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Composting of Protein Waste using Effective Microorganisms by Anaerobic Process

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Abstract

Compost is a mixture of ingredients used as plant fertilizer and to improve soil's physical, chemical, and biological properties. It is commonly prepared by decomposing plants, food waste, and recycling organic materials and manure. Compost enhances the nutrient content, moisture retention, and soil structure. This study is about to research the composting of two types of protein waste (fish and chicken) using effective microorganisms by the anaerobic process which later used as organic fertilizer. The comparison of two type of fertilizers; fish and chicken fertilizer were surveyed by the growth of Okra plant for 28 days. The okra plant was chosen to be used as an experimental material because the okra plant is one of the fast-growing plants[1]. Based on the property test, fish fertilizer has higher pH, temperature and ammonia nitrogen content; 6.8 pH, 55ºC and 155mg/L. This helped in boosting the Okra plant growth as the height increase by 4.6% each week compared to chicken fertilizer with increasing of 2.5%. It is particularly important for the development of healthy stems, leaves, and foliage. This study can make it easier to comprehend how compost can improve plant health overall, inhibit disease, and increase crop output.

1. Introduction

Solid waste includes waste from human and animal activities, including municipal garbage, industrial waste, and hazardous waste. Food waste, especially putrescible scraps, can pollute the environment and harm people's health and ecosystems if not managed properly. Food waste includes leftovers from handling, preparing, cooking, and eating food. It contains meat, bones, fats, oils, fruits, vegetables, carbohydrates, and moisture [2]. Disposing of food in landfills releases methane and {CO}_2, contaminating groundwater and causing leachate. It is a significant portion of Municipal Solid Waste, causing decay, odor, and leachate. Composting is a method for minimizing and preventing waste issues by biologically decomposing biodegradable solid waste under controlled, primarily aerobic conditions [3]. This process involves bacteria, fungi, and other organisms in a warm, wet environment, resulting in stable, safe materials for agriculture. Waste can be biological, liquid, or solid, and each form is managed and disposed of in a different way. All waste categories, including industrial, home, municipal, organic, biomedical,

and radioactive wastes, are dealt with by waste management. The classification of waste is according to three main categories; solid, liquid and gaseous [4].

Plant nutrients are provided by various substances, including natural and synthetic fertilizers, which differentiate them from non-nutrient additives. Modern agricultural practices primarily focus on nitrogen, phosphorus, and potassium for fertilization, with occasional micronutrient supplements. Farmers use various techniques for applying fertilizers, including hand tools, machines, liquid, dry, and pelletized processes[1]. A study done by [1] shows that protein waste is more suitable than NPK fertilizers. Because if the nitrogen value is excessive, it will cause the plant to lack fruit and flowers, while if the nitrogen value is low, it will cause the tree to be unhealthy and stunted. Fertilizers with high nitrogen content is good for plants, especially during periods of rapid growth or when plants exhibit symptoms of nitrogen deficiency. Nitrogen promotes leafy green growth, enhances photosynthesis, and increases the overall vigor of plants. It is important for the development of healthy stems, leaves, and foliage. However, if the value of nitrogen is excessive or unbalanced from the standard range value, it can give negative consequences [1]. When plants receive too much nitrogen, it can lead to excessive vegetative growth at the expense of other essential nutrients, such as phosphorus and potassium. This can result in imbalanced plant nutrition and may make plants more susceptible to diseases and pests.

Food processing industries produce waste products, including solid waste, which are raw materials with lower economic values than repurposing. These wastes can be considered valuable by-products if technical means are available and the value of the resulting goods exceeds reprocessing costs. The composition of waste in food processing facilities is significantly influenced by product type and production method. Canning sector waste has high sugar and starch content, while meat processing waste has high fat and protein content. Variations in waste amount and volume depend on the time of year, making it challenging to maintain a constant working process [5]. Fresh or dried plant material, animal manures and litter, agricultural byproducts, and other plant-derived substances make up organic fertilizers. The amount of nutrients in organic fertilizers varies widely depending on the materials used as their sources, and materials that can break down quickly are the best options. In comparison to chemical fertilizers, organic fertilizers often contain less nitrogen and phosphorus. Another element that lowers or dilutes the amounts of nitrogen and phosphorus in organic fertilizers is moisture content.

Compost is the degraded remains of organic materials decomposed into natural fertilizer. Compost enhances soil properties by increasing aggregate stability, water retention, and soil structure, enhancing soil properties in sandy and clayey soils. Mature compost, with its low physical similarities, is valuable as a soil supplement for improving chemical, physical, and biological properties. It is not a fertilizer, but can reduce fertilizer usage when used at standard rates. Composting converts organic waste into stable, biologically stable compounds, making it easier to handle and maintain soil quality [6]. Fertilizers are necessary for plants' accelerated growth. Chemical and organic fertilizers are two different types of fertilizers. Organic fertilizers are more effective than chemical fertilizers, according to documented studies. Organic materials including plants, meat, and paper are used to make organic fertilizers. NPK fertilizers, for example, contain compounds that will have an impact on plant development. Because the amount of nutrients in organic fertilizer is better balanced, it helps to maintain the health of plants. It also modifies the characteristics of the soil, which improve the mobilization of nutrients from chemical and organic sources and the breakdown of hazardous chemicals. In addition, organic fertilizer provides food to promote the growth of helpful microorganisms and earthworms, as well as to help fight off parasites, some plant diseases, and diseases transmitted through the soil. The greater quantity of organic fertilizer is required because it has a poor nutrient content, to offer necessary nutrients for growth. Additionally, the rate of nutrient release is too slow to satisfy crop needs.

Meanwhile, because the nutrients are instantly soluble to the plant, the effect of chemical fertilizer on the growth of the plant is often quick. The cost is more affordable and marginally less expensive than organic fertilizer. Chemical fertilizer also contains a lot of nutrients. Nutrients can easily be lost from soils by fixation, leaching, or gas emission, which can result in decreased fertilizer efficiency. Environmental issues can be resolved with organic fertilizers. For instance, disposing of food and vegetable waste will cause the environment to emit undesirable odors. Air pollution and other issues are also possible. The aim of this study is to make composted food waste into organic fertilizers. To create organic fertilizers, leftover meals like meat and vegetable waste were composted. The nutrients essential for accelerated plant growth are present in this outstanding and highly regarded organic fertilizer [7]

2. Materials and Methods

The raw materials, location, bin, and sample processing are all listed in the experiment setup. The protein waste will be gathered from Pasar Tani Pagoh Jaya from the hawkers such as meat, fish, chicken, and fish stomachs. However, the waste needs to be layered right after it is gathered. This study uses an anaerobic composting process.

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2.1 Materials

The step by step of this study were presented as in Fig. 1. The fish and chicken protein waste were gathered from Pasar Tani Pagoh Jaya. The other materials needed were brown sugar, Yakult and water. Brown sugar act as food for the microorganisms, Yakult act as an additional component in the compost as it promotes optimal plant growth and water for the mixing agent. All these ingredients were then mixed with the ratio of 5:1:10 and be prepared for the anaerobic process as shown in Fig. 2.

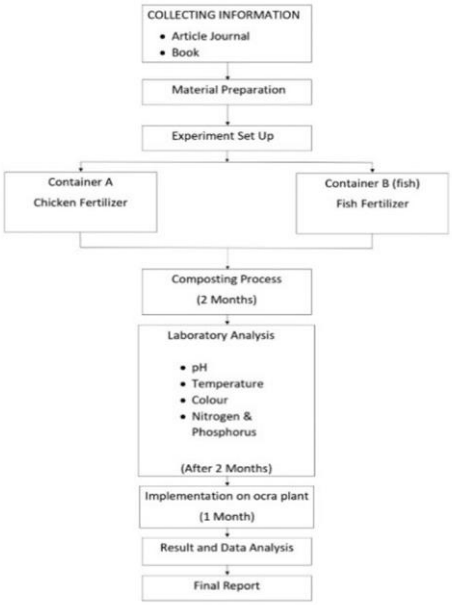

Fig. 1*: Flow chart of study*

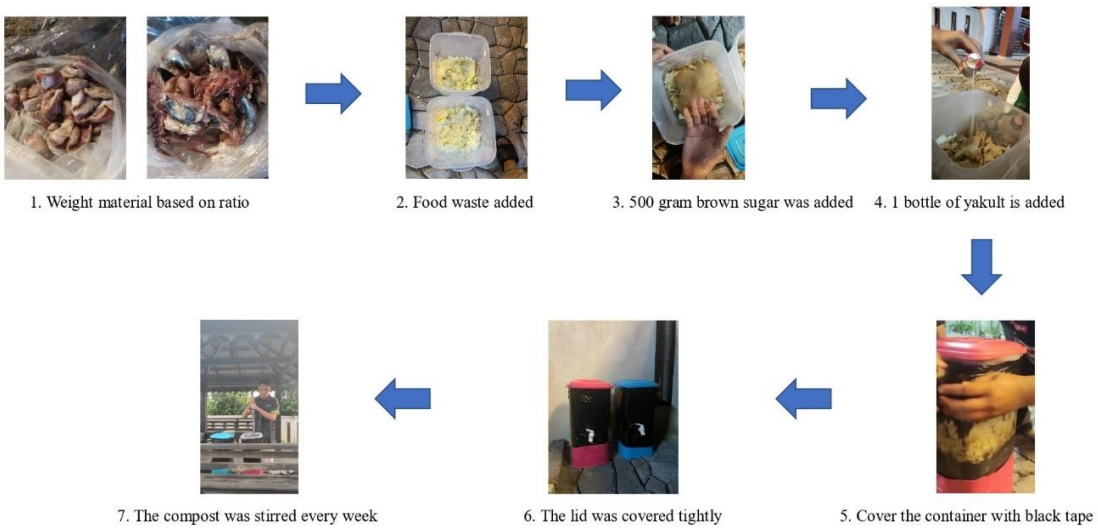

Fig.2 *Anaerobic composting procedure*

3. Results

This section describes about result of this experiment. The results will be provided in both a table and a graphical format. The outcome is used to assess the efficacy of fish fertilizer and chicken fertilizer based on the okra plants. As a result, based on the experiment's data, it determined the best fertilizer based on the height of the okra plant. The goal of this study is to investigate the composting process for the on-site treatment of source-separated protein waste using the effect of microorganisms and for its reuse by the compost producer.

3.1 Protein Waste Fertilizer Properties

After one month of anaerobic process, the fish fertilizer and chicken fertilizer were tested based on color, pH, temperature, and nitrogen to obtain its properties and micro visual of the materials.

Table 1 *Properties of Fish and Chicken Fertilizer*

Parameter	Fish Fertilizer	Chicken Fertilizer
Color	Dark brown	Dark brown
pH	6.8	6.5
Temperature, ºC	55	47
Ammonia Nitrogen, mg/L	120	90

Table 1 shows the properties for both fish and chicken fertilizer. The pH value of fish fertilizer (6.8 pH) is closer to 7.0 pH compared to chicken fertilizer (6.5 pH) which can be concluded that chicken fertilizer is more acidic than fish fertilizer. According to [8], Okra plant preferred neutral pH soil and soil pH is outside this range, it may affect the plant's ability to absorb nutrients efficiently and can impact its overall growth and productivity. The temperature for fish fertilizer is 55°C and chicken fertilizer is 47°C. Okra plants thrive in warm climates and are sensitive to frost and cold temperatures. Temperatures below 10°C can negatively impact the growth and development of okra plants [1]. In terms of ammonia nitrogen content there is significant difference between fish and chicken fertilizer. Fish fertilizer has 120mg/L whereas chicken fertilier only produced 90mg/L of ammonia nitrogen. As mentioned earlier, the ammonia nitrogen content is important for fertilizer. The optimum content will help in plant's growth. From this properties, it is expected for fish fertilizer to boost Okra plant growth more than chicken fertilizer as the pH, temperature and ammonia nitrogen content are all in fish fertilizer favor.

3.2 Effect of protein waste fertilizers on Okra plant growth

In order to compare the effectiveness of chicken and fish as fertilizer, the growth of okra plants has been conducted by using 10 okra plants, five for each fertilizer.

Table 2 *Growth of okra plant using fish fertilizer*

Height of okra (cm)	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	Average
Day 0	39.2	40.1	37.9	41.7	44.1	40.6
Day 7	41.0	42.0	40.0	44.0	46.0	42.6
Day 14	43.4	43.5	42.3	46.2	47.8	44.64
Day 21	45.9	45.2	44.1	47.9	49.7	46.56
Day 28	48.2	47.4	46.4	49.5	51.8	48.66

Table 3 *Growth of okra plant using chicken fertilizer*

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Height of okra (cm)	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	Average
Day 0	39.1	39.9	42.6	40.7	42.1	40.88
Day 7	40.0	41.0	44.0	42.0	43.0	42
Day 14	40.8	41.9	44.9	43.1	44.2	42.98
Day 21	42.0	43.1	46.0	44.3	45.3	44.14
Day 28	42.7	44.5	47.1	45.0	46.4	45.14

Table 2 and Table 3 shows the height of Okra plant for fish fertilizer and chicken fertilizer respectively. Table 2 shows the height of okra plant using fish fertilizer increased by 9.0 cm while Table 3 shows that the height of Okra plant using chicken fertilizer increased by 4.6 cm within 28 days. The average growth plant for fish fertilizer in Table 2 is 4.63% whereas for chicken fertilizer in Table 3 is 2.51%. The highest average of Okra plant for Table 2 is 48.66cm compared to Table 3 the highest average for Okra plant is 45.14cm Fig. 3 shows the five plant comparison of Okra plant growth by using fish fertilizer and chicken fertilizer. The average height of Okra plant before experiment is 40.75cm. The significant difference of ammonia nitrogen content does make a different in the growth. The conclusion is growth of okra with fish fertilizer is better than okra with chicken fertilizer.

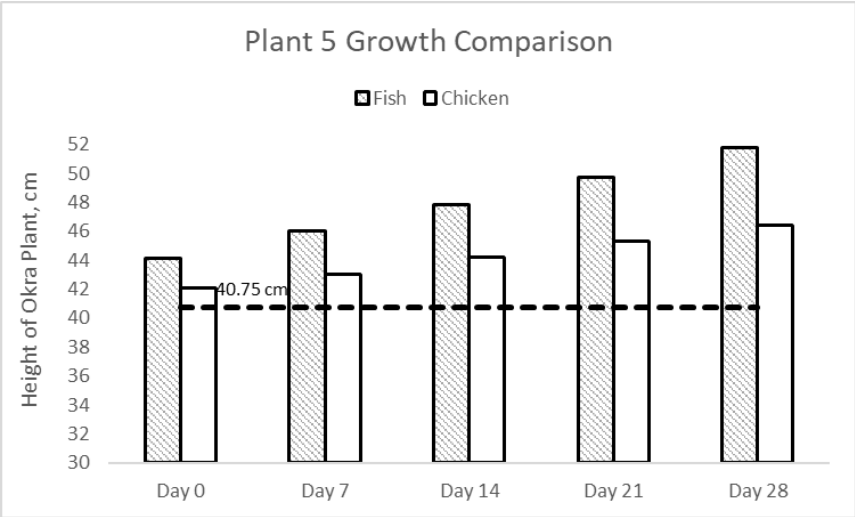

Fig. 3 *Plant 5 growth comparison*

4. Conclusion

Two types of protein waste were studied as organic fertilizers; fish and chicken. By using the anaerobic process, these protein wastes were decomposed for a month before it can be used as organic fertilizer for Okra plant. Based on the observation, fish fertilizers shows a significant improvement in Okra's height by 4.65% each week compared to chicken fertilizer with merely 2.6%. The properties of fish fertilizer contributes to the profound Okra plant growth as it contains 120mg/L of ammonia nitrogen compared to chicken with 90mg/L. The conclusions offered in this part provide important insights into the results of the composting project and offer suggestions for future composting and sustainable waste management initiatives.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design, data collection, draft manuscript:*** *Abdul Muiz Fahmy Abdul Rahman, Ahmad Adib Firdaus Ahmad Nazri, Afiq Afzal Ab Sofi;* ***draft manuscript preparation:*** *Abdul Muiz Fahmy Abdul Rahman, Ahmad Adib Firdaus Ahmad Nazri, Afiq Afzal Ab Sofi, Nor Farah Atiqah Ahmad. All authors reviewed the results and approved the final version of the manuscript.*

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