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Research

Organic Waste Management into Eco-Enzyme and Maggot Feed at A Hotel in Makassar: A Descriptive Qualitative Study

Munawir Amansyah[1], Alwiyah Nur Syarif*[2], Resky Ananda Putri[3], Khairiyah Reski Amalia[4], Siti Mutiah Fadilah[5], Nurfadila[6]

[1, 3, 4, 5, 6] Department of Public Health, Faculty of Medicine and Health Sciences, Universitas Islam Negeri Alauddin Makassar, Makassar, Indonesia
[2] Department of Pharmacy, Faculty of Medicine and Health Sciences, Universitas Islam Negeri Alauddin Makassar, Makassar, Indonesia

* Corresponding Author: alwiyah.nursyarif@uin-alauddin.ac.id

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ABSTRACT

Recent hospitality waste studies increasingly promote circular organic-waste treatment, yet empirical descriptions of how hotels operationalize low-cost bioconversion pathways (eco-enzyme fermentation and black soldier fly/maggot production) in day-to-day routines remain limited, particularly in Eastern Indonesia. This study aimed to describe the management of hotel organic waste into eco-enzyme and maggot feed at Mercure Makassar (Makassar City, Indonesia) using a descriptive qualitative design. Data were collected through non-participant observations of kitchen waste flows, in-depth interviews with key hotel personnel (food production, stewarding, housekeeping, engineering, and management), and document review (SOPs, training materials, and relevant local/national regulations). Data were analyzed thematically with iterative coding and triangulation across sources. The findings indicate that the system hinges on (i) source segregation at food-preparation and post-consumption points, (ii) stabilization steps to reduce contamination and odor before processing, (iii) standardized eco-enzyme fermentation using organic residues with sugar/molasses and water ratios commonly reported in the literature (e.g., 1:3:10 or 10:3:1 by weight/volume) and a multi-month maturation period, and (iv) BSF-based bioconversion that rapidly reduces restaurant waste while producing larval biomass and frass as by-products. Implementation is shaped by staff literacy, space constraints, pest-control requirements, and alignment with municipal and national waste-management mandates. Overall, this case demonstrates a feasible, practice-oriented circular pathway for hotels, with implications for SOP development, staff training, and measurable reduction of landfill-bound organic waste in Makassar.

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1. Introduction

Organic waste remains an urgent environmental issue due to its large volume, rapid putrefaction, and its contribution to methane emissions when disposed of in landfills (Zhu et al., 2026). Globally, municipal solid waste generation is projected to increase substantially by 2050, creating high social and environmental costs if not managed effectively. The United Nations Environment Programme (UNEP) emphasizes the need to transform waste management systems toward prevention, source separation, and circular economy approaches to reduce impacts on climate, health, and pollution. In terms of composition, the organic fraction—primarily food waste and green waste—has been reported as a dominant component in many regions and is often prioritized for intervention because it can be managed through relatively simple biological technologies (Wibisono et al., 2025).

At the national level, Indonesia faces challenges related to high waste generation and uneven waste management performance across regions. Several publications referencing KLHK/SIPSN data report that national waste generation in 2020 was approximately 67.8 million tons, with a substantial proportion still unmanaged, highlighting the need for waste reduction at source. In parallel, studies on food waste management underscore the importance of policy integration and the adoption of scalable organic waste treatment technologies, including bioconversion using Black Soldier Fly larvae (BSFL) and fermentation-based approaches, to increase organic waste diversion from landfills (Kumar et al., 2025).

The central problem of this study concerns how hotels—daily generators of organic waste from kitchens and restaurants—can manage the organic fraction effectively, hygienically, and sustainably under constraints such as limited space, odor risks, and operational compliance requirements. Scientifically, two relevant biological solutions for hotel settings include: (1) fermenting kitchen organic residues into eco enzyme using sugar/molasses, water, and fruit–vegetable residues; and (2) rapid bioconversion of food leftovers using BSFL to produce high-protein larval biomass and residual material (frass) with potential use as organic fertilizer.

Eco enzyme is commonly produced through anaerobic fermentation of organic materials (especially fruit peels and vegetable residues) with added palm sugar/molasses and water, using ratios frequently reported as 1:3:10 (sugar:organic waste:water) or equivalent variations based on weight/volume. The mixture is stored in sealed containers and placed in locations protected from direct sunlight. Several studies also emphasize a fermentation duration of approximately three months to obtain relatively stable liquid characteristics (e.g., acidic pH), enabling use as a natural cleaning agent or disinfectant in household/community settings and other relevant applications (Galintin et al., 2021; Fadilla et al., 2023).

BSFL-based bioconversion is considered a robust option for food waste due to the larvae's capacity to substantially reduce organic waste mass/volume while transforming it into larval biomass (protein and lipids) and residual solid/liquid fractions that may be further utilized. Scientific reviews report that BSFL can reduce organic waste volume/mass within high ranges under

certain conditions and generally supports resource recovery from organic waste streams. The literature also highlights the importance of hygiene control, feeding management, and safe handling of residues (frass) to ensure suitability for use as fertilizer or soil amendments (Klammsteiner et al., 2020).

Although eco enzyme and BSFL have been widely discussed as community-level technologies and small-to-medium-scale solutions for organic waste treatment, empirical evidence describing operational governance in the hospitality sector—including source separation, hygienic handling, odor control, human resource assignment, and SOP integration—remains limited, particularly for combined (dual-pathway) implementation within a single system. In the eco enzyme literature, many publications emphasize product characteristics and variations in fermentation ratios/duration rather than daily operational governance in service institutions such as hotels. In the BSFL literature, scientific evidence is strong regarding waste reduction performance and biomass quality, yet detailed documentation of real-world implementation in hotel units (with strict sanitation and guest comfort demands) is not always available.

Based on these gaps, the novelty of this study lies in providing a comprehensive descriptive account of organic waste management practices through eco enzyme production and maggot/BSFL feed processing at Mercure Makassar Nexa Pettarani Hotel as an institutional case study. This study aims to describe: (1) the dominant types and sources of the hotel's organic waste; (2) the sorting workflow and eco enzyme production process (including closed fermentation and internal utilization); (3) the use of food leftovers as maggot/BSFL feed (including facilities, hygiene practices, and breeding cycle management); and (4) organizational support, SOP integration, and operational factors influencing the sustainability of the hotel's organic waste reduction program.**Method**

The research method is discussed clearly and in detail consisting of 400-800 words, namely: The type of research and the approach used, Place and time of research, Consideration of subject selection and research situation, Sources of literacy and information, Population and sample and sampling method, Research procedures, including informed consent, Instrument used, Data processing/analysis, Processing, analysis, and presentation of data, Statement of having obtained a health code of ethics permit through the research ethics commission (optional).

2. Method

2.1 Study design and setting

This research employed a descriptive qualitative design using a case study approach at Mercure Makassar Nexa Pettarani Hotel, Makassar, Indonesia. Data collection was conducted on Thursday, 18 December 2025, focusing on the hotel's organic waste management activities involving conversion into eco enzyme and maggot feed. The study setting included waste generation points (kitchen/restaurant areas) and designated processing/storage areas used for eco enzyme fermentation and maggot-feed handling.

2.2 Population and participants

The study population comprised all personnel involved across the hotel's organic waste management chain. Informants were selected through purposive sampling based on direct involvement and knowledge of the program, including cleaning service/stewarding staff

responsible for daily implementation and management representatives familiar with policy, SOPs, and program support.

Inclusion criteria were: (1) employment in hotel units related to hygiene/waste management or program decision-making; (2) understanding of the organic waste management workflow or direct participation in its implementation; and (3) willingness to participate in interviews.

2.3 Data collection

Data were collected using three methods: Field observation of environmental conditions and the organic waste management workflow (sorting, storage, fermentation, and maggot-feed handling). Semi-structured interviews guided by an interview protocol covering: dominant waste types, fermentation mechanisms, product utilization, site hygiene, odor control, external collaboration, SOPs, human resources, government support, and financing. Document review of available internal materials (e.g., SOPs/work instructions, fermentation date labeling records, and relevant operational information).

2.4 Data analysis

Data were analyzed using thematic analysis through: brief transcription of interview outputs, initial coding based on thematic domains (waste types, sorting, eco enzyme, maggot/BSFL, hygiene, odor, SOP/HR, support, costs), grouping codes into categories and overarching themes, and triangulation across observation, interviews, and documents to strengthen credibility. Findings were presented as structured descriptive narratives and thematic summaries. The study followed qualitative research ethics principles. Researchers obtained verbal informed consent prior to interviews, explained the study objectives, ensured confidentiality of personal identities, and used the data solely for academic purposes**.**

3. Results & Discussion

This study was conducted on Thursday, 18 December 2025, at Mercure Makassar Nexa Pettarani Hotel, Makassar, Indonesia. The hotel has implemented organic waste management initiatives, particularly through eco-enzyme production and maggot-based bioconversion. The study employed a descriptive qualitative design aimed at systematically describing the process of converting hotel organic waste into eco enzyme and maggot feed within the hotel environment.

Data were collected through direct observation of the hotel's environmental conditions and organic waste management system, and structured interviews with relevant staff using a questionnaire as an interview guide.

3.1 Organic Waste Characteristics and Source

The hotel's organic waste was not evenly distributed across food scraps and vegetable/fruit residues. Based on interview responses, the waste stream was predominantly food leftovers, especially from kitchens and restaurants, while vegetable and fruit residues were present in smaller quantities.

"No. For organic waste in this hotel, the largest portion comes from leftover food, especially heavy leftovers from the kitchen and restaurant. There are also vegetable and fruit residues, but not as much as the main food leftovers." (Respondent)

This indicates that organic waste management strategies at the hotel must prioritize handling and processing high-moisture, high-volume food waste, which is typically more odor-prone and requires stricter containment and hygiene controls.

3.2 Processing Organic Waste into Eco Enzyme

Eco enzyme production at the hotel is carried out using a closed (sealed) fermentation method, which reduces odor and supports stable anaerobic fermentation conditions.

"Yes. We make eco enzyme here using a closed fermentation system. The materials are put into a sealed container so the fermentation runs well and to reduce odor during the process." (Respondent)

From field observation and interview information, eco enzyme is produced primarily from sorted fruit peels and vegetable residues. At the initial stage, these materials are placed into a sealed container that already contains clean water mixed with molasses to provide nutrients for fermentative microorganisms. The container is then sealed tightly to create anaerobic conditions and to minimize nuisance odors.

The fermentation is monitored using time control (start date marking) and lasts approximately 90 days before the eco enzyme is ready for use.

3.3 Utilization and by-product management

The resulting eco enzyme is utilized internally for hotel sanitation activities, such as floor mopping and toilet cleaning, sometimes mixed with fragrance to improve user comfort.

"Yes. Once the eco enzyme is ready, we usually use it directly for the hotel's cleaning needs, such as mopping floors and cleaning toilets. We often mix the liquid with a fragrance so the smell is more comfortable when used." (Respondent)

Importantly, the solid residue from fermentation is not discarded but reused by placing it into biopore holes, supporting environmentally sound waste handling and nutrient return to the soil.

3.4 Processing Organic Waste into Maggot Feed

3.1 Internal management and operational setup

In addition to eco enzyme, the hotel processes food leftovers into feed for maggots through an internal system without external partners.

"No. For processing organic waste into maggot feed, so far we manage it internally within the hotel. There has been no special collaboration with external parties because the hotel team can still handle it." (Respondent)

All food leftovers are sorted and placed into dedicated containers in a designated hygienic area. The storage area is maintained to prevent contamination and reduce environmental disturbance.

"Yes. We have provided a special place for storing waste used as maggot feed. The area is kept clean so it remains hygienic and does not disturb the surrounding hotel environment." (Respondent)

3.2 Use of food leftovers and waste reduction effect

All food leftovers generated by the hotel are utilized as maggot feed rather than being sent directly to disposal sites.

"Yes. All leftover food from the hotel is used as maggot feed. So the food waste is not thrown away directly; it is sorted and reused to make it more beneficial." (Respondent)

This maggot-based system contributes to significant reduction of organic waste volume.

"Yes. With maggot processing, the volume of organic waste in the hotel is greatly reduced. It can even be said that almost no organic waste is left to be disposed of." (Respondent)

3.3 Maggot seed source and sustainable breeding cycle

Initial maggot larvae were obtained from Hasanuddin University, after which the hotel developed and maintained the system independently. The hotel manages the maggot life cycle sustainably: larvae grow, transition to pupae, become adult flies, and then lay eggs on prepared media, producing larvae again and enabling continuous operation with minimal dependence on purchasing new seed stock.

3.5 Odor Control, Hygiene, and SOP Implementation

The hotel implements odor control through closed processing systems, dedicated processing areas, and routine cleaning by cleaning service staff.

"Yes. To control odor, the processing is done in a closed system and placed in a special area. In addition, the area is routinely cleaned by cleaning service staff so it does not produce disturbing odors." (Respondent)

Routine cleaning and disinfection practices were also confirmed:

"Yes. The waste processing area is cleaned routinely by cleaning service staff. Cleaning is carried out periodically so it remains clean and hygienic." (Respondent)

The hotel reported having a clear workflow and SOP for eco enzyme and maggot processing:

"Yes. The hotel already has a clear workflow or SOP related to processing organic waste into eco enzyme and maggot feed. So each stage has rules and staff simply follow the procedures." (Respondent)

Regarding human resources, the hotel does not have a separate specialized team; instead, the program is handled by appointed hotel staff (primarily cleaning service).

"No. Eco enzyme and maggot processing is carried out by hotel employees, especially from the cleaning service department. They are assigned and given responsibility to run the process." (Respondent)

3.6 Environmental Positioning and Financial Support

The hotel's organic waste management system aligns with its green hotel orientation and reduces the burden on final disposal.

"Yes. This organic waste processing activity strongly supports the green hotel program because waste is not only disposed of but processed into something useful." (Respondent)

The hotel does not routinely commercialize eco enzyme or maggots; both are primarily used internally, though maggots may be provided if requested by external stakeholders (e.g., local administrative units).

"No. The eco enzyme produced is not sold to external parties. So far, it is only used for internal hotel purposes." (Respondent)

"No. Maggots are also not sold routinely. However, if there is a request from outside parties, for example from a village office, we usually provide them as needed." (Respondent)

In terms of financing, costs were mainly incurred at the initial setup phase (containers, maggot seeds, and supporting tools), after which operational costs were minimal.

"Yes. In terms of costs, the hotel only spent money at the beginning, such as buying buckets, maggot seeds, and other supporting containers. After that, the management runs with relatively minimal cost." (Respondent)

The program also received support from the city government, and the hotel expects continued support, particularly in guidance and program development.

"Yes. At present there is support from the city government, and in the future we hope the support can continue, for example through coaching or program development so waste management can be more optimal." (Respondent)

3.7 Dual-pathway organic waste management as an operationally feasible model for hotels

The findings from Mercure Makassar Nexa Pettarani Hotel demonstrate a practical dual-pathway strategy for managing organic waste: (1) closed fermentation of fruit–vegetable residues into eco enzyme and (2) BSFL/maggot bioconversion of food leftovers. This combined approach is particularly relevant for hotels because organic waste is generated daily, concentrated in kitchen/restaurant units, and associated with strict requirements for hygiene, odor control, and guest comfort. By separating organic waste streams based on characteristics—fruit/vegetable residues for fermentation and mixed food leftovers for larval feed—the hotel applies a form of source segregation and targeted biological treatment, which is a core principle in circular waste management.

In hospitality settings, operational feasibility is often the limiting factor. Hotels typically face constraints related to space, time, and risk management (e.g., odor, pests, complaints). The present case indicates that biological technologies can be integrated into routine operations when supported by (i) clear segregation points, (ii) contained processing systems, and (iii) standardized workflows executed by assigned staff.

3.8 Closed fermentation eco enzyme: containment, monitoring, and institutional usability

Eco enzyme production in the hotel is conducted through closed anaerobic fermentation, which directly addresses one of the most critical barriers in institutional organic waste processing: odor nuisance. Sealed containers reduce exposure, minimize smell, and allow fermentation to proceed under controlled conditions without disrupting hotel operations. The practice of writing the fermentation start date on the container also reflects a simple but important element of process control—an operational "micro-SOP"—that enables staff to track maturation time and avoid premature use.

From a facility-management perspective, the use of eco enzyme for internal housekeeping (e.g., floor mopping and toilet cleaning) strengthens program sustainability because it creates direct internal value: the hotel converts waste into a usable cleaning input. This aligns with circular economy logic where waste is treated as a resource and offsets operational consumables. Although

the study did not quantify cost savings, the pathway is likely attractive for hotels because it requires minimal recurring expenditure once containers and inputs (molasses) are available. Importantly, the hotel's decision not to sell eco enzyme suggests the system is currently oriented toward service reliability and internal quality control rather than commercialization—an approach that may be more appropriate for hospitality institutions prioritizing standardization and risk reduction.

A notable environmental-strengthening feature is the reuse of fermentation residue (solid fraction) through biopore holes rather than disposal. This demonstrates an additional "downstream" control that reduces secondary waste and supports local infiltration and soil improvement functions. In institutional settings, such residue management is often overlooked; therefore, its inclusion strengthens the sustainability profile of the eco enzyme pathway (guo et al., 2024).

3.9 BSFL/maggot bioconversion: rapid diversion of food waste under hotel constraints

The full utilization of food leftovers as maggot feed indicates that the BSFL pathway is positioned as the hotel's primary mechanism for managing the largest fraction of organic waste: mixed food leftovers, which are typically high-moisture and challenging to manage. Bioconversion is particularly suitable for this waste type because larvae can consume and reduce it rapidly, turning waste into high-protein biomass and reducing the amount requiring external transport or landfill disposal (Ravi et al., 2020).

A key operational success factor in this case is the provision of a dedicated, hygienically maintained storage area for maggot feed (Stadler, 2020). In hotels, sanitation requirements are non-negotiable; thus, the existence of a designated area supports compliance and reduces risks of pest attraction, odor complaints, or cross-contamination. The routine cleaning practices described in the broader findings are essential to maintaining program acceptance within hotel operations (Khalil et al., 2024).

The most strategic aspect of the maggot program is the closed-loop breeding cycle. By allowing larvae to develop into pupae and adult flies that subsequently lay eggs, the hotel reduces reliance on external seed supply and builds self-sufficiency. This feature is particularly important for long-term viability, as external seed availability or costs can become barriers for institutions attempting to scale or maintain BSFL systems. The ability to sustain the life cycle internally can therefore be interpreted as a form of institutional resilience in organic waste management.

4. Conclusion

Based on field observation and structured interviews conducted at Mercure Makassar Nexa Pettarani Hotel on 18 December 2025, the hotel has implemented an effective and sustainable organic waste management system through the conversion of organic waste into eco enzyme and maggot feed. The dominant organic waste stream consists primarily of food leftovers, which are not directly disposed of but instead sorted and processed to generate practical benefits and reduce environmental burdens. Eco enzyme production is conducted using a closed fermentation system with clear procedures, enabling safer processing, improved hygiene, and odor reduction. The resulting eco enzyme is utilized for internal cleaning (e.g., floor and toilet sanitation), while

fermentation residue is further reused via biopore application, supporting circular waste management.

Additionally, the hotel fully utilizes food leftovers as maggot feed, operating an internal bioconversion system with hygienic storage and routine sanitation. The maggot system significantly reduces organic waste volume, reportedly leaving almost no organic waste for disposal. The implementation is supported by standard operating procedures, controlled processing areas, routine cleaning practices, and municipal government support, and it contributes directly to the hotel's green hotel orientation.

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