e-ISSN: 2745-9535
No. 105/E/KPT/2022
Jurnal Pengabdian Masyarakat
Editorial Office: Jl. Soekarno-Hatta, Rembuksari No. 1A, Malang, East Java, Indonesia, 65113
Contact: Phone: +62 (341) 478494 e-mail: jpm@asia.ac.id
The journal is published by LP2M Institut Teknologi dan Bisnis Asia Malang
Website: https://jurnal.stie.asia.ac.id/index.php/jpm
Member of: AJEBI
Indexed in: Google Crossref neliti GARUDA Journal Dimensions

Application of Tofu Waste Treatment Installation to Produce Land Remediation Culture in Punge Blang Cut Banda Aceh

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Volume
4
Issue
2
Edition
November
Page
506-512
Year
2023

Article History

Submission: 11-10-2023
Review: 13-10-2023
Accepted: 20-10-2023

Keyword

Bioremediation;
Microbial Culture;
Sustainable Agriculture;

How to cite

Darwin, Putra, B. S., Bulan, R., Rizal, M. (2023). Application of Tofu Waste Treatment Installation to Produce Land Remediation Culture in Punge Blang Cut Banda Aceh. Jurnal Pengabdian Masyarakat, 4(2), 506-512. https://doi.org/10.32815/jpm.v4i2.2004

Abstract

Purpose: This research paper explores an integrated solution for managing tofu waste from the SOLO Tofu Factory. By combining anaerobic digestion technology with urban organic farming, the study aims to provide a sustainable waste management model that benefits the factory and the surrounding community.

Method: The study utilized mixed methods, including qualitative interviews and quantitative on-site observations. Anaerobic digestion technology was employed for waste treatment, and its effluent was analyzed for its potential as a bio-fertilizer. A sustainable urban organic farming system was developed, utilizing treated waste for cultivation. Data analysis involved qualitative thematic and quantitative measurement analysis.

Practical Applications: The integrated approach offers helpful solutions. It provides the factory with an eco-friendly waste management solution, reducing pollution. The urban organic farming system promotes sustainable agriculture and remediates land, making it cultivable. This model serves as a blueprint for similar industries, fostering community development and environmental awareness.

Conclusion: The research demonstrates the effectiveness of integrating anaerobic digestion and urban organic farming for tofu waste management. This approach offers practical, scalable solutions, reducing pollution, promoting sustainable agriculture, and fostering community development.

Introduction

Waste is any material, substance, or byproduct that is no longer wanted, needed, or useful and is discarded, abandoned, or disposed of (Griffault et al., 2022). It can take various forms, including solid, liquid, or gaseous, and can be generated from residential, commercial, industrial, or agricultural activities. Waste can be classified as organic waste, hazardous waste, e-waste, and construction and demolition waste based on its composition and potential environmental and human health (De Quadros et al., 2023). The management of waste is a global challenge, and various strategies and technologies, such as anaerobic digestion (AD) for organic waste treatment, are being implemented to minimize its environmental impact and promote sustainability (Chatterjee & Mazumder, 2021; Yaqub et al., 2020).

Tofu processing waste typically contains very high organic matter. If this tofu waste is discharged directly into water bodies, it will increase the organic content in the water in the form of chemical oxygen demand (COD) (Pratiwi et al., 2022; Sukmawati & Wijiastuti, 2021). High organic waste may also reduce the dissolved oxygen content in water sources. This condition may cause water to become cloudy and smell bad and damage the aquatic ecosystem (Anugraheni & Isworo, 2021; Rahmalia et al., 2021).

The problem partners face in running a tofu production business is that tofu waste, produced in large quantities daily, cannot be accompanied by effective waste handling and processing, so the impact of environmental pollution caused by the continuous disposal of organic waste can damage the environment in the settlements of the village residents of Punge Blang Cut Village, Banda Aceh City. Without serious handling of tofu waste, it will impact the static production of tofu from factories. This happens because an increase in tofu production will automatically increase the waste generated from the factory.

Some of the solutions offered by this Community Service Program activity include constructing a tofu waste treatment plant based on anaerobic digestion (AD) technology and building a sustainable urban organic farming system (a sustainable urban organic farming system). The community service team chose this type of technology because this AD technology is very effective for treating organic waste (Ahmedelbdawy et al., 2018; Prihandoko et al., 2019). Studies showed that AD technology waste treatment could reduce the organic content in wastewater, as indicated by the significant reduction in the percentage of COD and Volatile solids in organic wastewater so that the waste can be safely applied to agricultural land (Anas et al., 2021; Artun & Aşkin, 2022).

This service activity will also build and assist the development of organic farming systems in narrow urban areas. Even though the location of this community service activity is in an urban area, narrow land use in urban residential areas can also be carried out by developing organic farming, such as vegetable products and agricultural products, which are staples such as chilies, tomatoes, and onions. This is done to empower the community around the tofu factory to utilize land remediation culture to support the development of organic farming in urban areas and become independent, clean, and prosperous villages.

This activity aims to build a tofu waste treatment plant based on anaerobic digestion technology that can process tofu waste into a functional product with economic value, namely biofertilizer. This activity also taught factory workers about techniques and skills in managing and processing tofu waste to reduce environmental pollution, especially water.

Method

Implementing Community Service Program activities uses descriptive analysis methods, demonstrations, and direct practice by partners and community groups. For the operation of the tofu waste processing installation, the focus will be on demonstration methods based on operational control at the main partners of the SOLO Tofu Factory by prioritizing operator safety.

Next are the stages of preparation and field observations. At this stage, field observations were made to quantify the organic waste produced by the tofu factory. At this

stage, an analysis is also carried out to determine the condition of the waste disposal and the environment around the disposal, especially the condition of the drainage, sources, water catchments, and soil conditions in the factory area. This stage also includes an analysis of the level and potential for pollution due to the disposal of tofu organic waste.

After that, it is needed to design and build a tofu waste treatment installation. This installation is needed to speed up organic waste processing during the anaerobic digestion process and reduce overloading and failure of the waste treatment process. This is a pilot scale installation to an industrial scale, not a bench or lab. Scale, therefore, the design, construction, and operation follow the safety standards of factory operators.

The last one, monitoring and evaluation activities, are carried out by involving reviewers to ensure that community service programs and activities run according to the expected targets. In this activity, the service team will also evaluate and respond quickly in overcoming obstacles both partners and community groups involved so that community service activities can run smoothly. At this stage, the community service implementation team also provides training and debriefing discussions with partners and community groups regarding the performance of waste treatment installations and the utilization of remediation culture products that can be used as bio-fertilizers.

Result

This product-based community service program has successfully designed and built a tofu waste processing installation. The successfully designed and built equipment is a work and creative idea from the community service implementing team. The equipment produced is waste treatment installation equipment integrated with organic farming systems.

This sewage treatment plant equipment integrates biological and physical wastewater treatment systems. The tofu waste treatment plant has a working volume capacity of 150 liters. The anaerobic system sewage treatment plant is equipped with an electric component in the form of an automatic thermostatic water heater, which can regulate the temperature so that during the waste treatment process, the temperature in the reactor remains stable at 35 degrees Celsius. Waste that has gone through an anaerobic treatment can be used as a biofertilizer or land remediation culture for organic farming. The hydraulic retention time (HRT) applied is 25 days for the anaerobic treatment process of tofu waste.

In this waste treatment installation, an aerobic treatment installation is also installed where the reactor for the aerobic treatment process is equipped with an air pump system. An air pump is needed to supply oxygen tofu waste undergoing anaerobic treatment (Ferella et al., 2019; Pambudi et al., 2022). This process is necessary so that organic matter that has not been completely degraded during the anaerobic digestion can be further processed through aerobic treatment. Continuous oxygen supply is also needed to increase dissolved oxygen in water to reduce wastewater's biological oxygen demand (BOD).

The tofu waste installation also has a system for separating organic matter through a reverse osmosis membrane. Membrane separation equipment is needed so that organic matter and other pollutants can be cleaned through the membrane layer (RO) so that the results of tofu waste treatment can be ready to be discharged into the river.

Figure 1. Design and build of a waste treatment plant

Before the tofu waste treatment plant was designed and installed at the SOLO tofu factory site, the community service implementation team made field observations regarding the tofu waste disposal system. From the results of sewage field observations, it is known that the sewage disposal system is carried out directly from the drainage inside the factory, which is channeled through pipes to the river.

Figure 2. Waste disposal system of a tofu factory

The community service implementation team also observed the waste disposal system in the river. This step is needed as input material to determine the feasibility of the waste installation that has been designed so that the placement of the waste treatment plant and equipment for the organic farming system is by the factory layout. Figure 3 shows the waste disposal system from a tofu factory where the waste from the tofu-making process is discharged daily into the river without being treated first.

Figure 3. Tofu waste dumped into the river

This community service activity received an excellent response from partners and community groups. This is evidenced by the enthusiasm of the partners and the community when the service team opened the question-and-answer discussion. During this community service activity, the implementing team received many questions regarding operating the tofu waste treatment installation (Figure 4).

Figure 4. Installation of a waste treatment plant at the SOLO Tofu Factory

Discussion

Implementing the product-based community service program, integrating anaerobic digestion technology with an urban organic farming system, has yielded significant positive outcomes. The program addressed the pressing issue of tofu waste management faced by the SOLO Tofu Factory in the Punge Blang Cut Village, Banda Aceh City. The community service team effectively tackled the challenge of large-scale organic waste disposal by constructing a tofu waste treatment plant utilizing anaerobic digestion (AD) technology. The integration of AD technology reduced the chemical oxygen demand (COD) and volatile solids in the wastewater and transformed the treated waste into valuable biofertilizers and land remediation culture. This approach benefits the factory by mitigating environmental pollution and provides an economical avenue through biofertilizer production, fostering sustainable practices and economic growth.

Furthermore, implementing the urban organic farming system is a testament to the project's holistic approach. The community transformed limited urban spaces into productive organic farms by utilizing the effluent from the AD process as a biofertilizer. This empowers the local community with sustainable agricultural practices and rejuvenates the soil, making it suitable for cultivation. The positive response from both partners and the community underscores the program's success, highlighting the shared enthusiasm and eagerness to learn about operating the tofu waste treatment installation. This program exemplifies effective waste management and sets a precedent for sustainable, community-driven initiatives, showcasing the potential of integrating technology and agriculture to address environmental challenges and foster community development.

Conclusion

This product-based community service has resulted in a product in the form of a tofu waste treatment plant installed in the tofu solo factory area. This dedication also produces a product in the form of a land remediation culture that can be used as a biofertilizer in organic farming systems that are directly integrated with tofu waste treatment plants. The results of this community service activity also produce effluent cleaning products that are not used as fertilizer and are cleaned before being discharged into the river.

Acknowledgments

The author and the community service team would like to thank the management of the SOLO Tofu Factory in Punge Blang Cut Village, Banda Aceh, who has supported the implementation of this activity.

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