RUMPHIUS PATTIMURA BIOLOGICAL JOURNAL
2021, 3 (1): 24-29
E-ISSN : 2684-804X

UTILIZATION OF ORGANIC WASTE USING TECHNIQUES BIOREACTOR SUBMARINE IN PATI CENTRAL JAVA

Siti Nur Sofiyah[1*], Achmad Ali Fikri[1]

[1]Department of Tadris Biologi, Faculty of Tarbiyah, Institut Agama Islam Negeri Kudus.
Jl. Conge Ngembalrejo No 51. Kudus 59322. Indonesia

**Corresponding Author* e-mail: nursofiyah84@gmail.com

Received: 2 January 2021 Accepted: 1 March 2021 Published: 25 March 2021

ABSTRACT

One of the waste that is often found is organic waste. The existence of this waste needs to be handled so that it does not pollute the environment and has more use value. Through proper processing, organic waste can be used as organic fertilizer and biogas. One of the techniques used for this processing is to use the submarine bioreactor technique. This study aims to explore the processing of organic waste in Ngemplak Kidul Margoyoso Pati Village using the submarine bioreactor technique. This research is a field research with a qualitative approach and then analyzed descriptively. The stages of processing organic waste with the submarine bioreactor technique are enumeration, then the stage of producing decomposers, the stage of producing fertilizer and the stage of producing biogas. The advantage of this submarine bioreactor technique is that if a leak occurs it can be detected and can distribute gas over long distances and is safe in its use. Even though it takes a long time and costs a lot, this bioreactor is proven to be able to produce effective fertilizer and biogas for large quantities of plants. After this research, it is hoped that it will provide an overview of waste processing using the submarine bioreactor technique and can become a reference for village governments or other institutions to implement in their area as a solution for organic waste processing.

Keywords: *bioreactors, organic waste, organic fertilizer*

To cite this article:
Sofiyah, S.N., Fikri, A.A. 2021. Utilization of organic waste using techniques bioreactor submarine in Pati Central Java. *Rumphius Pattimura Biological Journal*. 3 (1): 24-29. *DOI:https://doi.org/10.30598/rumphiusv3i1p024-029*

INTRODUCTION

Ngemplak Kidul village is in Margoyoso subdistrict, Pati district, Central Java. In this village there is a fruit market which operates every day. The activities of sellers and buyers in this market produce quite a lot of waste, especially waste from leftover oranges. There is a bad habit of sellers, namely throwing market waste carelessly on the streets, which causes the roads to become slippery and the appearance of unpleasant odors. Apart from the fruit market, the Ngemplak Kidul Village area is surrounded by cassava and fruit plantations, making it synonymous with agriculture and plantations. With this plantation land, the use of pesticides and agricultural medicines with chemicals cannot be avoided. The size of agricultural land or plantations can influence the amount of chemical fertilizer used. According to Ida Syamsu Roidah, recently there has been various pollution caused by fertilizers and the use of chemicals in agriculture which can reduce environmental quality and have an impact on human health (Ida, 3013). Pollution due to the use of chemical fertilizers can pollute the environment and reduce environmental quality such as the quality of water and soil or can even give rise to various kinds of diseases.

This increasingly complex environmental problem requires a solution as soon as possible so that further damage does not occur. One solution that can be taken to deal with this problem is to process waste from the market so that it can become a product that has high use value, especially for plantations in Ngemplak Kidul Village, namely by processing it as organic fertilizer. Organic waste is waste that comes from the remains of organic materials. This type of waste is mostly composed of organic compounds in the form of plant, animal or dung residues. This waste is easily broken down by living organisms, especially microorganisms (Nur, 2018). This is because the organic compounds contained in organic waste can be utilized by microorganisms for their survival. The ability to decompose organic waste possessed by microorganisms can be utilized in making organic fertilizer. Processing is needed to be able to produce fertilizer and biogas from this organic waste, one of which is the submarine bioreactor technique.

In addition to organic waste in the form of leftover vegetables and fruits, manure from livestock can also be processed to become a starter in composting and can produce biogas. This livestock manure can produce energy due to fermentation from anaerobic bacteria that live in environments with minimal or no oxygen. This biogas can be an alternative energy because it is more environmentally friendly than fossil energy. This is because biogas comes from processing the remains of organic waste which is not as difficult to obtain as fossils and is abundant (Mujahidah, 2013). According to Wahyuni in (Sunyoto, 2016) a cow can produce 25 kg of manure. By using a digester that has a container area of 7 m3, the biogas produced can be used for cooking using a gas stove by 3 households and can produce 800 watts of electricity. It was also explained that a digester with a capacity of 3.5 m3 could meet the energy needs of a household with 6 members. In addition, a digester with a capacity of 5 m3 can produce energy for cooking for 5-10 hours/day, liquid fertilizer 60-80 liters/day, and solid fertilizer 5 kg/day.

One way that can be done to deal with organic waste is to process it into fertilizer. Making organic fertilizer is a method used to convert organic materials into simpler materials by utilizing microbial activity. The manufacturing process can be carried out under aerobic and anaerobic conditions. Aerobic composting is a technique of decomposing organic matter in the presence of oxygen (air), the main products of aerobic biological metabolism are carbon dioxide, water and heat. While anaerobic composting is a way of decomposing organic matter without using free oxygen with the end products being methane, carbon dioxide and certain compounds such as organic acids (Nur, 2018). Processing organic waste can be a solution to the problem of waste piling up around us. Aside from being an answer to reducing waste, processing organic waste to produce organic fertilizer is an added value as an alternative to reducing the excessive use of chemical fertilizers. Therefore, it is necessary to have proper processing techniques so that this organic waste can be used optimally and provide effective results. One technique that can be used to process organic waste is by using the submarine bioreactor technique. Therefore, researchers want to explore more deeply how organic waste is processed using this submarine bioreactor technique. After this research, it is hoped that it can become an example or reference for other villages or regions in processing organic waste and reducing the use of chemical fertilizers.

METHODE

This research is field research with a qualitative approach and then analyzed descriptively. The method used in this research is field research, where the researcher makes direct observations in the field and then provides a description and explanation of the conditions in the field (Manzilati, 2017). Data collection techniques were carried out by observation and interviews. The research was conducted at Bumdes Kusuma Abadi, Ngemplak Kidul Village, Margoyoso District, Pati Regency, Central Java. This research was carried out from April to June 2020. The research was carried out by observing the process of processing organic waste using the submarine bioreactor technique to produce liquid and solid organic fertilizer. After observing the processing, the researchers made observations at an organic plantation in Bumdes Kusuma Abadi which implemented the use of fertilizer from a submarine bioreactor. In addition to making observations, researchers also conducted interviews with Bumdes managers, namely Putri and Sukmono.

DISCUSSION RESULT

The raw material for making organic fertilizer using the submarine bioreactor technique is organic waste, especially citrus fruit waste and cow and goat manure. To be able to process it, the ingredients are put into a hole in the ground and shaped like a submarine. A biorector is an equipment or container in which biochemical transformation occurs with the activity of microbial cells or enzymes in it. The basic function of a bioreactor is to provide a controlled environment in terms of temperature, pH, dissolved oxygen content,

etc. This adjustment to environmental conditions is intended to support microbial growth in producing a desired product. The construction of a bioreactor must have certain requirements so that it can carry out its function optimally. These requirements include that the vessel must be able to operate aseptically, have adequate aeration and agitation for aerobic microbial growth, consume as little power and electricity as possible, have a temperature and pH control system, have facilities for sampling, evaporation is not excessive, equipment must be practical and requires little manpower, the inner surface of the bioreactor is smooth, the geometry of small-scale, pilot plant and large-scale bioreactors should be the same to facilitate scale doubling (Sabrina, 2012).

The construction of the submarine bioreactor building in Bumdes Kusuma Abadi, Ngemplak Kidul Village, Margoyoso District, Pati was designed by the inventor of the submarine bioreactor, Mr. Muhammad Sobri. The building consists of several parts, namely an enumeration site equipped with a chopping tool, a water reservoir shaped like a tower and reactor rooms that are embedded in the ground with a depth of 2 m. The entire submarine bioreactor building uses cement and is equipped with several chimneys to allow oxygen to enter. Submarine bioreactors have several chambers for each processing stage. These chambers are underground and shaped like a submarine, so they are called submarine bioreactors. The application of the submarine bioreactor technique was inspired by the previously existing submarine bioreactor invented by Mr. Muhammad Sobri in Langse Village, Margorejo Pati. This submarine bioreactor was established in Ngemplak Kidul Village in 2019 to address the problem of organic waste from the fruit market and was designed directly by the inventor of the submarine bioreactor, namely Mr. Muhammad Sobri.

Waste Treatment Process

According to (Aji, 2019) there are stages in processing organic waste, the first stage is that organic material will be degraded into weak acids with the help of acid-forming bacteria. These bacteria will decompose waste at the level of hydrolysis and acidification. Hydrolysis is the decomposition of complex compounds or long chain compounds such as fats, proteins, carbohydrates into simple compounds. Meanwhile, asifdification is the formation of acids from simple compounds. In processing waste using the submarine bioreactor technique carried out in Ngemplak Kidul Village, there is no addition of starter microbes but only uses organic waste and animal waste. There are several stages in processing organic waste with a submarine bioreactor.

1) Enumeration; before the material enters the fermentation chamber, the material is chopped so that its size becomes smaller. This process is carried out using a special grinder that can cut and grind fruit waste, even salak seeds. After being chopped, the ingredients will go into the rooms that are underground with a depth of 2 meters.
2) Processing at P1; After the ingredients from the fruit waste become fine, this waste will enter P1 and be collected in the room to produce a decomposer.
3) Processing at P2; after the decomposer is formed from P1, then it goes to P2. In this P2 animal manure is added to produce organic fertilizer. After about 25 days, fertilizer can be taken.
4) Processing at P3; At P3, processing should occur to produce biogas, but because there is no generator for biogas processing at Bumdes Kusuma Abadi, this stage cannot be carried out yet.

After going through the processing stages, the results of this organic waste processing will produce liquid fertilizer and solid fertilizer. These two types of fertilizer will be stored in different shelters so that they can then be collected and used at Bumdes. The collection of organic fertilizer from the results of this processing is still in a simple way, namely by transporting the fertilizer in the bioreactor.

There are several stages of activity carried out by microorganisms to produce fertilizer, decomposer and biogas. The stages of microorganism activity are as follows:

1) Hydrolysis stage

   At this stage, hydrolytic microorganisms decompose complex organic compounds into simple molecules using water to separate chemical bonds in the ingredients. The results of this reaction are simple molecules with short chains including glucose, amino acids, organic acids, ethanol, carbon dioxide and energy. In a submarine bioreactor, this stage occurs in the processing stage at P1.

2) Acidogenesis stage

   At this stage, the decomposition process of chemicals such as carbohydrates, yeast or mold occurs in conditions without oxygen. The results of the hydrolysis stage will be metabolized by hydrolytic and non-hydrolytic bacteria. The results of this stage are acetic acid, propionic acid, butyric acid, hydrogen, carbon

dioxide and small amounts of lactic acid, formic acid, methanol, ethanol, butanediol and acetone. In a submarine bioreactor this stage occurs at P2.

3) Acetogenesis stage (acid formation)

At this stage, the fermentation products in the previous stages are converted into acetic compounds, fatty acids, carbon dioxide and hydrogen.

4) Methanogenesis stage (methane formation)

At this stage, the formation of methane gas (CH4) from acetate compounds as well as hydrogen and carbon dioxide occurs by methanogenic bacteria. At the stage in the submarine bioreactor, this occurs at P3.

The initial result of processing waste with this bioreactor is in the form of sludge or mold which will later be reprocessed to produce liquid and solid organic fertilizer. To be able to obtain two types of fertilizer, namely liquid and solid organic fertilizer, it is necessary to filter the sludge or mold. This sludge will be filtered using a special filter with a very fine density. The water from this filter will be collected and used as liquid fertilizer, while the mud, which has a drier texture, is used as solid fertilizer (Wibowo, 2020). There are two types of fertilizer produced in this submarine bioreactor technique, namely solid organic fertilizer and liquid organic fertilizer. Liquid organic fertilizer is a solution resulting from the decomposition of organic materials originating from plant residues, animal and human waste which contains more than one nutrient element. The second type of organic fertilizer is liquid fertilizer. This fertilizer comes from plant residues, animal waste and human waste which are partially or completely solid (Efeni, 2018).

According to Muhammad Sobri, as the inventor of this submarine bioreactor, one unit of this submarine bioreactor can produce approximately 200 kg of organic fertilizer so it takes around 25 days to produce 5 tons of organic fertilizer which can be used to fertilize one hectare of rice fields or plantations. Therefore, using this bioreactor can be used to fertilize hectares of rice fields or plantations (Firmansyah, 2016). The advantage of this submarine bioreactor compared to other waste and waste processing systems or tools is that in this submarine bioreactor, if a leak occurs it will be detected because there is water around the reactor so bubbles will appear when a leak occurs. Apart from that, the gas pressure in the submarine bioreactor is also high so there is no need to add a compressor and blower to start the generator or other machines. Based on the results of the submarine bioreactor in Langse Margorejo Village, Pati, this bioreactor can flow gas over a distance of more than 10 km and can light 100 stoves simultaneously.

Utilization of Processing Results

Organic fertilizers are very useful for increasing agricultural productivity both in terms of quality and quantity. Organic fertilizers can conserve nutrients, reduce environmental pollution and can improve land quality in a sustainable manner (Hartatik, 2011). Organic waste that has been processed and processed is applied in organic farming in Bumdes as organic fertilizer. In this farm, we are committed to using organic materials, especially fertilizers produced from submarine bioreactors, both liquid fertilizers and solid fertilizers. The organic fertilizer that has been produced is applied to various plants in Bumdes Kusuma Abadi, namely red onion (Allium cepa L.), papaya (Carica papaya), cassava (Manihot esculenta), eggplant (Solanum melongena), tomato (Solanum lycopersicum), chili (Capsicum sp), butterfly pea flower (Clitoria ternatea), corn (Zea mays), sweet potato (Ipomoea batatas), elephant grass (Pennisetum purpureum), and others. The results of this organic farming are then marketed online as organic fruit and vegetables.

Based on interviews and observations that have been made, the use of organic fertilizer at Bumdes Kusuma Abadi from the results of this submarine bioreactor is very good for plant growth. This is evident in the yield of papaya fruit which is bigger and sweeter than papaya fruit with chemical fertilizers. However, for pest control, this organic fertilizer is still not effective enough. This is proven by the presence of pests that cannot be controlled in papaya plants. Another alternative carried out by Bumdes management is to apply light trap technology as a pest control. The production of both organic and liquid fertilizer at Bumdes Kusuma Abadi is very abundant so apart from being used for organic farming at Bumdes, this organic fertilizer is also sold. Apart from producing fertilizer, the submarine bioreactor also produces decomposers which can be used as starters in composting. These decomposers are not used by Bumdes themselves, but are sold to Bumdes visitors who want to make their own compost on the spot. Adequate use of organic fertilizer and biological fertilizer can increase soil fertility so that plants can grow and produce better. Apart from that, providing organic fertilizer can also increase the microbial population which can encourage an increase in the activity of acid and base phosphomonoesterase enzymes which play a role in providing nutrients (P) in the soil (Firmansyah, 2016).

The use of organic fertilizers is an alternative to improve and increase soil fertility due to increased nutrient content in it. In addition, using organic fertilizers can also improve the content of elements in the soil that has been polluted by chemical fertilizers. By using organic fertilizers, the organic content of the soil which was originally changed due to the addition of chemical fertilizers can return to its natural state due to the addition of organic fertilizers whose composition is the same as the initial element content in the soil. Not only to answer one problem, processing organic waste with the bioreactor technique can also answer two problems at once, namely the problem of abundant organic waste and the production of organic fertilizer. Proper processing with this technique can reduce organic waste from fruit market activities as well as create organic fertilizer which is an alternative to reducing the use of chemical fertilizers. Even though it takes a long time to process and costs a lot to build a submarine bioreactor, this bioreactor is proven to be able to produce effective organic fertilizer for plant growth in large quantities. In addition, this bioreactor also has the potential to produce abundant biogas, such as the existing submarine bioreactor in Langse Village, Margorejo Pati District, Central Java.

Figure 1. Submarine bioreactor at Bumdes Kusuma Abadi

CONCLUTION

The process of processing organic waste using the submarine bioreactor technique starts with chopping, then fermentation in P1 to produce decomposer, processing in P2 to produce solid fertilizer and liquid fertilizer, and processing in P3 to produce biogas. However, the production of biogas at Bumdes Kusuma Abadi cannot yet be implemented because there is no generator for the processing stage that produces biogas. The results of processing organic waste can be used as organic fertilizer and biogas. The advantage of this submarine bioreactor technique is that if a leak occurs it can be detected and can distribute gas over long distances and is safe in its use. Even though it takes a long time and costs a lot, this bioreactor is proven to be able to produce effective fertilizer and biogas for large quantities of plants. After this research, it is hoped that it will provide an overview of waste processing using the submarine bioreactor technique and can become a reference for village governments or other institutions to implement in their area as a solution for organic waste processing.

ACKNOWLEDGMENTS

Thanks to Bumdes Kusuma Abadi officers who have supported the smooth completion of this research. Special thanks to Mr. Achmad Ali Fikri, M.Pd. as the supervisor in the research and writing of this article.

REFERENCES

Ida Syamsu Roidah. 2013. The Benefits of Using Organic Fertilizers for Soil Fertility. Univ. Tulungagung Bonorowo. 1(1), 30–42.

T. Nur, A. R. Noor, and M. Elma. 2018. Creating liquid organic fertilizer from household organic waste using em4 (Effective Microorganisms) Bioactivators. Konversi, 5 (2), 1-5.

Mujahidah, Mappiratu, and R. Sikanna. 2013. Study of Biogas Production Technology from Household Wet Waste. J. Nat. Sci. 2 (1), 25–34.

Sunyoto, D. D. Saputro, and Suwahyo. 2016. Organic Waste Processing Using Biogas Reactors in Kendal Regency. Engineering. vol. 14 (1), 29–36.

A. Manzilati. 2017. Qualitative Research Methodology: Paradigms, Methods and Applications. Malang: UB Media.

N. Sabrina, Mayang. 2012. Bioindustry: Bioreactors. Malang: UB Distance Learning.

K. P. Aji and A. N. Bambang. 2019. Conversion of biogas energy into electrical energy as a renewable and environmentally friendly energy alternative in langse village, margorejo district, pati regency. Pros. Sentikuin (Seminar Nas. Technology. Ind. Environment and Infrastructure). 2 (2).

A. Efendi P and N. Putri A. N. 2018. Making Liquid and Solid Organic Fertilizers from By-products of Water Hyacinth Biogas Anaerobic Processes. Ten March Institute of Technology.

S. H. Wibowo and Z. T. K. Sidqi. 2020. Utilization of Biodigester Technology in Making Organic Fertilizer and Biogas. Semarang. Wahid Hasyim Press.

W. Hartatik and D. Setyorini. 2011. Use of Organic Fertilizer to Improve Soil Fertility and Plant Quality," Book, pp. 571–582.

I. Firmansyah, L. Lukman, N. Khaririyatun, and M. P. Yufdy. 2016. Growth and Yield of Shallots with the Application of Organic Fertilizer and Biological Fertilizer on Alluvial Soil," J. Hortik., vol. 25, no. 2, p. 133.