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PRODUCTION OF LIQUID COMPOSTER USING A HOUSEHOLD SCALE BIOGAS REACTOR IN THE PERSPECTIVE OF TOXICOLOGICAL STUDIES ON PUBLIC HEALTH

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ABSTRACT

Organic waste in the Health Polytechnic Of Kendari has been transported by garbage transport trucks to the Puuwatu Landfills or destroyed by burning. Burning garbage will hurt air quality. This study aims to determine the adequate time needed to produce quality liquid compost from organic waste at the Health Polytechnic Of Kendari and examine the toxicological effects of waste on human health. This type of research is an experimental laboratory with a one-shot case study design. And sampling in this study was carried out by purposive sample, namely by determining the average amount and type of organic waste in the Poltekkes Environment of the Ministry of Health Kendari per day. The results showed that the effective time for producing liquid compost was 36 days with a volume of 2500 mL, and the fastest liquid compost production was 7 days with a volume of 1200 mL. The ideal ratio of C/N composting is 30 : 1. There was a temperature fluctuation within 109 days. The mesophilic phase at the beginning of this study lasted 22 days with a temperature range of 34.5 – 34.9 ^oC. The second phase is the thermophilic phase, characterized by an increase in temperature, namely up to 40-54.9 ^oC, which lasts for 36 days. And the maturation stage in this study lasted for 51 days with a temperature range of 44.4 – 32.2 ^oC. The pH of liquid compost from organic waste has increased, ranging from 2.3 – 4.2. on day 7, the compost turned light brown; from day 44 to day 109, it turned dark brown. Liquid compost production from day 7 to day 85 has a distinctive odour, while liquid compost from day 95 to day 109 has a slight odour. The toxicological effects of organic waste include polluting the environment and disrupting human health, namely respiratory problems, heart problems, cancer, risk of death or premature death.

Kata Kunci:

Sampah organik;
Komposter cair;
Reaktor biogas;
Toksikologi;
Kesehatan masyarakat.

ABSTRAK

Sampah organik di Lingkungan Poltekkes Kemenkes Kendari selama ini diangkut dengan truk pengangkut sampah untuk dibawa ke TPAS Puuwatu atau dimusnahkan dengan cara dibakar. Membakar sampah akan berdampak buruk bagi kualitas udara. Penelitian ini bertujuan mengetahui waktu produksi kompos cair yang efektif dari sampah organik penambahan bioaktivator dan cara mendapatkan kualitas pengomposan cair yang baik dengan menggunakan reaktor biogas skala rumah tangga. Jenis penelitian ini adalah eksperimen laboratorium dengan desain *one-shot case study*. Dan Pengambilan sampel pada penelitian ini dilakukan dengan cara *purposive sample* dengan menentukan jumlah rata-rata dan jenis sampah organik yang diambil per hari. Hasil penelitian menunjukkan Waktu efektif produksi pupuk kompos cair adalah 36 hari sebanyak 2500 mL, pembuatan kompos cair tercepat adalah 7 hari sejumlah 1200 mL. Rasio ideal pengomposan C/N adalah 30 : 1. Terjadi fluktuasi suhu dalam rentang waktu 109 hari. Pada fase mesofilik pada awal penelitian ini berlangsung selama 18 hari dengan kisaran suhu 34,5 – 34,9 ^oC. Fase kedua adalah fase termofilik, fase ini ditandai dengan peningkatan suhu yaitu hingga 40-54,9 ^oC yang berlangsung selama 36 hari. Dan tahap pematangan pada penelitian ini berlangsung selama 51 hari dengan kisaran suhu 44,4 – 32,2 ^oC. pH kompos cair dari sampah organik mengalami peningkatan berkisar antara 2.3 – 4.2. pada hari ke 7 pupuk kompos berubah berwarna coklat muda, pada hari ke 44 sampai hari ke 109 berwarna coklat tua. produksi kompos cair hari ke 7 sampai hari ke 85 memiliki bau yang khas sedangkan hari ke 95 sampai hari ke 109 agak sedikit berbau. Efek

toksikologi sampah organic antara lain mencemari lingkungan dan menggangu kesehatan manusia yaitu masalah pernafasan, gangguan jantung, kanker, resiko kematian atau kematian dini.

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INTRODUCTION

Waste management is an increasingly urgent problem, especially in Kendari City, the increase in population and volume of waste from year to year is not matched by adequate facilities and infrastructure, causing serious environmental problems (Purnomo, 2021). In addition to population, it turns out that lifestyle effect waste volume (Surakusumah, 2008). The large amount of waste accumulated due to human activities not only impacts health by becoming a source of disease but also impacts the human side of life (Yuliananda et al., 2019). According to (Sahwan, 2018) states that in waste management there are still obstacles and dilemmas, namely the need for labor, costs, availability of space. Waste management at landfills will be more useful if it is not only a place for sorting but can also be continued with processing. Improper waste management can result in a decrease in the level of public health and environmental quality (Shofi et al., 2023)

Classified types of organic, inorganic and B3 waste will make it easier to recycle. However, waste mixed with other types of waste can inhibit other processes, thereby inviting disease vectors, causing unpleasant odors and reducing the aesthetic value of the environment (Prasasti et al., 2023). There are several unresolved waste management problems including: Public awareness in waste management is still low, the ability of waste handling services is still not optimal (65%), the community does not separate organic and non-organic waste and causes waste management to become more difficult and inefficient, limited landfill land, inconsistent law enforcement (Budi, 2017; Pinontoan & Sumampouw, 2019).

Pinontoan & Sumampouw, (2019) mentioned that human health can be affected by waste. Among them are location and inadequate waste management (uncontrolled waste disposal) is a suitable place for several organisms and attractive to various animals such as flies and dogs which can transmit various diseases (diarrhea, dengue fever, typhus, fungal diseases, tapeworms). Garbage impacts the environment because seepage of waste that enters the drainage or river will pollute the environment. This causes fish to die and changes the ecosystem. The decomposition of garbage in river water produces organic acids and organic gases such as methane, besides smelling bad, this gas can explode in high concentrations. It has been reported that the toxic effects of garbage in Japan approximately 40,000 people died from consuming fish contaminated with mercury (Hg). This mercury comes from waste dumped into the sea by factories that manufacture batteries and accumulators. Some of the biodegradable organic materials in landfills are generally unstable and quickly decompose because they undergo a degradation process that produces nutrients, toxic chemicals and simple organic matter, causing a pungent odour and disturbing the sense of smell. Biogas household waste can reduce the accumulation of organic waste produced. This can reduce air pollution, which emits an unpleasant odour around the final waste disposal area, and the community can use energy from biogas in their daily lives to reduce living costs (Harun & Sokku, 2022).

Data from the Kendari City Environment and Forestry Service (Denisah, 2022), the volume of waste produced by the people of Kendari City reaches 229.46 tons per day. Of the 229.46 tonnes of waste per day, 53% is organic waste originating from markets and households, 31% is plastic waste, 9% is paper waste, 4% is rubber, 1% is fabrics and textiles, 1% metal and 1% glass . SIPSN (Sistem Informasi Pengelolaan Sampah Nasional-National Waste Management Information System) in 2022 was obtained from 181 regencies/cities throughout Indonesia, waste generation reached 14,834,510 tonnes/year with 17.85% waste reduction, 42.75% waste handling, 60.6% managed waste, and 39 unmanaged waste 4%. So far, organic waste in the Kendari Ministry of Health Polytechnic environment is only transported by garbage trucks to be taken to the Puuwatu Landfills or destroyed by burning, while burning the waste itself will hurt air quality, so it is far from creating a healthy and clean environment. Preservation of a clean and healthy environment reflection the balance of the ecosystem that starts in every household.

If it is related to the location of the landfills, which is usually far from the source of waste so that the cost of transporting waste becomes expensive, then efforts to recycle waste close to the source of waste are better. Thus, it is very appropriate to recycle household waste into compost (Huda et al., 2022). This concept supports Law Number 18 of 2008 concerning waste management. The law was passed to improve environmental quality and public health and turn waste into a resource. The soul of the law is the handling and reduction of waste (Law No. 18/2008 Regarding Rubbish Management., 2008).

Waste management activities are a series of activities starting from sorting, collecting, transporting, processing, and final waste. Processing from these activities, there are 3 handling locations: the place of origin of the waste (one of which is a household), a temporary shelter or integrated waste processing site and a final processing site (Law No. 18/2008 Regarding Rubbish Management., 2008). What is meant by waste reduction is the activity of limiting the generation, recycling and reuse of waste. Waste recycling activities in the context of turning waste into a resource are closely related to the composition of waste in Indonesia. About 71% of waste can be used as compost. The characteristics of high organic waste water content (59.88%) 4, C/N ratio of 37.1 and a size range of about 2.5-7.5 cm, are values suitable for the composting process (Golueke, 1977; Haug, 1980; Kayhanian & Tchobanoglous, 1993; Sahwan, 2004).

Organic waste in the Kendari Ministry of Health Polytechnic Environment has so far only been transported by waste trucks to be taken to the Puuwatu landfill or destroyed by burning, while burning the waste itself will hurt air quality, where during the combustion process, smoke and small particles are released into the atmosphere. This smoke contains a variety of harmful substances, including carbon monoxide, volatile organic compounds, and heavy metals (Zhang et al., 2021). They were making it even further from creating a sustainable, healthy, clean environment. Meanwhile, preserving a clean and healthy environment reflects the balance of the ecosystem, which begins when every household, office and commercial environment maintains cleanliness by managing waste into something beneficial for life and the environment.

Efforts to compost household waste using a "composter" can help municipal waste management efforts by reducing the amount of waste generation, reducing the cost of transporting waste, and extending the life of the landfills (National Standardization Agency, 2004). According to Xie et al., (2023) states that organic matter is degraded through the process of microorganism activity, so it is useful for plant nutrition and plant improvement. Through composting humus material is reduced significantly by up to 40%. Utilization of organic waste for the production of liquid composter using household-scale biogas reactors is expected to assist in maintaining human health and improving environmental health.

In previous research Indraprahasta & Alamsyah (2014) in his research stated that the extent to which household-scale biogas hassupported rural development, where Cibodas Village is used as case study to give deeper descriptionabout the relation of biogas and rural development. In the study conducted participant observationapproach, the researcher is directly involved as active agents and sources of information, participate actively participating in learning process directly, or be passive recipients of information. This study reveals that biogas and its bio-slurry, to certain extent, have effectivelyaddressed several issues of rural development in Cibodas Village, mostly under the infrastructure, economy, and environment aspects. Institution and entrepreneurship have played critical role to link natural and human-cultural resources and have acted as driver of change. In another study on the utilization of household waste using a biogas reactor Rupf et al., (2016) say that suitable feedstocks for household, community, and institutional biodigesters include crop residues, night soil/domestic sewage, and the organic fraction of municipal solid waste (OFMSW). Significant untapped feedstocks exist from SSA agro-processing and food production industries. Biodigesters available in SSA for household, community, and institutional installations include variations of fixed dome, plug flow, and floating cover digesters. Commercial digester designs applicable to the region include continuously stirred tank reactors and fixed film digesters.

Based on this background, this research was conducted to determine the effective time needed to produce quality liquid compost from organic waste at the Health Polytechnic of Kendari and examine the toxicological effects of waste on human health.

METHODS

Research Design

This type of research is an experimental laboratory with a one-shot case study design, a research design with treatment of independent variables followed by observation or measurement of dependent variables (Asari et al., 2023). Conditions are controlled so that no other variables (other than the treatment variable) influence the dependent variable. So that conditions can be controlled, experimental research uses a control group and experimental research is carried out in the laboratory (Yang, 2007). Parameters for analyzing the quality of compost in this case are the presence of microbial contaminants (E. Coli and Salmonella sp, maturity level (C/N ratio, N-NH4/N- total and N-NO3/N-NH4) and suitability for compost characteristics. Suitable liquid, namely colour, odour, temperature and pH.

Location and Time of Research

Location and time this research was conducted in four locations of the health polytechnic of the ministry of health in kendari including the Department of Medical Laboratory Technology, the Department of Nursing, the Department of Midwifery and the Canteen. Composter sampling was carried out in March-May 2022. Meanwhile, the time frame for making "composter" research was carried out in June-November 2022.

Population and Sample

Sampling in this study was carried out by purposive sample, namely by determining the average amount of organic waste per day. According to Sugiyono (2019) Purposive sampling is a technique for sampling data sources with certain considerations. The considerations referred to include certain characteristics or characteristics that are appropriate to the research. The organic waste referred to in this research is food waste originating from the canteen in the Health Polytechnic Of Kendari Environment, namely vegetable pieces, fruit peels and other food waste which are rich in Nitrogen, while dry leaves, wood fiber, twigs and corn husks are rich in carbon element content.

The sampling process is divided into 6 stages and uses several parameters to analyze the quality of compost, namely: the presence of microbial contaminants (E. Coli and Salmonella sp, maturity level (ratio of C/N, N-NH 4/N- total and N-NO3/N-NH4) and conformity with the characteristics of good liquid compost: 1) Brownish in colour 2) Does not smell pungent 3) Ambient temperature 35-65°C 4) Neutral pH 6.5-7.5, as well as observation of the colour of the compost where the colour of the liquid compost differs depending on the content of organic material in it. The organic material inserted is only in the form of remaining fruit skin, where the initial composter is a light-coloured liquid. After some time, the resulting composter will change colour to a rather dark-coloured liquid.

Data Collection

The method used in this study is a survey and observation method in the field where the data taken is in the form of primary and secondary data. The data collection techniques used in this study are as follows:

1. Literature study
   One way to obtain data is by reading literature related to the problem being studied.
2. Documentation methods
   That is a data collection technique by taking data related to the problem being studied from the publications of government institutions or agencies or other organizations, such as the Environmental Control Service.
3. Observation methods

That is the collection of data through direct observation of the object studied, namely about the average amount of organic waste in the Health Polytechnic Environment of the Ministry of Health Kendari produced daily.

4. Sampling method
   For sampling, it is used with a tool in the form of a biogas reactor as a storage container composter, where the composter used is an aerobic composter designed by the Environmental Community "City Without Waste", which is made using materials: 60-litre plastic buckets 2 pieces, filters, connector rings, caps, rubber, hubcaps, PVC pipes, nuts and bolts, faucets.

Tools And Materials

The tools used in this study include biogas reactors, digital thermometers, pH meters, Types / Organic Materials (Carbon and Nitrogen), carbon-rich materials used: Dry husks, Corn husks, Wood shavings, Eggshells. Materials rich in Nitrogen used: Food waste, Vegetable waste, Fruit peel, Vegetable pieces. The "composter" used is an aerobic "composter" designed by the "Zero Waste City" Environmental Community, which is made using materials: 60-liter plastic buckets of 2 pieces, sieves, connector rings, caps, rubber, hubcaps, pvc pipes, nuts and bolts, faucets. A picture of a household-scale biogas composter can be seen in figure 1.

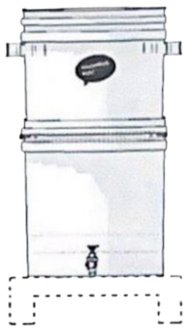

Figure 1. Design of household-scale biogas composter tools

Composting Method :
Composting is carried out with a controlled aerobic system, with the following stages:

Figure 2. Composting Method

Stage 1. Sprinkle carbon material on the base for the composting process base
Stage 2. Put organic waste that has been separated from other waste, and has been cut into small pieces so that it is 0.5-1 cm in size
Stage 3. Mix carbon materials to balance the C/N ratio

Stage 4. Spray the bioactivator liquid evenly on the top of the composter which contains 3 kg of compost which functions as a starter as well as a conditioner.

Stage 5. The waste is stirred evenly by stabbing the composter with a pipe so that the organic residue is not too dense.

Stage 6. Sprinkle carbon material as the top layer to anticipate and limit the movement of small animals that will arise. On the next day the same thing is done with stage 1 and stage 2 until the composter is full. After it is full, the stirring process is still attempted to be carried out once a week.

Data Analysis

Statistical data analysis in this study uses the Spearman rank correlation method. According to Sugiyono (2019) Spearman's rank correlation is an analytical method used to determine whether there is a relationship between two ordinal scale variables, namely the independent variable and the dependent variable. The parameters for analyzing the quality of compost are: the presence of contaminant microbes (E. Coli and Salmonella sp, the degree of maturity (C/N ratio, N-NH_4/N- total and N-NO3/N-NH 4) and conformity with the characteristics of liquid compost is good:1) Brownish in color 2) No pungent odor 3) Ambient temperature 35-65^{0}C 4) neutral pH 6.5-7.5, as well as observations of composter colors where the color of liquid compost differs depending on the content of organic matter in it. For those that include only the rest of the skin of the fruit, liquid compost is rather light in color. If to put food waste in its composter, then the liquid will be a little dark in color.

RESULTS

This study aims to make and know the effective process in making liquid organic fertilizer by utilizing organic waste in of the Health Polytechnic of Kendari environment as raw materials and by adding EM_4 bioactivators. As for whether the process is effective or not, it is to look at the influencing factors and characteristics of a good liquid composter using a household-scale biogas reactor, namely: C / N ratio, temperature, pH, color observation, and odor observation.

Based on figure 3, it shows that the longest time needed for the production of liquid composter fertilizer is 36 days with the amount of liquid composter which is 2500 mL, while the fastest liquid composter production time is 7 days with the amount of liquid composter which is 1200 mL.

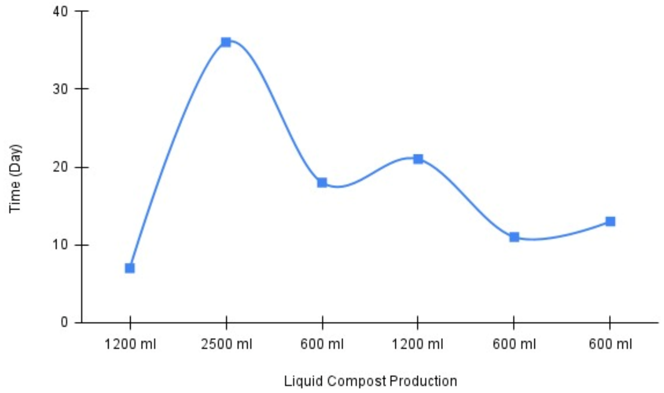

Figure 3. Graph of the Relationship between the Length of Production Time of Liquid Composter Fertilizer from Household Waste with the Addition of Bioactivators

A balanced ratio of Carbon (C) and Nitrogen (N) will affect the harvest speed of liquid composters. Too much N material causes excess residual Nitrogen to escape into odorous ammonia gas. Excess material C causes the composter to dry too much and makes it take long to decompose. From figure 4. It is seen that the ideal ratio of composting C/N is 30 : 1 where 30 parts Carbon to 1 part Nitrogen in weight. Each organic material has a Carbon and Nitrogen content, but each property of this material is different because it has a different C/N ratio ratio.

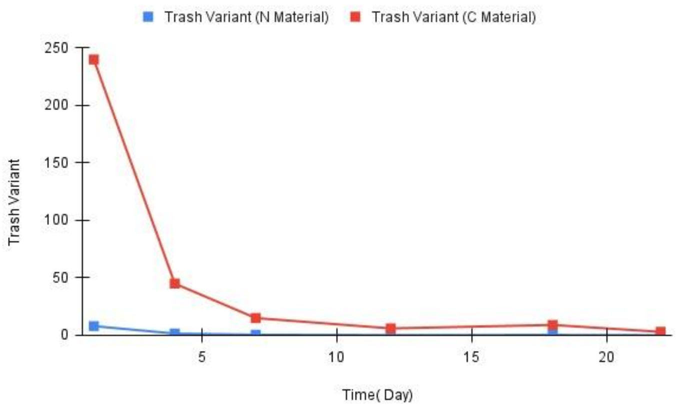

Figure 4. Graph of the Relationship of the Effect of Waste Type on the C/N Ratio of Production Liquid Composter

Figure 4 shows the relationship of the effect of waste type on C/N Ratio production Liquid Composter. The most effective ratio of C/N is 30/1. It will produce good liquid composter because not to dry and not to wet.

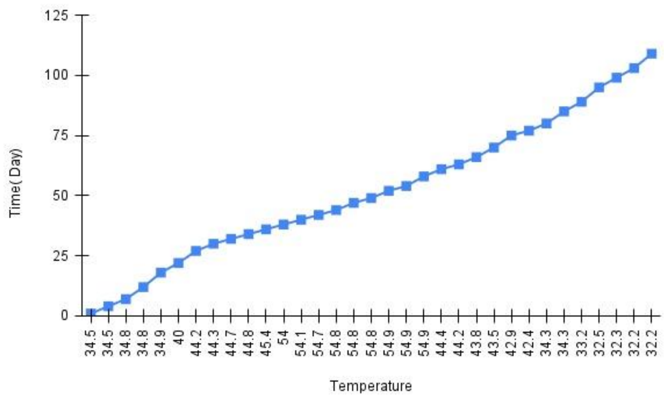

Figure 5. Average Graph of Liquid Compost Fertilizer Temperature Parameters

Based on figure 5. Shows that temperature measurement is carried out daily for a total of 3 months and 6 days (109 days) using a digital thermometer. Observation of temperature parameters shows that, temperature fluctuations occur in the span of 109 days.

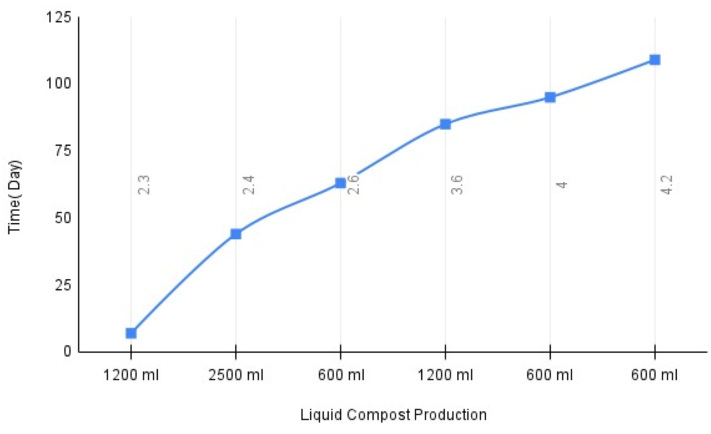

Figure 6. Graph of Average pH of Liquid Compost Fertilizer

Figure 6 shows the measurement of the pH of the liquid compost products, which was taken six times over a period of 109 days using a digital pH meter. The data collected showed an increase in the pH of the liquid compost produced from organic waste, in particular the pH of the liquid compost varied from 2.3 to 4.2.

Table 1. Data from the Observation of Color Parameters of Liquid Compost Fertilizer

No	Liquid Compost Production	Time (Day To)	Color
1	1200 ml	7	Light brown
2	2500 ml	44	Dark brown
3	600 ml	63	Dark brown
4	1200 ml	85	Dark brown
5	600 ml	95	Dark brown
6	600 ml	109	Dark brown

Tables 1 and 2 provide an account of the colour and odour of liquid compost fertilizer following 109 days of observation. Over a period of 109 days, compost odour was examined six times, while compost colour was monitored on six occasions. The colour of the liquid compost created from organic waste has undergone changes, with the compost being light brown on the seventh day, while it turns dark brown during production from the 44th until the 109th day. Observation of the scent emanating from liquid compost created from organic waste indicates that during the production of liquid composters from day 7 to day 85, there is a distinct aroma, whereas from days 95 to 109, there is a faint odour.

Table 2. Data from the Observation of Odor Parameters of Liquid Compost Fertilizer

No	Liquid Compost Production	Time (Day To)	Smell
1	1200 ml	7	Distinctive Smell
2	2500 ml	44	Distinctive Smell
3	600 ml	63	Distinctive Smell
4	1200 ml	85	Distinctive Smell
5	600 ml	95	Slightly Smelly
6	600 ml	109	Slightly Smelly

DISCUSSION

Length of Production Time for Liquid Compost Fertilizer from Household Waste with the Addition of Bioactivators.

There is a significant difference in the amount of production between producing liquid composters in a fast time and for a long time. The longer it takes to produce a liquid composter, the greater the number of liquid composters that will be produced. The composting cycle is a natural recycling process carried out by nature on its organic materials. Composting means converting organic waste into needed material into nutrients for the soil and other living things. The process of decomposition to decompose organic matter into humus material is carried out by microorganisms. Microorganisms use plant residue components as substrates to obtain energy formed through the oxidation of organic compounds with the main products CO_2 (released into nature) and carbon (for the synthesis of new cells) (Purba et al., 2022). The process of overhauling organic matter in this study took place under aerobic conditions. Where composting under aerobic conditions means composting organic matter using O_2. The final result of aerobic composting is a biological metabolic product in the form of CO_2, H_2O, heat, nutrients and humus.

Reactions that occur in the overhaul of the aerobic system:

Sugar $(CH_2O)x + O_2 \longrightarrow x\,CO_2 + H_2O + E$
(Cellulose, hemicellulose)
N-organic (Protein) $\longrightarrow NH_4^+ \longrightarrow NO_2^- \longrightarrow NO_3^- + E$
Organic Sulphur (S)+X O_2------>SO_4^{-2} + E
Organic Phosphorus (Fitin, Lecithin)------>H_3BO_3------> Ca (HPO_4)
Whole Reaction :

$$\text{Orgnaik Material} \xrightarrow{\text{activity mikroorganism}} Co_2 + H_2O + \text{nutrient} + \text{humus} + E$$

(484-674) Kcal/mol glucose)

The reaction that occurs in the overhaul of the aerobic system to process organic matter into liquid composters is influenced by several factors including: C/N ratio, temperature, pH, color observation, and odor observation.

Factors Affecting the Maturity of Liquid Composters

a. Effect of Waste Type on C/N Ratio of Liquid Composter Production

Materials that are rich in Nitrogen content are usually those produced from our organic remains at home. Its characteristics are that it has more water content, is more mushy, and rots quickly. Nitrogen material is commonly referred to as green material. The nitrogen material content in this study was obtained from vegetable waste, fruit residue, rice residue, banana peel, and fruit peel. While materials that are rich in carbon content usually have the characteristics of a harder surface, less water content, difficult to rot, if decomposed the shape will become like flakes. Carbon material is commonly referred to as brown material. Carbon material in this study was obtained from dry husk waste, eggshells, and corn husks (Aisyah, 2016).

The effective C/N ratio for the composting process is 25:1 – 40:1. Where microbes break down compound C as an energy source and use N for protein synthesis. At a C/N ratio between 25 and 40 microbes will get enough C for energy and N for protein synthesis. If the C / N ratio is too high, microbes will lack N for protein synthesis so that decomposition runs slowly, it is necessary to add N material so that the decomposition process can run quickly (Herdiyantoro, 2010).

In addition to the C/N Ratio of Oxygen (O) is also indispensable for decomposing microbes to live in it. If the oxygen content is too small, the decomposition process will also run slowly and the process is prone to turn into an anaerobic process. The cause of lack of oxygen can occur because of two things, namely the contents in the composter are too dense and the composter is submerged in water. An indication of a lack of oxygen is that the composter smells rotten and is too wet. In order for oxygen to enter, it must routinely flip through the contents of the composter or skewer it using a stick (Purnomo, 2021).

b. Effect of Temperature on Liquid Composter Production Time

Microbes cannot directly metabolize particles of insoluble organic matter. Microbes produce two extracellular enzyme systems, namely a hydrolytic system that produces hydrolase and functions to degrade cellulose and hemicellulose while the oxidative system is ligninolytic and functions to degrade lignin. Microbes produce extracellular enzymes to degrade large organic matter to smaller and soluble in water (substrate for microbes). The microbes will then transfer the substrate into the cell through the cytoplasmic membrane to complete the decomposition of the organic matter.

(Suwatanti & Widiyaningrum, 2017) in their research stated that there are several phase stages in composting, namely: The mesophilic phase which is at the beginning of the composting period with a temperature between 25 - 40 ^{o}C. this time When microbes begin to decompose organic remains. Its temperature will increase further as the activity of microbes works. In this phase what is decomposed are sugar and starch. The mesophilic phase at the beginning of this study lasted for 22 days with a temperature range of 34.5 – 34.9 ^{o}C.

The second phase is the thermophilic phase, this phase is characterized by an increase in temperature, which is up to 40-54.9^{o}C. In this phase the activity of the cellulase enzyme is able to reduce the amount of cellulose by 25% within 3 weeks. Where the activity of enzymes increases and decreases during the composting process. The presence of enzyme denaturation due to heat so that microbes that are not heat resistant will die. Due to the heat that appears, the composter also begins to emit moisture and sweat on the lid or edges. The thermophilic phase in the study lasted 36 days.

The third phase is the cooling and maturation phase, which is the phase where microbial food begins to run out and the working activity of microbes decreases. In this process it undergoes a decrease in temperature until it returns to room temperature. This process makes the remaining organic matter returned to humus. The maturation phase in this study lasted for 51 days with a temperature range of 44.4 – 32.2 ^{o}C.

c. Effect of pH on Liquid Compost Production Time

The composting process will cause a change in pH. The process of acid release leads to a decrease in pH (acidification). Where the production of ammonia from nitrogen-containing compounds will increase the pH in the early phases of composting. The pH of mature compost is usually close to neutral. The optimum pH for the composting process ranges from 6.5 – 7.5 (Sinaga, 2009). In this study, although the pH of the liquid composter fertilizer produced was still in an acidic atmosphere, it was seen that there was an increase in pH towards neutral pH, if the composting process continued, the pH of the compost would also increase closer to the neutral pH. According to Herdiyantoro (2010) naturally composting will take place within a few weeks to 2 years until the compost is fully matured.

d. Color Observation of Liquid Compost Fertilizer Production

According to Adriani et al (2021) the characteristics of good liquid compost are brownish to blackish brown. The discoloration of the compost is carried out by microorganisms with the help of sufficient oxygen, so that it can isolate the heat that causes the base material to decrease (Ani, 2016).

e. Observation of the Smell of Liquid Compost Fertilizer Production

Anif et al., (2007) in their research stated that the physical character of compost physical quality indicated by smell is significantly related to the formation of compost color, namely the faster the compost color shows brown to blackish brown, the faster the compost will not smell. This happens because when the organic matter in the waste has degraded into nutrients indicated by the change in the color of the compost, then at that time the compost does not smell.

Toxicological study of organic wastes for human health before and after composting

Fruits, vegetables, oilseeds and beverages are some of the major contributors to food wastes classified as organic wastes. Most of these wastes contain essential elements, and also consist of trace levels of toxic elements that cannot be ascertained within permissible limits for human health or the environment, such as Al, Pb, Cd and As. For example, pineapple peels tend to accumulate Al (590 ± mg kg-1), As (0.2 ± 0.1 mg kg-1) and Pb (6.4 ± 2.1 mg kg-1). The highest As concentration was found in apple pomace (0.2 ± 0.1 mg kg-1), while the highest Cd concentration was found in olive pomace (2.9 ± 1.6 mg kg-1). The highest total toxic metal content was found in pineapple peel (597 mg kg-1) followed by used tea leaves (568 mg kg-1). These toxic elements may originate from polluted soil where food crops are grown, and then the plants tend to accumulate them in certain parts such as peel, skin/pulp or pomace (Kuppusamy et al., 2017). Although food wastes contain some toxic compounds, most food wastes are known to be utilized as soil improvers to improve soil fertility and increase limited soil nutrients such as N, P, K and S. This is mainly because some food wastes such as coffee grounds, tea leaves, radish peels, watermelon peels, and pineapple peels contain many essential elements such as N, P, K, S, and Fe. In addition, food waste can contribute to improving crop productivity, and can be used as a substrate for composting, biofertilizers, and toxin bioadsorbents (Kuppusamy et al., 2017).

Another issue that can pose a health conflict is the most common contaminants found in food wastes such as pesticides, mycotoxins, microbial contamination, heavy metals, and biogenic amines. Besides pesticides, exposure to mycotoxin contaminants can be an important health concern mainly because mycotoxin contaminants can have carcinogenic, genotoxic, hepatotoxic, teratogenic, estrogenic, immunosuppressive, nephrotoxic, or neurotoxic effects. Most types of waste materials are also found to contain large amounts of microbes that can potentially produce pungent odors from the breakdown of proteins in organic waste materials and are often associated with foodborne pathogens such as *Salmonella* spp. and *E. coli*. The presence of biogenic amines in organic waste materials formed from the decarboxylation process of amino acids or from the amination and transamination reactions of aldehydes and ketones, can also be a problem in itself, especially when it can cause unwanted toxicological effects in humans, including rashes, edema, headaches, hypotension, vomiting, palpitations, diarrhea, and heart problems (Vilas-Boas et al., 2021).

In addition to the above problems, the toxicological effect of organic waste contaminations is the formation of harmful gases such as volatile organic carbons (VOCs) including terpenes, butane, halogenated compounds, aromatic compounds, isobutane, pentane, butane, dimethyl sulfide, and dimethyl disulfide (*Rudziak*, 2022). These volatile organic carbons can emit odors during low aeration conditions and high humidity levels, increasing the volatility of compounds by increasing the vapor pressure and availability of microorganisms to degrade food or organic wastes (Sánchez-Monedero et al., 2018). Higher concentrations of VOCs are more concerning for human health. Long-term VOC emissions from food or organic wastes can increase carcinogenicity, irritate olfactory cells, alter the body's physiological functions, and harm the endocrine, respiratory, and nervous systems (Zheng et al., 2020). Organic wastes can induce odors that can interfere with the function of olfactory cells and can increase the risk of olfactory cell damage, and these odors can spread atmospherically to nearby residents, and cause occupational safety problems for workers in landfills, waste contamination areas and compost sites (Kong et al., 2015; Mao et al., 2006; Mustafa et al., 2017). In this case, odors can irritate olfactory cells, decreasing the safety and quality of life of affected individuals. Other respiratory health problems often associated with gaseous emissions from food waste are lung irritation and carcinogenicity (Rudziak, 2022).

Besides VOCs, other gaseous compounds from organic wastes, such as ammonia, can be precursors to the formation of particulate matter 2.5, which is known to cause severe respiratory complications as it accumulates in the alveoli, hindering their function and shape (Rudziak, 2022; Xing et al., 2018). Particulate matter 2.5 (PM 2.5) is a complex mixture of very small particles and liquid droplets with a diameter of less than 2.5 μm. Exposure to PM 2.5 can cause several clinical effects, such as short-term effects such as decreased lung function, increased respiratory symptoms, cardiac arrhythmias, heart attacks, and premature death (Nieder & Benbi, 2022). Meanwhile, long-term effects of PM 2.5 exposure can cause decreased lung function, chronic bronchitis, lung cancer, and premature death. Hydrogen sulfide, aromatic compounds, and halogenated compounds are also among the gaseous emissions in food or organic waste that can have a negative impact on human health, complicating various organ systems and increasing the risk of death and cancer (Rudziak, 2022).

Research contribution to environmental and public health problems

This research will have a big impact on environmental problems and public health if it is applied properly and continuously. Waste that previously accumulated in the landfills or temporary dump can be reduced and used for liquid fertilizer or compost. Especially organic waste that contains nitrogen will grow maggots, smell bad and attract lots of flies. This triggers the emergence of digestive disorders such as diarrhea, dysentery, respiratory system diseases and other diseases. If people are aware and enthusiastic about managing this waste, not only will they gain healthy profits but they can also indirectly increase food security by using liquid fertilizer and compost for household gardens which can meet the household's daily food needs. Households do not need to buy fertilizer and compost to fertilize family plants. If in large quantities, fertilizer can be sold and generate household income.

CONCLUSIONS

Producing liquid fertilizer from organic matter is a viable approach for minimizing household waste. The study's findings indicate that the optimal composting conditions for generating liquid fertilizer are a Carbon:Nitrogen ratio (30:1) over a span of 7-36 days or up to 109 days. The maturation phase of this liquid fertilizer is characterized by attributes such as a pH range of 2.3-4.2, a faint aroma, and a dark brown tint. This home-based liquid fertilizer composting process utilises carbon and nitrogen sources found in household organic waste, along with bioactivators. It is expected that this process can not only reduce waste quantity, but also mitigate the toxicological impact of organic waste in inadequately managed environments, which could lead to the emergence of various health disorders. Therefore, it is advisable to conduct further research, particularly to optimize a liquid fertilizer formula that is more efficient, to develop bioactivators and analyse the performance of the bioreactor to achieve optimal liquid fertilizer production.

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