MARI

MULTIDISCIPLINARY APPLIED RESEARCH AND INNOVATION
e-ISSN: 2773-4773

Vol. 7 No. 2 (2026) 219-224
https://publisher.uthm.edu.my/periodicals/index.php/mari

Study of Maggot as a Natural Decomposer of Food Waste at UTHM Cafe, Pagoh Campus

Adib Afnan Rosmadi[1], Izat Yahaya[1,2]*, Muhammad Ainal Yaqin M Z Mulyady[1], Nabil Hakimi Fazdli Fazdrul Izwan[1]

[1] *Department of Civil Engineering, Centre for Diploma Studies, Universiti Tun Hussein Onn Malaysia, Pagoh Higher Education Hub, 84600 Pagoh, Johor, MALAYSIA*

[2] *Ecohydro, Centre for Diploma Studies, Universiti Tun Hussein Onn Malaysia, Pagoh Higher Education Hub, 84600 Pagoh, Johor, MALAYSIA*

*Corresponding Author: yahizat@uthm.edu.my

DOI: https://doi.org/10.30880/mari.2026.07.02.028

Article Info

Received: 1 March 2026
Accepted: 1 May 2026
Available online: 30 June 2026

Keywords

Black Soldier Fly Maggot (BSFM), Food Waste Decomposition, Maggot-to-Waste Ratio, Sustainable Waste Management, Circular Economy, Small-Scale Composting.

Abstract

Organic waste generated by institutional sources, such as university cafeterias, is a growing environmental concern due to its contribution to pollution, unpleasant odors, and ineffective disposal practices. This study investigates the potential of Hermetia illucens larvae, commonly known as Black Soldier Fly Maggots (BSFM), as a natural decomposer for food waste produced at the UTHM Pagoh Residential College cafeteria. The main objective was to determine the optimal maggot-to-waste ratio for rapid, efficient decomposition. The experiment was conducted over a two-month period, from April to early June 2025, using a home-like lab setting with one container per cycle across six experimental conditions. In Set 1, the BSFM weight was fixed at 500g while the food waste amount varied (250g, 500g, 750g). In Set 2, the food waste was fixed at 500g while the maggot weight varied (250g, 500g, 750g). Decomposition time and reduction efficiency were recorded, alongside physical observations such as waste liquefaction, odor development, and larval changes. The most effective decomposition occurred when 500g of BSFM was paired with 250g to 500g of food waste, achieving over 75% reduction within 5 to 7 days. These findings highlight BSFM as a low-cost, eco-friendly solution for small-scale organic waste management, particularly in institutional settings, and support the development of scalable composting systems that reduce waste by reusing organic materials rather than throwing them away.

1. Introduction

Food waste has become a significant environmental challenge, particularly within institutions such as university campuses. At Universiti Tun Hussein Onn Malaysia (UTHM), Pagoh Campus, the cafeteria generates a considerable amount of food waste daily, contributing to foul odours, unsanitary conditions, and environmental degradation. The use of traditional waste disposal methods like landfilling further exacerbates this issue, leading to the release of greenhouse gases and long term soil and water pollution. Without intervention, this problem may intensify and negatively impact the health and well-being of the campus community [1]. While conventional composting methods have been employed to manage food waste, they tend to be slow, space intensive, and often inefficient in settings with high waste volumes and limited infrastructure. This limitation has prompted the search for more innovative and scalable alternatives. One such approach is the use of Black Soldier Fly Maggots (BSFM), known for their ability to rapidly break down organic waste while producing valuable byproducts such as protein-rich larvae and organic compost [2], [3]. BSFM offers a sustainable, low cost, and environmentally friendly method of reducing food waste at the source.

BSFM, or Hermetia illucens, is particularly effective due to its short decomposition cycle, high consumption rate, and adaptability to various organic materials such as cooked food, vegetables, and meat residues [4]. Their role in reducing methane emissions, preventing landfill overload, and enabling circular economy practices makes them an ideal candidate for institutional waste management. Studies have shown that BSFM can reduce food waste by up to 80% within 3 to 7 days, outperforming many conventional biological methods [5]. Consequently, the immense volume of residue left behind known as frass serves as a nutrient-rich organic fertilizer, making this rapid bioconversion a highly efficient strategy for agricultural resource recovery [6]. This study aims to evaluate the performance of BSFM in decomposing food waste collected from the UTHM Pagoh cafeteria. The research investigates the optimal maggot-to-waste ratio and monitors key indicators such as decomposition time, waste reduction percentage, and physical transformation of both the waste and the larvae. By doing so, the study not only explores the viability of BSFM as a waste solution but also contributes to UTHM's larger sustainability efforts. Furthermore, it seeks to provide a replicable model that other campuses and small communities can adopt to manage food waste in a practical and eco conscious manner.

2. Methodology

This study adopted a quantitative, experimental design to evaluate the decomposition efficiency of Black Soldier Fly Maggots (BSFM) in managing organic food waste collected from the UTHM Pagoh Residential College cafeteria. The experimental work was conducted over a period of two months, from April to early June 2025, using a controlled home-based setup to minimize environmental variability and allow for consistent observation. Food waste, consisting primarily of rice, vegetables, and cooked leftovers, was collected biweekly and sorted to remove any non-biodegradable materials. Each batch was weighed using a digital scale according to the test condition. The study was divided into two experimental sets. A complete overview of the experimental parameters for each set is presented in Table 1. In Set 1, the BSFM mass was fixed at 500g, while food waste amounts were varied at 250g, 500g, and 750g. In Set 2, the food waste was kept constant at 500g, while BSFM mass was varied between 250g, 500g, and 750g. A total of six cycles were conducted, with one container used per cycle.

Table 1 *Experimental parameters of each set*

Set	BSFM Mass (g)	Food Waste (g)	Variable
1A	500	250	Food Waste
1B	500	500	Food Waste
1C	500	750	Food Waste
2A	250	500	BSFM Mass
2B	500	500	BSFM Mass
2C	750	500	BSFM Mass

Each sample was placed into a ventilated plastic container and allowed to decompose under natural indoor conditions. No additional feeding, mixing, or artificial control of moisture or temperature was applied during the process. Daily visual observations were made and recorded, focusing on physical changes in the food waste (e.g., texture, color, odor) and BSFM behavior (e.g., movement, pupation). No instruments were used to measure temperature or moisture all assessments were done by eye. Decomposition was considered complete when no visible food particles remained, and only frass was present. The number of days taken for complete decomposition was recorded for each cycle, and reduction efficiency was calculated based on the initial and final waste weights.

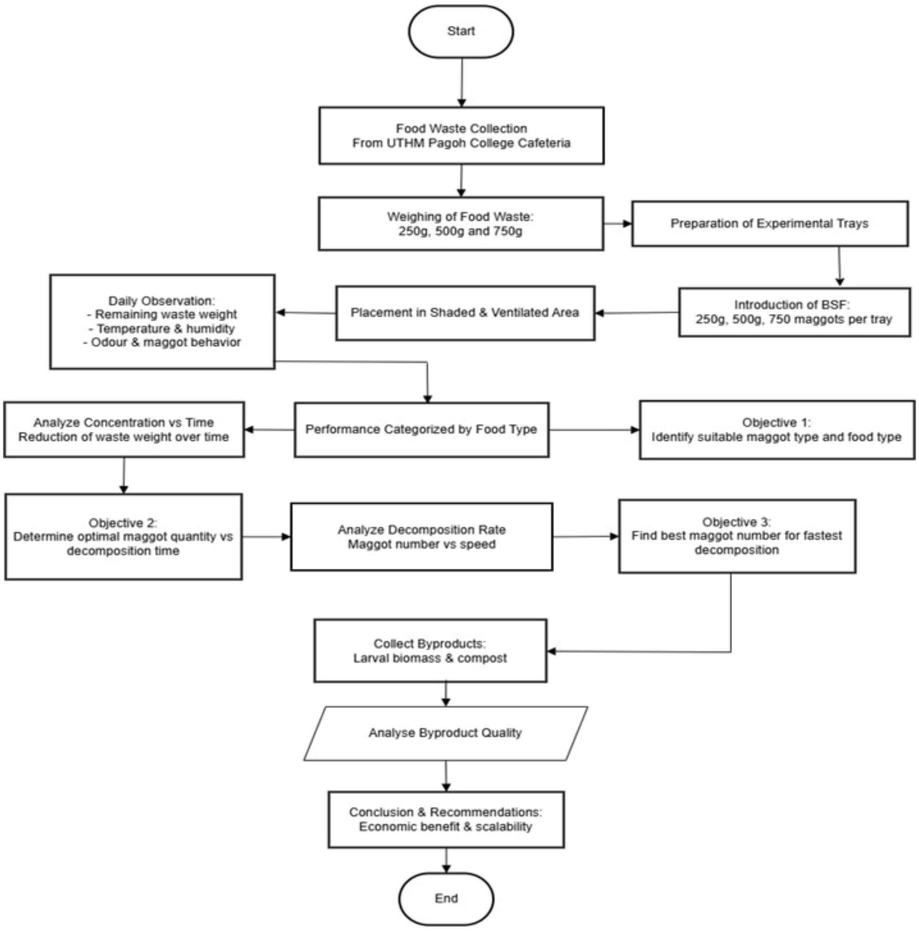

Fig. 1 *Flowchart of the research methodology*

Fig. 1 presents the complete flow of the experimental process in the form of a flowchart. The experiment began with the collection of food waste from the UTHM Pagoh College Cafeteria. The waste was then weighed in three different amounts: 250g, 500g, and 750g, and placed in separate trays. BSF larvae were also introduced in corresponding amounts to match the food waste quantity. All trays were kept in a shaded, well-ventilated area. Daily observations were carried out to monitor the progress of decomposition. The process was designed to meet three key objectives: identifying the most suitable food and maggot combination (Objective 1), determining the optimal number of maggots for efficient decomposition (Objective 2), and finding the fastest decomposition rate based on maggot quantity (Objective 3). After the decomposition process, byproducts such as larval biomass and compost were collected and analyzed. The study concluded with an evaluation of the quality of these byproducts, along with recommendations regarding the economic benefits and scalability of using maggots for food waste management.

3. Results and Discussions

The results showed that both the quantity of food waste and the number of maggots significantly influenced the decomposition rate and overall efficiency. In Set 1, where the maggot mass was fixed at 500g, increasing the food waste amount from 250g to 750g extended the decomposition time from 5 to 9 days. Efficiency dropped accordingly, from 84.0% for 250g to just 66.7% for 750g (Table 2). This trend suggests that overloading maggots with excess food reduced their processing capacity, likely due to limited oxygen, space, and microbial imbalance within the substrate.

Table 2 *Decomposition results for varying food waste mass*

Foods Waste (g)	Days to Decompose	Efficiency (%)
250	5	84.0
500	7	77.0
750	9	66.7

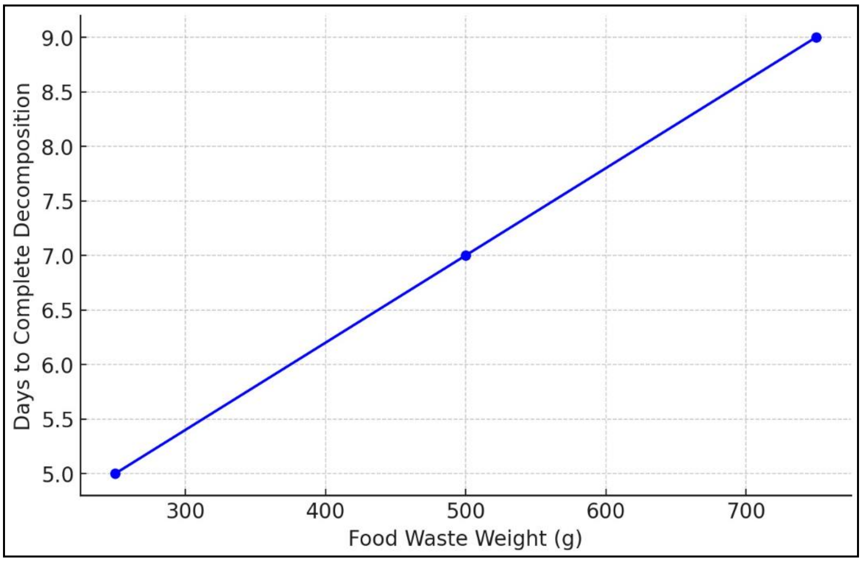

Fig. 2 *Food waste weight vs decomposition time*

In Set 2, where the food waste quantity was fixed at 500g and maggot weight was varied, increasing BSFM from 250g to 750g significantly improved both speed and efficiency. Fig. 2 shows decomposition time dropped from 9 days to 5 days, while efficiency rose from 68.0% to 87.0%. These findings align with prior studies, including [2], who reported that larval density plays a critical role in accelerating decomposition rates and reducing organic matter residuals. High density maggot populations ensure that more larvae feed simultaneously, leading to faster substrate breakdown. Table 3 presents the specific decomposition results recorded for each tested maggot mass configuration.

Table 3 *Decomposition results for varying maggot mass*

BSFM Mass (g)	Days to Decompose	Efficiency (%)
250	9	68.0
500	7	77.0
750	5	87.0

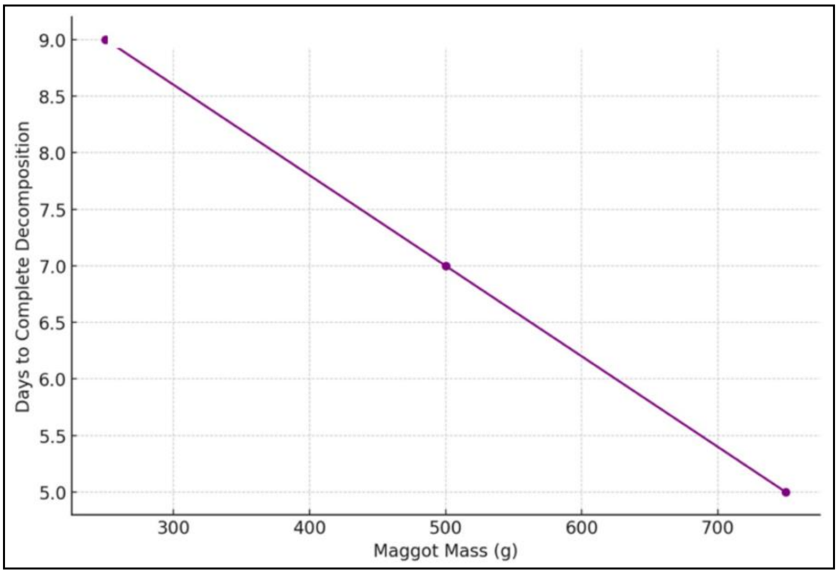

Fig. 3 *BSFM mass vs decomposition efficiency*

Fig. 3 shows a negative correlation between both food waste mass and maggot quantity with decomposition time. Specifically, Set 1 demonstrated that increasing food waste from 250g to 750g while keeping maggot mass constant at 500g led to an increase in decomposition time from 5 to 9 days. In Set 2, increasing the maggot mass from 250g to 750g (with 500g food waste) reduced decomposition time from 8 to 5 days, but the rate of improvement declined after 500g, indicating diminishing returns. The decomposition curve began to plateau beyond 750g, suggesting possible overcrowding, competition for space, or oxygen limitation, which may hinder larval efficiency. These trends support the conclusion that the optimal maggot-to-waste ratio lies between 500g BSFM and 250–500g food waste.

From a physical observation standpoint, decomposition followed consistent biological phases. Softening of the waste was evident by Day 2, with noticeable odor and liquefaction by Day 3. Color changes in the larvae from cream to grayish black and reduced mobility indicated entry into the prepupal stage, typically by Day 6 or 7 in the most effective treatments. The endpoint of each cycle was validated when no visible food particles remained, and only frass and inactive larvae were present. These visual and biological indicators make BSFM composting a practical, real time monitoring method, especially suitable for low tech, small scale waste management systems.

Fig. 4 *Observation photos (food & maggot)*

Fig. 4 shows one of the experimental trays used in the study, filled with food waste and Black Soldier Fly (BSF) larvae. In this image, pieces of bread can be seen placed on top of a substrate where the larvae are actively decomposing the organic material. This setup was part of the daily observation process, where parameters such as the remaining weight of food waste, ambient temperature, humidity, maggot activity, and changes in odor were recorded. The photo documents the actual condition of the decomposition environment, providing a visual reference of how maggots interact with food waste under controlled conditions.

4. Conclusion

This study demonstrated the potential of Black Soldier Fly Maggots (BSFM) as an effective natural decomposer for food waste collected from the UTHM Pagoh cafeteria. Through controlled experiments using varying combinations of maggot and food waste quantities, the results showed that BSFM can significantly reduce food waste volume within 5 to 9 days. The most efficient decomposition occurred when 500g of maggots were paired with 250g to 500g of food waste, completing the process within 5 to 7 days and achieving reduction efficiencies above 75%, which is consistent with earlier findings on BSFM's high feed conversion rates. These findings highlight that the maggot-to-waste ratio plays a critical role in determining both the speed and success of decomposition. With minimal infrastructure and low maintenance requirements, BSFM offers a sustainable and scalable solution for small-scale organic waste management systems. Future research may focus on environmental factors, variations in waste types, and the potential economic uses of BSFM byproducts, such as maggot protein for animal feed and frass as organic fertilizer.

Acknowledgement

The authors would also like to thank the Centre for Diploma Studies, Universiti Tun Hussein Onn Malaysia for its support.

Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** Adib Afnan Rosmadi, Muhammad Ainal Yaqin M Z Mulyady, Nabil Hakimi Fazdli Fazdrul Izwan, Izat Yahaya; ***data collection:*** Adib

Afnan Rosmadi, Muhammad Ainal Yaqin M Z Mulyady, Nabil Hakimi Fazdli Fazdrul Izwan; ***analysis and interpretation of results:*** Adib Afnan Rosmadi, Muhammad Ainal Yaqin M Z Mulyady, Nabil Hakimi Fazdli Fazdrul Izwan*;* ***draft manuscript preparation:*** dib Afnan Rosmadi, Muhammad Ainal Yaqin M Z Mulyady, Nabil Hakimi Fazdli Fazdrul Izwan, Izat Yahaya;*. All authors reviewed the results and approved the final version of the manuscript.*

References

[1] S. Diener, C. Zurbrügg, and K. Tockner, *Conversion of organic material by black soldier fly larvae: Establishing optimal feeding rates*. Harlow: Prentice Hall, 2011.

[2] C. Lalander, S. Diener, C. Zurbrügg, and B. Vinnerås, "*Effects of feedstock on larval development and process efficiency in waste treatment with black soldier fly (Hermetia illucens)*," J. Cleaner Prod., vol. 98, pp. 128–137, 2015.

[3] S. A. Siddiqui, M. I. Bashir, and N. A. Malik, "*Black soldier fly larvae (BSFL) and their affinity for organic waste processing*," Waste Manage., vol. 140, pp. 1–13, 2022.

[4] G. Andari, N. M. Ginting, and R. Nurdiana, *"Black soldier fly larvae (Hermetia illucens) as a waste reduction agent and an alternative livestock feed*," J. Ilmiah Peternak. Terpadu, vol. 9, no. 3, pp. 246–252, 2021.

[5] Y. K. Chia, M. Tanga, and S. Khoo, "*Frass from black soldier fly larvae as soil amendment: A review*," Agriculture, vol. 11, no. 7, pp. 644–657, 2021.

[6] I. G. Lopes, J. W. Yong, and C. Lalander, "*Frass derived from black soldier fly larvae treatment of biodegradable wastes: A critical review and future perspectives*," Waste Manage., vol. 142, pp. 65–76, 2022.