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UTILIZATION OF VEGETABLE WASTE AS AN ENVIRONMENTALLY FRIENDLY NATURAL DECOMPOSER

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ABSTRACT: Natural decomposers are a collection of various kinds of decomposing microorganisms in nature that can be used as bioactivators. Natural decomposers are often referred to as Natural Microorganisms (MOL). One of the materials that can be used as a source of microbes in decomposers is vegetable waste because vegetable waste is a good medium for the proliferation of decomposing microorganisms. Apart from being a source of organic matter, rotten vegetables can be a source of bacteria as a decomposer. The manufacturing process also requires carbohydrates in rice washing water and glucose in sugar which acts as a source of energy or nutrition for microorganisms. This study aims to determine the types of microbes contained in the vegetable waste decomposer and to obtain the correct composition of washing water for rice and sugar for the highest number of microbes in the MOL decomposer. The research was conducted with anaerobic fermentation process for 14 days. From the research results it can be concluded that a. The types of microbes contained in local microorganisms of vegetable waste are Bacillus Subtillus, Bacillus Cereus, Lactobacillus Acidophilus, Spirillum, Streptoverticillium, and Leuconostoc Mesenterousdes b. The composition of washing rice water and sugar is right for the results of the highest number of microbes in sample C1, namely 91 x 105 Colonies / 100 mL in MOL of vegetable waste is 650 mL of rice washing water and 100 grams of granulated sugar.

Keywords: Natural decomposers, Rice washing water, Sugar, Anaerobic fermentation

1. Introduction

The existence of waste as a material that is wasted or disposed of from sources of human and natural activities that do not have economic value has become a crucial environmental problem [23]. Organic waste is a type of waste that is composed mostly of organic compounds such as plant, animal or fecal remains. In nature, organic waste can be classified as degradable waste, which is a type of waste with natural properties that is easy to degrade by living things, especially microbes [35]. In the process of degradation or decomposition of organic matter, microbes act as an inoculum or starter (activator) which accelerates the breakdown process [16].

Various kinds of decomposing microorganisms in nature which are often referred to as local microorganisms (MOL) can be used as bioactivators. These types of microbes can be cultured using a variety of organic material sources. Vegetable waste can be a good source of organic matter and media for the proliferation of decomposing microorganisms, and can be used as bioactivators [32]. In addition to a source of organic matter which after rotting can be a source of bacteria for moles, in its manufacture moles also require carbohydrates in rice washing water and glucose in sugar which acts as a source of energy or nutrition for microorganisms in mole solutions [15]

In previous research conducted by Suwatanti (2017), it was not known the types and amounts of microbes contained in the MOL solution of vegetable waste which could become bioactivators. In that study, before being used as a mole, the fermented solution was only physically tested to determine whether MOL was successfully formed or not.

Because of the theoretical basics above and the results of previous research, we would like to conduct research on making environmentally friendly MOL from vegetable waste with variations in the provision of nutritional sources to determine the types of microbes contained in the moles and the composition of the right nutrient sources for MOL results. the highest number of microbes. The final expected result is finding the right composition in MOL.

2. Methodology

2.1 Natural Micro-organisms (MOL)

Bioactivators are mixed inoculums of various types of cellulotic and lignolytic microorganisms. In bioactivators there are various genera of microorganisms for fermentation and decomposers. Globally, there are several main groups of microorganisms in bioactivators, namely photosynthetic bacteria, Lactobacillus sp., Streptomycetes sp., Yeast (yeast), and Actinimycetes [20].

Bioactivator is a solution containing various kinds of microorganisms. The activity of these microbes results in a decomposition process. The speed of the decomposition process is influenced by the state and type of microbes that are active during the process. Therefore, the optimum conditions for microbial activity need to be considered such as growth media and food sources for these microbes. In addition to increasing the speed of decomposition, bioactivators can also increase the breakdown of organic matter and improve the quality of the final product [4]

Effective Microorganism is a mixed culture of various types of beneficial microorganisms (photosynthetic bacteria, lactic acid bacteria, actinomycetes and fermented fungi) with a total plate count of 2.8 x 106 colonies / 100 ml which can increase soil microbial diversity and can be used as a bio-activator [33]. Apart from commercial EM4 products, various kinds of decomposing microorganisms in nature can also be used as bioactivators. Microbes of this type are often referred to as local microorganisms (MOL) [32].

MOL is a microorganism that is used as a starter in the manufacture of solid organic fertilizers and liquid fertilizers. The main ingredients of MOL consist of several components, namely carbohydrates, glucose, and a source of microorganisms [21]. MOL has the ability to grow on organic material with sufficient nutrient content and water content [4]. Usually MOL contains not only 1 type of microorganism but also several other microorganisms Rhizobium sp, Azospirillium sp, Azotobacter sp, Pseudomonas sp, Bacillus sp and phosphate solubilizing bacteria [15].

MOL solution is a type of fermented solution from raw materials for various organic waste resources such as banana weevil, golden snails, urine, vegetable and fruit waste [4]. The MOL solution succeeds in presenting microorganisms to decompose organic matter if it shows signs of water turning cloudy, pieces of waste crumbling, and emitting gas during the manufacturing process [32]

The purpose of making MOL is to develop a source of destruction of organic matter (decomposer) and increase plant activation and additional nutrients for plants. The benefits of MOL include:

1) As a starter in the decomposition process of organic matter
2) As a starter for liquid organic fertilizers for plants
3) Providers of nutrition for plants
4) Helping the smooth absorption of nutrients by plant roots, because of their electrolyte content [15]

2.1.1. Fermentation Making MOL

The term fermentation is used in processes that involve microorganisms such as bacteria, yeast and fungi to produce products that are useful for humans. The definition of fermentation in the world of microbiology refers more to the process of cell growth in large quantities both in aerobic and anaerobic conditions [19]

Anaerobic fermentation is a fermentation process that does not require oxygen. Anaerobic fermentation has been widely used by humans for important industrial processes since ancient times, for example, the production of ethanol from yeast, the production of lactic acid in food and beverage ingredients, the breakdown of polysaccharides and protein in the production of biogas. One of the biggest advances in industrial microbiology is the anaerobic degradation of waste which also detoxifies harmful contaminants [37].

Factors affecting fermentation:

1) Types of Microorganisms
   Selection of microorganisms generally depends on the type of substrate, growth requirements and expected fermentation products.
2) Nutrition
   Nutrients are needed for microorganisms for their growth. Nutrients for the growth of microorganisms are divided into three, namely macronutrients such as carbon and nitrogen, micronutrients such as phosphorus, sulfur, calcium, iron, sodium and magnesium, and trace elements such as cobalt, manganese, iron, nickel and zinc.

3) Media

Fermentation media functions to grow and reproduce microorganisms in order to obtain the desired product [19].

2.1.2. Raw Materials for Making MOL

The process of making local microorganisms is carried out with several main raw materials and supporting raw materials, namely:

a. *Rice Washing Water as a Source of Carbohydrates*

Carbohydrates are an important food ingredient in a source of energy found in plants and animals. Carbohydrates have a role as the main source of energy, every 1 gram of carbohydrates contains 4.1 calories, forming organic compounds such as fat and protein [27]. To provide carbohydrates for microorganisms, it can be obtained from rice washing water (41.3%), used rice / stale rice (40.6%), cassava skin (36.8%), and others. Because of the highest carbohydrate content, rice washing water is the most potential source of carbohydrates as a source of energy for microorganisms [15].

b. Sugar as a source of glucose

Glucose is a monosaccharide that acts as a carbon source in microbial growth media. Carbon sources that act as nutrients are necessary for the survival of bacteria. If nutrients are abundant, viability increases [23]. This material is also a source of energy for microorganisms that are spontaneous (easier to eat them). Glucose can be obtained from sugar, brown sugar, molasses, sugar water, coconut water, sap water, and others. Because it is the easiest to dissolve and process, sugar is the most potential source of glucose as a source of energy for microorganisms [15]

c. *Vegetable Waste as a Source of Bacteria (microorganisms)*

Materials that contain many microorganisms that are beneficial to plants include rotten fruits, rotten vegetables, golden snails, rice, bamboo shoots, banana weevils, rabbit urine, pumpkin leaves, cassava tapai and maja fruit [15]. Vegetable waste is a collection of various kinds of vegetables after being sorted because they are not suitable for sale and are usually dominated by cabbage and mustard greens [34]. Almost all vegetable waste will undergo lactic acid fermentation, which is usually carried out by various types of Streptococcus, Leuconostoc, Lactobacillus, and Pediococcus bacteria [32]. For growth, these bacteria eat the sugars found in vegetables [30].

Extracts from cabbage and mustard greens that have been ripened with the addition of salt and molasses produce Fermented Vegetable Waste Extract (ELSF). The 0 hour curing process shows yeast in the starter because the ELSF contains Saccharomyces yeast. In addition, the vegetable waste extract contains active bacteria such as Lactobacillus sp and Sacaromyces and contains 2.1 x 1010 CFU of lactic acid bacteria [22]. Total lactic acid bacteria in the medium during the mustard fermentation produced ranged from 7.28 to 9.03 log CFU / ml. During fermentation, the total lactic acid bacteria tends to increase. Factors that affect the growth of lactic acid bacteria include fermentation temperature, added salt content and the presence of nutrients [36]. Cabbage belongs to the species Brassica olaracea, family Cruciferae. The weakness of cabbage waste is a high water content of 92.44% which causes cabbage waste to rot easily so it is necessary to make a subscription by making a fermentation starter containing the original active microorganisms of the material [34]. This rotting cabbage leaf waste is the place for a bacteria called Lactobacillus plantarum, Lactobacillus delbrukil, Laktobacillus fermentum and Lactobacillus brevis to live [30].

At the beginning of the mustard fermentation, generally the lactic acid bacteria that grew were Leuconostoc mesenteroides. At 18 ° C fermentation goes well, Lactobacillus brevis and Lactobacillus plantarum species can grow well [36].

Tomato (Lycopersicum esculentum L.) is a vegetable that is easily damaged due to its high water content, including mechanical, biological and microbiological damage [38]. In every traditional market, it is easy to find tomatoes that are not suitable for consumption. Rotten tomatoes are a good medium for the growth of decomposing microorganisms [4]

2.2 Exprimental

The research was conducted at the Chemical Engineering Laboratory of ITN Malang. Control variable are salt weight: 45 grams, vegetable waste weight: 500gram and Mol fermentation time: 14 days. Independent variable are Volume of water washing rice: 600, 625, 650 ml, weight of sugar: 100, 125, 150, 175, 200 grams

2.3 The Materials and Equipment

Materials and tools used are fermenters, rice washing water, salt, sugar and vegetable waste (cabbage, mustard greens and tomatoes).

2.4 Research procedure

The stages of the research procedure "Utilization of Vegetable Waste as an Environmentally Friendly Natural Decomposer" are as follows: prepare 500 grams of vegetable waste (a mixture of cabbage, mustard greens, tomatoes) and then chop it until the size of the waste becomes small; put vegetable waste into the fermenter with a size of 1.5 liters modified with plastic intermittent cover; connecting a plastic hose to a 600 ml plastic bottle filled with lime water which functions to observe the presence or absence of CO2 gas; adding sugar to vegetable waste in the fermenter as much as 100, 125, 150, 175, 200 grams respectively for fermenters 1, 2, 3, 4, 5; adding washing water of rice from the first wash to vegetable waste in the fermenter as much as 600 ml for fermenter A1-A5, 625 ml for fermenter B1-B5 and 650 ml for fermenter C1-C5, respectively; adding 45 grams of salt for each fermenter; fermenting vegetable waste anaerobically (fermenter tightly closed) for 14 days; observing the presence or absence of water discoloration, physical pieces of rotten vegetable waste, and the presence or absence of CO2 gas as indicated by the presence or absence of lime deposits formed in the plastic bottle filled with lime water above; open the lid of the fermenter bottle after 14 days of fermentation and then perform an analysis test of the type of microbe and total microbes of the sample of the Mole solution

3. Result and Discussion

3.1 Results of Analysis of Microbial Types

The results of the analysis of microbial types carried out at the Chemical Engineering Microbiology Laboratory of ITN Malang.

The results of the analysis of microbial types carried out at the Chemical Engineering Microbiology Laboratory of ITN Malang

Table 1. Analysis of Microbial Types.

Sample	Rice Washing Water (mL)	Sugar (gram)	Types of Microbes
A1	600	100	*Bacillus Subtillus, Lactobacillus Acidophilus*
A2		125	*Bacillus Cereus*
A3		150	*Spirillum*
A4		175	*Bacillus Subtillus, Streptoverticillium*
A5		200	*Bacillus Subtillus, Bacillus Cereus*
B1	625	100	*Bacillus Subtillus, Streptoverticillium, Spirillum*
B2		125	*Bacillus Subtillus*
B3		150	*Bacillus Subtillus*
B4		175	*Bacillus Subtillus, Spirillum*
B5		200	*Spirillum, Bacillus Subtillus*
C1	650	100	*Spirillum*
C2		125	*Bacillus Subtillus, Leuconostoc Mesenterousdes*
C3		150	*Leuconostoc Mesenterousdes, Lactobacillus Acidophilus*
C4		175	*Bacillus Subtillus, Streptoverticillium, Bacillus Cereus*
C5		200	*Bacillus Subtillus*

Table 2. Results of Analysis of the Number of Microbes

Sample	Rice Washing Water (mL)	Sugar (gram)	Number of Microbes (Colony / 100 mL)
A1	600	100	61×10^4
A2		125	36×10^5
A3		150	6×10^5
A4		175	93×10^4
A5		200	29×10^4
B1	625	100	27×10^4
B2		125	173×10^4
B3		150	61×10^4
B4		175	12×10^4
B5		200	12×10^4
C1	650	100	91×10^5
C2		125	15×10^4

Sample	Rice Washing Water (mL)	Sugar (gram)	Number of Microbes (Colony / 100 mL)
C3		150	36 x 10^4
C4		175	15 x 10^3
C5		200	3 x 10^4

3.1.1 Results of Analysis of Microbial Types

From the analysis of the types of microbes in the sample solution, it is known that the microbes contained in local microorganisms from vegetable waste are Bacillus Subtillus, Bacillus Cereus, Lactobacillus Acidophilus, Spirillum, Streptoverticillium, and Leuconostoc Mesenterousdes.

Bacillus Subtillus is a type of microbe that can be used as a decomposer because it is proteolytic so that it is able to hydrolyze protein into amino acids. In its utilization, B. Subtillus is used to increase nitrogen and phosphorus content [2]. In addition, according to Ruhnayat, et al. (2007), B. Subtillus is also widely available in bio fertilizers because it is a type of phosphate solvent microbe. These microbes can grow on insoluble phosphate (insoluble phosphate) and can also convert natural-phosphate into a soluble form.

Bacillus Cereus is a type of Bacillus Sp microbe that has the ability to degrading organic matter [12]. According to Sari, et al. (2017), apart from being able to degrade organic matter, B. Cereus also has the potential to degrade organic acids and decrease levels of COD and BOD. With its ability to hydrolyze starch, these microbes are able to increase the average quality of nitrogen.

Lactobacillus Acidophilus is a type of microbe that ferments carbohydrates and sugars to produce lactic acid. In addition, L. Acidophilus is also able to inhibit the growth rate of pathogenic bacteria because it is a type of probiotic microbe [1].

Spirillum is a type of denitrification microbe that is able to reduce nitrates and nitrites to nitrogen. As a denitrifying microbe, Spirillum is also a type of facultative microbe that can live in aerobic and anaerobic conditions [29]. According to Kunarso (1988), Spirillum is a reducent or decomposer microbe that is able to decompose organic and mineral materials into nutrient sources of energy.

Streptoverticillium is a type of Actinomycetes microbe that plays a role in forming humus and expanding the growth area with long chain spores. These microbes can be found in soils with high organic matter content as well as in the rhizofer of plants [26]. According to Nugroho, et al. (2019), Streptoverticillium is also called Streptomyces and belongs to the microbial transglutaminase group, which is a type of microorganism capable of producing transglutaminases. In addition, Streptomyces is also a root-fertilizing microbe that produces nutrients and growth hormones and acts as a biocontrol agent in biological organic fertilizers which can improve soil respiration [5]

Leuconostoc Mesenterousdes is a type of lactic microbe that has the ability to break down complex compounds into simpler compounds that produce lactic acid [3]. In addition, according to Kusmiati, et al. (2002), L. Mesenterousdes can change the quality of fermented products.

3.1.2 Results of Analysis of the Number of Microbes

The results of the analysis of the number of microbes from the Mole solution of vegetable waste showed the highest results for the number of microbes in sample C1, namely 91 x 10^5 Colonies / 100 mL and the lowest for the number of microbes in sample C4, namely 15 x 10^3 Colonies / 100 mL.

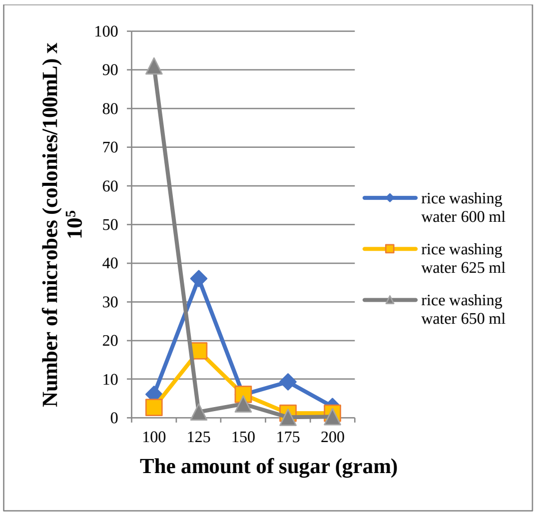

Figure 1 Graph of the Relationship Between the Amount of Sugar and the Number of Microbes in Various Amounts of Rice Washing Water

To increase the amount of washing water for rice, it was shown that there was an increase in the number of microbes in treatment 1 while in treatment 2, 3, 4, and 5 there was a decrease in the number of microbes.

This increase is because the carbohydrate content in rice washing water is a source of nutrients needed by microbes to grow [7]. Carbohydrates are a type of staple food for anaerobic microbes as a source of energy [10]. According to Marsiningsih, et al. (2015), the amount of nutrients available in Mole solutions is a factor that affects the availability of the number of microbes present in Moles. So with the increasing number of nutrients, the number of microbes present in the Mole solution also increases.

While the decrease in the number of microbes occurs because in the early stages of fermentation, certain types of microbes break down carbohydrates or starches to produce glucose, so that glucose increases but levels of carbohydrates or starches decrease. The decrease in starch content as an energy source for certain types of microbes results in a decrease in the number of microbes that survive.

To increase the amount of sugar, showed an increase and decrease in the number of microbes in treatment A, B, and a decrease in the number of microbes in treatment C.

The increase is because sugar as a food source provides energy which causes optimal microbial growth. The increase is also because the microbes are in the log growth phase which causes the defense of microbial cells to increase.

Meanwhile, the decrease in the number of microbes is because there are microbes that die in the competition for nutritional sources. Competition as the interaction that occurs affects the ability of microbes to grow and live. In addition, the decrease in the number of microbes also occurs because some microbes are in the static phase and then the death phase [11].

According to Budiyani, et al. (2016), in addition to a source of nutrition or energy for microbial growth, there are several other factors regarding operating conditions that affect microbial growth in the fermentation process, namely temperature, pH and oxygen. The decrease in the number of microbes that occurs is thought to be due to the anaerobic fermentation process that is not maintained so that a leak occurs on the fermenter lid which results in oxygen entering and making the microbes die.

In the fermentation process, carbohydrates will break down into simpler sugars, namely dextrose, mannose and sucrose which are used by lactic acid bacteria as an energy source and produce acidic compounds such as lactic acid and other volatile compounds which cause an acidic atmosphere so that Low product pH [6]. This causes bacteria to work extra in the process of breaking down carbohydrates into simpler sugars so that the bacteria have an excess source of energy or carbohydrates, where excess carbohydrates can cause death in fermenter microorganisms this is due to the result of too much alcohol so that it can damage microorganisms [9]

4. Conclusions

From the research results of making local microorganisms (MOL) from vegetable waste with variations in the provision of nutritional sources, the following conclusions were obtained:

1. The types of microbes found in local microorganisms of vegetable waste are Bacillus Subtillus, Bacillus Cereus, Lactobacillus Acidophilus, Spirillum, Streptoverticillium, and Leuconostoc Mesenterousdes
2. The composition of washing rice water and sugar is right for the highest number of microbes in sample C1, namely 91 x 105 Colonies / 100 mL in MOL of vegetable waste is 650 mL of rice washing water and 100 grams of granulated sugar.

Suggestions

It is necessary to do ANOVA test on MOL solution to determine the effect of nutrient sources on the type and number of microbes present in the MOL solution from vegetable waste and further research for MOL from vegetable waste with other variable variants

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