

## Processing of Organic Waste Using Biopori Infiltration Holes (Case Study: Organic Waste at Christian University of Technology Solo)

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### ABSTRACT

Christian University of Technology Solo produces quite a large amount of waste, which in 1 day produces around 7 kg of waste resulting from the activities of 2 canteen units, dry leaf waste on the UKTS campus yard, and waste from the activities of students, staff and lecturers at Solo Christian University of Technology. This method uses biopore infiltration holes located in the yard of Solo Christian University of Technology, where organic waste is divided into two groups, namely kitchen waste and dry leaves. Kitchen waste is mixed into one consisting of leftover rice, vegetables, chicken bones, fried leftovers and dry leaves which are cut and crushed into leaf powder. The waste is put in the biopori infiltration hole and given water to keep it moist. Humidity was measured every week and water was added. The results of this study were that from 5 biopori infiltration holes with 4.88 kg of dry leaf waste, 1.48 kg of compost was produced with a decomposition process time of 57 days, while the 6th biopori infiltration hole had the amount of waste. a 6.5 kg kitchen produces 1.3 kg of compost with a decomposition time of 30 days.

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## **INTRODUCTION**

As a big city in Indonesia and one of the main tourist destinations in Central Java and Indonesia, the city of Surakarta faces a major problem, namely waste management. Every day it produces an average of 275 tons of waste. (Fitriani, 2019). Organic waste management if not managed properly will cause an unpleasant odor and become a medium for disease transmission through flies, rats and mosquitoes. Organic waste if decomposed anaerobically will produce CH<sub>4</sub> gas, which is a gas that can cause global warming. (Banna & Salem, 2014) Many organic wastes are generated by various activities of the food and beverage industry, manufacturing industry, agricultural activities, markets and households (Bijmans et al., 2011) Organic waste can be categorized as a by-product that can be decomposed by anaerobic processes from the food and beverage industry, municipal waste, households and if burned will cause pollution and have a serious impact on human health in the long term. (Pandey et al., 2022). Making efforts to recycle organic waste will produce materials that can be used for food for livestock such as fish and pigs, renewable fuels, compost and can prevent soil and water pollution. (Kowalska et al., 2020).

Biopori is a hole made vertically into the ground which functions to increase soil absorption of rainwater, and can be used for [processing organic waste into compost and increasing water reserves in the soil. Biopori infiltration holes are made in waterways, around trees and on the sides of fences This is to prevent overflow of water from entering residents' homes (Fauziya, 2022). Biopores are holes that are useful for accelerating the absorption of rainwater into the soil due to the decomposition of organic waste by living microorganisms such as worms, ants and termites. (Syahrudin et al., 2021).

Composting is a process of biologically decomposing organic waste anaerobically. Microorganisms in the composting process convert organic matter into a more stable form, namely water, CO<sub>2</sub>, ammonia and release heat as metabolic waste products. (Cesaro et al., 2015). Most of the material for the composting process is agricultural waste, agro-industry, and residual organic matter that can decompose (Sánchez et al., 2017) Compost is made from a uniform substrate and is important in agriculture because the organic matter contains very high amounts of phosphorus [11]. The main advantage of composting organic waste is reducing the volume of waste (M.P. Bernal et al., 2009). Anaerobic decomposition process is an interesting and important process in organic waste processing because it is capable of producing biogas. (Grosser et al., 2017) In theory, solving the waste problem requires a change in approach from an end-end to a source approach. In the source approach, waste is treated upstream before reaching the final treatment plant (downstream). (Yudistirani et al., 2015).

Likewise, in every activity of the entire UKTS academic community and the 2 canteens in the UKTS environment, they also produce quite large amounts of organic and inorganic waste. around 5 kg of organic matter and the remaining 2 kg is inorganic waste. Organic waste includes: leftover rice, crackers, leftover vegetables, grated coconut pulp, paper, banana leaves,

bakwan, fried tempeh and tofu. Meanwhile, non-organic waste includes: food plastic, styrofoam, and plastic bottles.



Figure 1 Separation of organic and inorganic waste at Christian University of Technology Solo

Waste treatment with biopori infiltration holes is a method for producing organic fertilizer, fertilizing the soil, harvesting rainwater and controlling rainwater runoff at Christian University of Technology Solo. (Case Study: Organic Waste at Christian University of Technology Solo)

## **THEORETICAL REVIEW**

The remaining waste discharged into nature can be in the form of solid, semi-solid, liquid or gas from industry or households. Apart from these two places, the rest of the waste also comes from places such as hospitals, agriculture, plantations, farms, offices, markets and many other places. It is undeniable that most human activities must produce waste in various places.

Based on its nature, waste is divided into two groups, namely organic waste and inorganic waste. Both of these properties are related to the remaining components of the waste. It also refers to the process of decomposing materials in nature. Organic waste is waste material that comes from products made from biological materials that can be easily broken down by microorganisms or microbes. Decomposition by microorganisms occurs naturally, examples of such wastes are kitchen scraps, food scraps, flour, vegetables, fruit peels, leaves and twigs. Places that produce a lot of organic waste are for example traditional markets which produce waste materials in the form of vegetables, fruits and others.

Compost is the result of imperfect (partial) decomposition of organic matter, which under certain conditions is accelerated by various bacteria or microbes. The result is compost that can be used as fertilizer

The benefits of compost are increasing soil fertility, improving soil properties and structure, increasing microbial activity in the soil, increasing soil water, improving plant quality and adding nutrients to the soil.

### ***Composting Stage***

In the composting process, microorganisms play a role in decomposing organic matter to produce an organic final product, namely compost. The composting process occurs in several stages, namely: 1. Decomposition of the active phase, when microorganisms begin to decompose materials that can be decomposed, the population increases, heat generated by microbial activity accumulates in the heap and the temperature continues to increase through the mesophilic range (25-45°C) to thermophilic (more than 45°C), temperature (55°C and above) is preferred because it can kill many pathogenic bacteria, weeds and fly larvae in the compost material (Niwagaba et al., 2008). At temperatures above 65°C it kills various forms of microbes and limits the speed of decomposition, so aeration is needed to keep the temperature below this point. 2. Cooling phase: when the supply of high-energy materials runs out, the temperature of the compost gradually drops and mesophilic microorganisms increase again 3. Ripening phase: this condition occurs at a low temperature but still experiences the reactions that occur in this phase, even though the microbial activity is relatively higher lower than the previous stage (Jenn-Hung Hsu & Lo, 1999)

### ***Process of Overhauling Organic Materials***

The biological process of decomposing organic matter into humus material of microorganisms is known as decomposition or composting. The basic activity of soil microorganisms is using plant residue components as a substrate to obtain energy which is formed through the oxidation of organic compounds, with the main product CO<sub>2</sub> being released back into nature, and a carbon source for the synthesis of new cells. Decomposition or composting is also known as microbial respiration or mineralization, which is a part of the carbon cycle.

Microorganisms are generally short lived. The dead cells will be decomposed by other populations of organisms to become a more suitable substrate than the plant residue itself. Overall the decomposition process generally includes a broad spectrum of microorganisms that utilize these substrates, which are distinguished by the type of enzyme they produce. This combined effort can change the carbon present in various forms of organic compounds into an oxidized form, namely CO<sub>2</sub>. One form of transformation product is soil organic matter (humus).

### ***Biopore Infiltration Hole***

Biopores, also known as biopore infiltration holes (LRB), are holes made perpendicular to the ground. This hole has a diameter of between 10-30 cm and does not have a shallow groundwater table. The hole is then filled with organic waste which has a function as food for living creatures in the soil, such as worms and plant roots. (Anonim, 2018)

## **METHODOLOGY**

This research was carried out on a field scale using the installation of biopore infiltration holes that had been installed in the courtyard of the Solo

Christian University of Technology. The research location was at Solo Christian University of Technology, Jl RW Monginsidi No 36-38 Margoyudan, Surakarta.



Figure 2 Research Locations

A summary of the conditions in this study can be seen in table 1 below, which consists of waste parameters, quality plans for the compost produced, how long it takes for composting to start when it is put in the biopore infiltration hole and the need for water to speed up the process of decomposing organic waste into compost. It is planned that it will take 30-60 days.

Number	Parameter	Description
1	Organic Waste	Compost is made from organic waste found at the Solo Christian University of Technology, including: dry leaf waste and waste from the kitchen, for example leftover vegetables, tempeh, tofu, meat, chicken bones, meat, mango skin, coconut pulp, watermelon, melon.
2	Compost	Compost produced in the form of black humus
2	Composting time	Planned 30-60 days
3	Water	To speed up the decomposition process and keep the waste moist

Table 1 Summarizes the research conditions

While the types and specifications of the tools used can be seen in table 2 below. The types of tools used are all tools that directly support this research.

Number	Tool type	Spesification
1.	Pipe drill tool PVC/Halo saw	Kodenki HK202
2.	Scales 50 kg	Goastsbrand
3.	Biopore infiltration holes	Within 1 meter
4.	Crowbar	Made of steel
5.	Bucket	Capacity 10 liter
6.	Biopore drill tool	Drill bit thread diameter of 100 mm
7.	Knife	Dry leaf chopper and kitchen waste

Table 2 Types and specifications of the equipment used

The design of the biopori infiltration hole tool can be seen in Figure 3 below. This biopori infiltration hole consists of 1 meter long PVC pipe with a diameter of 100 mm, which is given holes with a distance of 5-10 cm and is covered with PVC DOP. PVC DOP is given a hole with a function for water and oxygen to enter. Organic waste is inserted with a capacity of 75% of the pipe length.

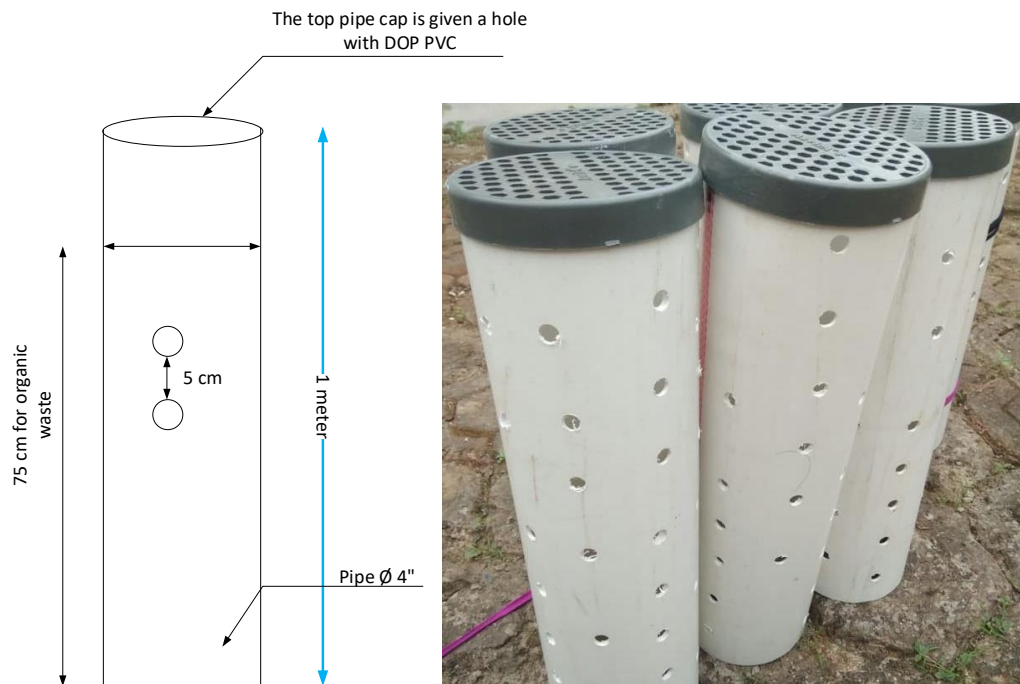


Figure 3 The design of the Biopori Infiltration Hole tool

The stages in this research can be seen in Figure 4 below as follows:

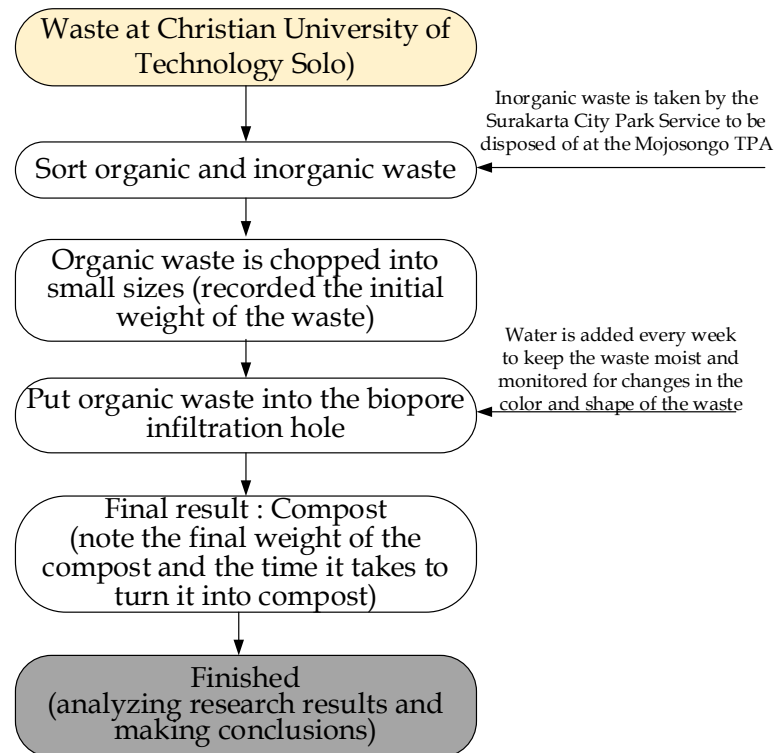


Figure 4 Research scheme process

## RESULTS

The implementation mechanism in this study is as follows: Prepare the equipment to be used, including: 50 kg scales, biopori drill tool, crowbar, knife for chopping organic waste, buckets and writing implements, Biopori infiltration holes are cleaned to add organic waste. organic waste before putting it into the biopori infiltration pit, record the weight of the waste. Put organic waste into the biopori infiltration pit which is divided into 2 groups, namely food waste and leaf waste. Each biopori infiltration hole is inspected weekly for the shape and texture and smell of organic waste. Biopori infiltration is given water to keep it moist. In week 4, the compost results are checked and the weight is recorded. The results of this study are presented in a table and then analyzed.



Fig. 5 Biopori Infiltration Holes Around the Solo Christian University of Technology

## DISCUSSION

### *Analysis of the weight of organic waste by weight of compost.*

At Christian University of Technology Solo, there are 6 biopore infiltration holes, with specifications: biopore depth of 1 meter, biopore diameter of 100 mm and made of PVC pipes that have been perforated with a distance between holes of about 5 cm. The function of the PVC pipe is to keep the soil around the biopores do not collapse and the holes in the PVC pipes function to keep the waste moist and the decomposition results can fertilize the surrounding soil. The result of this aerobic decomposition is compost.

Number	Biopore Hole	Organic waste weight (kg)	Compost weight (kg)	Kind of organic waste
1	A	5,1	1,6	Dried leaves
2	B	5,3	1,7	Dried leaves
3	C	4,3	1,2	Dried leaves
4	D	4,6	1,4	Dried leaves
5	E	5,1	1,5	Dried leaves
6	F	6,5	1,3	dry leaf waste and waste from the kitchen, for example leftover vegetables, tempeh, tofu, meat, chicken bones, meat, mango skin, coconut pulp, watermelon, melon.

Table 3 Compost weight yield

Based on table 1 above, with different waste weights for each biopori infiltration hole, different compost weights are obtained with different decomposition times. The weight of the waste produced ranges from 1.2 kg-1.7 kg of compost. The condition of this decomposition process occurs in the dry season. In biopori hole number 6, the organic waste that is put in is a type of kitchen waste leftover vegetables, tempeh, tofu, leftover rice, leftover fried food, coconut dregs, with a compost yield of 1.3 kg and a weight of 6.5 kg of waste included with the characteristics of the compost produced relatively a little but the decomposition process is relatively faster when compared to dry leaf type waste. While organic waste types of dry leaves, the process of decomposition of waste is relatively longer for 57 days.

The process of decomposition of organic matter is an important photosynthetic catabolic process carried out by soil microorganisms (Jangir et al., 2019). This process is a conversion of complex organic matter so that it becomes simpler by microorganisms in the soil (Barrios, 2007) Worms in the soil play an important role in the decomposition of organic matter contained in the soil. Earthworms break down soil litter and organic matter into small particles

to be broken down by microbes. The amount and activity increase when the organic matter passes through the intestines of earthworms. Earthworms are rich in clay, glycoproteins, polysaccharides, bacteria, fungi and many other microorganisms that help speed up the efficiency of microbial degradation(Edwards & Arancon, 2004)(Furlong et al., 2002).Brussaard(Brussaard, 1997) states that nearly 90% of the process of decomposition of organic matter is caused by microorganisms in the soil, namely bacteria, fungi, and others.

The result of the decomposition of organic waste as shown in Figure 4 below is humus. The process of occurrence of humus in the soil is a slow process in which darkening of soil fungi occurs mainly due to chemical reactions and microbial activity (Edwards et al., 2010). From the compost harvest in the biopori holes, 1 to 5 of the compost is dark black in color and takes quite a long time, which is 1 to 2 months more. This is in accordance with research (Canellas et al., 2002), humic acid is the largest portion of humus, which can be seen from its main dark color. Organic matter formed from the decomposition process of organic waste can be formed in a few months depending on environmental conditions and the presence of earthworms.



Figure 6 Results of the process of decomposing organic waste in the form of compost

***Analysis of the weight of organic waste with a long time of decomposition.***

From the results of this study, it was found that to obtain compost requires quite a long time, which is around 40-65 days. Every week, treatment is carried out for each biopori infiltration hole by adding water which functions to speed up the waste decomposition process.

Number	Biopore Hole	Organic waste weight (kg)	Decomposition time (Days)	Kind of organic waste
1	A	5,1	50	Dried leaves
2	B	5,3	57	Dried leaves
3	C	4,3	65	Dried leaves
4	D	4,6	55	Dried leaves
5	E	5,1	58	Dried leaves
6	F	6,5	1,3	dry leaf waste and waste from the kitchen, for example leftover vegetables, tempeh, tofu, meat, chicken bones, meat, mango skin, coconut pulp, watermelon, melon.

Table 4 Length of Decomposition Time

**CONCLUSIONS AND RECOMMENDATIONS**

The decomposition process of organic waste is highly dependent on the humidity of the waste and the soil. The length of time for the decomposition process varies between dry waste and kitchen waste. From 5 biopori infiltration holes with 4.88 kg of dry leaf waste, 1.48 kg of compost is produced with time the decomposition process took 57 days while the 6th biopori infiltration hole amounted to 6.5 kg of kitchen waste which produced 1.3 kg of compost with a decomposition time of 30 days.

**FURTHER STUDY**

This research aims to produce compost through a natural decomposition process without the addition of EM4 compounds or solutions to speed up the composting process. Therefore, it takes a relatively long time to decompose organic waste.

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