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# Physical and Chemical Characteristics of Liquid Organic Fertilizer from Shrimp Shell Waste and Old Coconut Water

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**ABSTRACT:** The rapid growth of people and industry generates organic waste of 50-60% of production materials. These wastes can be used for agriculture, as human awareness of healthy consumption causes agriculture to start using organic materials. Organic waste from industry in the form of shrimp shells and old coconut water can be used as organic fertilizer for plant growth and development. This study aims to examine the dynamics of reactions that occur during the process of making organic fertilizer and test the physical and chemical quality of the resulting organic fertilizer. This research has a combination design of 2 factors. The first factor is the fermentation method (F) which consists of 2 levels, namely: $F_1$ = container with air hose (aerobic), $F_2$ = tightly closed container (anaerobic). The second factor is the organic fertilizer raw material (L) which consists of 3 levels, namely: $L_1$ = shrimp shell waste, $L_2$ = old coconut water, $L_3$ = shrimp shell waste + old coconut water. The results showed on the physical characteristics, aerobic fermentation treatment is faster to produce organic fertilizer than anaerobic, and the speed of producing organic fertilizer is also influenced by the characteristics of raw materials. Wheareas based on the chemical properties, all treatments have not met the Indonesian national standards, but there are several chemical components that meet such as pH, C-organic and N-total. The treatments that are close to the standard are $F_1L_1$ and $F_1L_3$ treatment for N-total, $F_1L_2$ and $F_2L_2$ for C-organic.

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**KEYWORDS:** Aerobic, Anaerobic, Old Coconut Water, Organic Fertilizer, Shrimp Shell

## INTRODUCTION

The rapidly growing population along with the development of urbanization and industrialization produces complex industrial waste (Singh et al., 2014). The resulting organic waste is a potential resource as a source of macro and micro nutrients, and as a soil conditioner (Krismawati & Hardini, 2014). Agriculture is currently leading to sustainable agriculture that prioritizes inputs from organic materials as well as a form of solution to increase company revenue in the production cycle by utilizing organic production waste (Fernández-Delgado et al., 2022). There are several types of organic materials in the environment such as cow urine, cow dung, coconut water, garbage waste, leaves, rotten fruits that contain compounds and various decomposing bacteria that can increase soil fertility.

Fresh organic matter generally has a high C/N ratio so it takes a long process to reduce the ratio to meet the standard, which is a C/N ratio of 10-20%. An indication of the perfection of the process of making organic fertilizer can be seen from the maturity of organic fertilizer which includes physical characteristics (smell, color, texture that resembles soil, weight shrinkage reaches 60%, stable temperature), chemical (neutral pH, nutrient content, humification rate), and biological (low level of phytotoxicity) (Kusmiyarti, 2015; Rahmah et al., 2014).

Indonesia is one of the countries that export shrimp. Based on data from the Ministry of Maritime Affairs and Fisheries, production throughout 2022 increased by 15% compared to 2021, an increase of 953,177 tons (Grahadyarini, 2023). Shrimp produced in the production process generates waste amounting to 50-60% of the weight of the produced product (Nirmal et al., 2020). In addition, coconut waste in the form of old coconut water can be an organic fertilizer. The potential of this waste can be used as an alternative organic fertilizer material.

This study aims to examine the dynamics of reactions that occur during the process of making organic fertilizer and test the physical and chemical quality of the resulting organic fertilizer. The results of this study are expected to provide information for farmers and business people to be able to utilize waste for economic gain while preserving the environment.

## MATERIALS AND METHODS

This research was conducted in the Demonstration Garden of the Plantation Department of Samarinda State Agricultural Polytechnic from July to September 2022. The tools used in this research include: plastic jars with a capacity of 4 L, analytical balance, stirrer, thermometer, chopper, water hose, blender, stationery, cloth sieve, stale rice. The materials used were shrimp shell waste, old coconut waste, brown sugar, distilled water.

### Research Methods

This research has a combination design of 2 factors. The first factor is the fermentation method (F) which consists of 2 levels, namely:

$F_1$ = container with air hose (aerobic)

$F_2$ = tightly closed container (anaerobic)

The second factor is the organic fertilizer raw material (L) which consists of 3 levels, namely:

$L_1$ = shrimp shell waste

$L_2$ = old coconut water

$L_3$ = shrimp shell waste + old coconut water

### Research Procedure

Shrimp shells are chopped until smooth using a chopper, then brown sugar plus stale rice are blended or pounded until smooth. All ingredients that have been refined and other ingredients are put into plastic jars that have been modified based on the treatment of fermentation methods, then mix all the ingredients and stir until evenly distributed. During the fermentation process, physical observations are made every day such as room temperature, fertilizer temperature, color, and odor until the signs of the fertilizer have been finished which is marked by a stable temperature, no smell and color adjusted to the basic ingredients such as yellow or brown, then analyze the nutrient content according to the treatment.

### Research Parameters

The parameters used are physical parameters in the form of room temperature, fertilizer temperature, colour, and smell (Rofi'i et al., 2021; Tsaniya et al., 2021), while chemical parameters are C-Organic, N-Total, Phospate, Potassium, Copper, Zink, Manganese and compared with the Minister of Agriculture Decree No. 261/KPTS/SR.310/M/4/2019 for the quality of the fertilizer produced.

### Data Analysis

The data obtained from observations and laboratory tests are presented objectively and descriptively.

## RESULTS AND DISCUSSIONS

### Characteristics Physical of Organic Fertilizer

Based on the results of the study, it can be seen that the temperature that occurs during the process of making organic fertilizer fluctuates. All the treatments that have stable temperatures are on day 10 to day 25 and among all the treatments, the treatments that quickly become organic fertilizer are $F_1L_2$ and $F_2L_2$ treatments which are already stable on day 15, followed by $F^1L_1$ treatment (Figure 1). Temperature observations are included in the physical observations to directly determine the process of transformation of materials into organic fertilizer. The increase in temperature that occurs on the 10th day indicates that the thermophilic phase is underway and then gradually decreases and stabilizes, so that in this phase it is in optimal conditions for the maturation process of the material into organic fertilizer, the process is influenced by different types of microorganisms, namely thermophilic microorganisms and mesophilic microorganisms. This is in line with the opinion of (Pratiwi et al., 2013; Wibisono et al., 2016). The increase and decrease in temperature in the fertilizer maturation process is due to the presence of working microorganisms such as mesophilic and thermophilic microorganisms that take turns playing a role until the temperature gradually decreases due to the reduction of organic matter that can be decomposed by microorganisms, indicating that it is starting to mature.

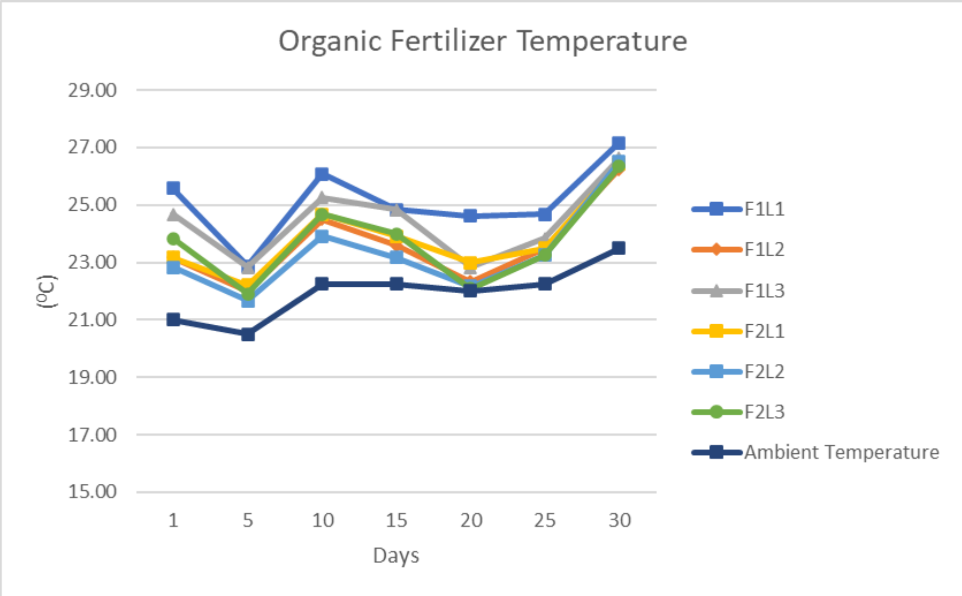


**Figure 1. Organic Fertilizer Temperature during manufacturing Process**

The difference of the average temperature of the organic fertilizer material in the first was due to particle characteristics of materials, in which particles of shrimp shell was greater than the old coconut water, so that the air circulation, and it generated more higher heat. Research findings by (Rahman et al., 2022; Rusmini et al., 2017) explained that shrimp shells contain microorganisms that can break down the material, which requires more energy due to the high chitin content of shrimp shells.

We observed the physical parameter of fertilizer consisted of colour, and smell during 30 days of the organic fertilizer manufacturing process. The physical observation can be seen in Table 1.

**Table 1. Physical parameter observation of Organic Fertilizer**

| Parameters | Treatment | Days | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 5 | 10 | 15 | 20 | 25 | 30 |
| Colour | $F_1L_1$ | red-brown | red-brown | light brown | brown-black | brown-black | brown-black | brown-black |
| | $F_1L_2$ | brown | brown-black | brown-black | black | black | black | black |
| | $F_1L_3$ | red-brown | red-brown | light brown | black | black | black | black |
| | $F_2L_1$ | red-brown | red-brown | red-brown | black-brown | black-brown | black-brown | black-brown |
| | $F_2L_2$ | brown | brown-black | brown-black | black | black | black | black |
| | $F_2L_3$ | red-brown | red-brown | red-brown | black | black | black | black |
| Smell | $F_1L_1$ | original smell | original smell | strong smell | strong smell | strong smell | smell weathered (fragrant) | smell weathered (fragrant) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | $F_1L_2$ | original smell | original smell | strong smell | smell weathered (fragrant) | smell weathered (fragrant) | smell weathered (fragrant) | smell weathered (fragrant) |
| | $F_1L_3$ | original smell | original smell | strong smell | strong smell | smell weathered (fragrant) | smell weathered (fragrant) | smell weathered (fragrant) |
| | $F_2L_1$ | original smell | original smell | original smell | strong smell | strong smell | strong smell | smell weathered (fragrant) |
| | $F_2L_2$ | original smell | original smell | strong smell | smell weathered (fragrant) | smell weathered (fragrant) | smell weathered (fragrant) | smell weathered (fragrant) |
| | $F_2L_3$ | original smell | original smell | original smell | strong smell | strong smell | smell weathered (fragrant) | smell weathered (fragrant) |

The physical observation of fertilizer in either all treatments after 30 days show the same color and smell, which were black and smelled good (fragrant). Fastest fertilizer making process occurs in the treatment of $F_1L_2$ and $F_2L_2$ treatments which took only 15 days. The faster process of fertilizer production is believed to be due to the presence of microorganisms that can accelerate the decomposition of materials into fertilizer. This is in accordance with the opinion of the research results (Nur et al., 2009) stated that the decomposition of cellulose, hemicellulose, fats, lignin release carbon dioxide ($CO_2$), water and heat energy, causing the weight and content of the basic raw materials of compost will be reduced to 40-60 % and depends on the basic raw materials of compost and composting process. Decomposition is greatly influenced by the composting microorganisms, which break down organic material with the help of oxygen to produce $H_2O$, $CO_2$, nutrients and energy. The overhaul of the structure of the material compaction occurs, the loss of pore water and air storage, so that raw materials are composted severe shrinkage. In addition to the raw materials, the fermentation method also affects the accelerated process of organic fertilizer production. Table 1 shows that the best fermentation method is aerobic fermentation. This is in accordance with the opinion of (Suharno et al., 2021) which states that the composting rate using an aerobic composter is faster to become organic fertilizer than using an anaerobic composter.

**Chemical Properties of Organic Fertilizer**

Based on Table 2, it can be seen that the organic matter content of shrimp shells, coconut water waste, shrimp shells + coconut water waste in the fermentation method treatment aerobic and anaerobic still have components that are below Indonesian national standards no. 261/KPTS/SR.310/M/4/2019, but the best C-organic component is the $F_2L_2$ treatment, the best N-total and $P_2O_5$ components are in the $F_1L_1$ treatment. N-Total component that meet the standard are $F_1L_1$ and $F_1L_3$. Nitrogen is a nutrient that promotes plant growth and plays a crucial role in the plant's metabolic processes, and cannot be substituted. The nutrient content varied greatly between treatments depending on the characteristics of the raw materials and the type of fermentation. The increase and decrease of nutrients occurred due to the mineralization process during the composting process. This is in accordance with the report (Kusmiyarti, 2015) that the quality of nutrients contained in compost depends on the characteristics of the raw materials.

Nutrients contained in all treatments did not meet the standards, allegedly because microorganisms working in the overhaul of materials take nutrients to survive. This is in accordance with the opinion Rusmini et al. (2023) that microorganisms that help in decomposition, in addition to working to break down organic matter into simple, also use organic matter for their metabolic activities. In addition, based on the report of Darmawan et al. (2018), the increase in fermentation time will lead to a decrease in nutrients due to the lack of microorganisms that utilize C-organic. Compared with the fermentation method of producing organic fertilizer, aerobic fermentation has the best nutrient content compared with anaerobic fermentation. This is in line with the opinion of Nursanti (2017) which states that the nutrient content of N, P, K and C-organic is higher than anaerobic.

**Table 2. Result of Analysis of nutrient content in raw material organic fertilizer**

| Parameters | Unit | Treatments | | | | | | Indonesian Standards No. 261/KPTS/SR.310/M/4/2019 |
|---|---|---|---|---|---|---|---|---|
| | | $F_1L_1$ | $F_1L_2$ | $F_1L_3$ | $F_2L_1$ | $F_2L_2$ | $F_2L_3$ | |
| pH | | 7,35 | 4,21 | 7,85 | 6,27 | 3,73 | 4,69 | 4-9 |
| C-Organic | % | 2,70 | 13,89 | 2,02 | 1,45 | 14,13 | 1,28 | Min 10 |
| N-Total | % | 1,73 | 0,21 | 0,76 | 0,16 | 0,23 | 0,11 | Min 0,5 |
| $P_2O_5$ | % | 0,44 | 0,09 | 0,07 | 0,07 | 0,09 | 0,30 | 2-6 |
| $K_2O$ | % | 0,20 | 0,55 | 0,24 | 0,08 | 0,55 | 0,10 | 2-6 |
| Cu Total | ppm | 0,65 | 0,21 | <LOD | <LOD | 0,05 | <LOD | 25-500 |
| Zn Total | ppm | 6,33 | 2,62 | 3,54 | 3,38 | 3,50 | 6,39 | 25-500 |
| Mn Total | ppm | <LOD | <LOD | <LOD | <LOD | <LOD | <LOD | 25-500 |

Based on Table 2, pH organic fertilizer all treatment can be seen ranged from 3,73 to 7,85. pH elevated if fermentation time was extended because the composting accours in neutral pH range. The pH of compost rises due to microbial activity and the presence of ammonia. Organic matter and pH are both affected by the composting process. Sadeli et al. (2022); Sarah et al. (2023) Reported the composting process itself will cause changes in the organic matter and the pH of the material itself. The process of releasing acid, temporarily or locally, will cause a decrease in pH (acidification), while the production of ammonia from nitrogenous compounds will increase pH in the early stages of composting. Composting over a period of days will cause changes in the pH of the compost material. The initial pH of the compost starts from neutral, then the pH increases with further incubation due to the breakdown of protein and the release of ammonia.

## CONCOLUSION

Based on the physical characteristics, aerobic fermentation treatment is faster to produce organic fertilizer than anaerobic, and the speed of producing organic fertilizer is also influenced by the characteristics of raw materials. Wheareas Based on the chemical properties, all treatments have not met the Indonesian national standards, but there are several chemical components that meet such as pH, C-organic and N-total. The treatments that are close to the standard are $F_1L_1$ and $F_1L_3$ treatment for N-total, $F_1L_2$ and $F_2L_2$ for C-organic.

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