

Average Weights of Larvae After Feeding by Food Group

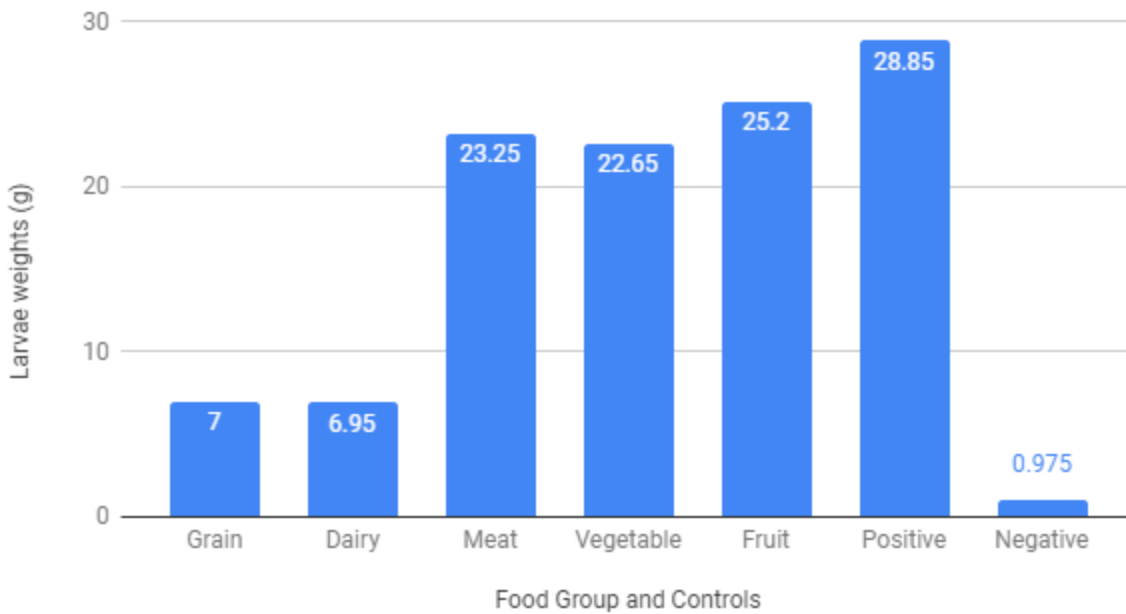


Fig. 1. Mean weight (in grams) of *Hermetia illucens* larval cohorts after 5 days of feeding, separated by food group. The low weights in the grains and dairy cohorts indicate an unknown failure to thrive in those specific food groups.

The positive control weighed 5.11 grams, while the negative control weighed 5.08 g. The average weight of the larvae in both cohorts after feeding is described in Figure 1 above.

The overall weight difference was as follows: larvae in fruits increased by 21.58 grams, larvae in meats increased by 19.47 grams, larvae in vegetables increased by 19.29 grams, larvae in grains increased by 3.75 grams, larvae in dairy increased by 3.45 grams, positive control increased by 25.74 grams, and negative control decreased by 4.11 grams.

Discussion

This study provides new data on the effectiveness of black soldier fly (BSF) larvae in decomposing biodegradable food

waste. In total, the larvae were most successful at decomposing fruit, meat, and vegetables. When considering the nutritional makeup of these food products, fruits are high in glucose and sucrose, which are used by cells to produce ATP. This allows the larvae to have increased energy production and, ultimately, increased growth and weight gain. Meats such as chicken are a great source of protein, and increased protein intake also allows for increased growth. Vegetables, including the collard greens used in this study, are extremely rich in nutrients like vitamin A, iron, vitamin E, and other nutritional organic compounds that all contribute to increased growth (Saini 2017). On the other hand, white bread lacks many essential nutrients, contributing to decreased growth. These larvae did not have the proper nutrients to continue to grow and feed. Cheese is also considered a good source of

protein, but in this study, it did not promote growth in the same way as chicken did. This may be because of increased preservatives or additives found in grocery store cheeses. All in all, BSF larvae seem to be able to decompose fruit, meat, and vegetables more successfully than dairy and grain. One additional factor that could have affected the ability of the larvae to decompose the foods was the moisture content of each food sample. The peaches and collard greens contained the most moisture content in all of our food groups, which the bread and cheese lacked. The chicken contained some moisture but not as much as the fruit and vegetable food groups. The food groups with the most moisture content displayed the most successful results when fed to the larvae. This study demonstrates that BSF larvae can successfully decompose common household food waste, such as fruit, meat, and vegetables, in a 2-week timespan.

Many researchers have looked into using BSF larvae to decompose organic waste and it has been shown that BSF larvae can turn this organic waste into useful byproducts and edible biomass (Kumar et al 2018, Spranghers et al 2016). Creating composting bins in a domestic setting greatly reduces food waste in landfills. Waste will continue to be an issue and this study provides insight on how individuals can address this serious problem with a simple solution. The results of this study are valuable to any individual who produces waste and will be useful for the future of composting and waste management. As the global population continues to increase, waste management is a primary concern in the developing world. The data collected in

this study reinforces the utilization of BSF larvae in decomposing large amounts of organic food waste and may help provide insight into new ways of waste management in upcoming years. Future studies using similar methods to compare different foods in the same food groups would help to expand our knowledge of these flies as decomposers. Utilization of various other fly species would also be a worthwhile inquiry. Moreover, since there seems to be a difference in the decomposition and utilization of overly processed foods, a composting study using foods high in preservatives would also help researchers understand how these foods decompose. Furthermore, future studies could examine the effectiveness of BSF larvae at decomposing other organic material such as manure, which is becoming an environmental concern as the increased demand for animal products necessitates more concentrated farms with higher levels of waste (Čičková et al 2015). There are still many questions about composting that need answers, but this study provides a solid base of information about the decomposition habits of the BSF.

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