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# Characteristic of Orange Peel Waste-Based on Eco Enzyme at Different Fermentation Duration

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**Abstract:** One effort to overcome the waste problem is by recycling waste into something useful, such as by making eco enzymes that can be used in various fields through fermentation process. The duration of eco enzyme fermentation is determined by the purpose of its production, but most studies require a fermentation duration of 3 months to produce ideal eco enzyme. The raw material used in making eco enzyme in this study is the peel of the Kintamani orange (*Citrus nobilis*) that widely cultivated in Bali. This study was aimed to examine the differences in the characteristics of eco enzyme based on orange peel waste with different fermentation durations. The research method used is experimental. Fermentation was carried out on orange peel waste, brown sugar, and water with a ratio of 3:1:10. Fermentation was carried out at a duration of 10 days, 30 days, 60 days, 90 days. Each eco enzyme with a different fermentation duration was chemically analyzed for PH, TSS, TDS, BOD, COD. The results showed that as the fermentation duration lengthened, there was a decrease in the TSS, TDS, BOD, and COD parameters in orange peel-based eco enzyme, but there was no change in PH. Teen days of fermentation was able to produce eco enzymes with an ideal PH, fresh sour aroma, and high organic content, however, the fermentation did not produce a dark brown color. This research helps in providing reference for the best fermentation duration that need to make eco enzyme.

**Keywords:** Chemical Parameter; Eco Enzyme; Fermentation Duration; Orange Peel Waste

## Introduction

In the era of globalization, the world's population continues to increase, including the population in Indonesia, which in 2020 has reached 273.52 million people. This large population produces a large amount of waste. It is estimated that Indonesia produces 64 million tons of waste each year which is dominated by household waste (Larasati et al., 2020; Utpalasari et al., 2020). Most of the household waste is known to be dominated by organic waste. Of all vegetable and fruit production in the world, it is known that 30-40% is disposed of as household waste (Hemalatha & Visantini, 2020).

Real efforts must be made in order to protect the environment from waste, namely by recycling waste and adding value to it (Bhola et al., 2022). One of these efforts can be by carrying out organic fermentation for eco-enzymes. In this method, organic waste is converted into useful enzymes through a fermentation process. The enzymes produced are referred to as waste enzymes or eco-enzymes, which have characteristics as multifunctional disinfectants (Efremenko et al., 2008; Galintin et al., 2021).

The duration of eco enzyme fermentation is determined by the purpose of its production. Most studies require a fermentation duration of 3 months (Patel et al., 2021; Rasit et al., 2019; Verma et al., 2019). However, according to research by Kamaruddin et al. (2019), the eco enzyme fermentation process only takes 8-10 days and can produce an ideal pH below 4.0. Until now, no research has studied the characteristics of eco enzymes from time to time of fermentation, so the best fermentation duration to produce eco enzymes cannot

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be determined. In addition, the production of eco enzyme using only one ingredient, namely orange peel, is still rarely studied. Moreover, the high organic content in orange peel can affect the characteristics of the eco enzyme produced. Kintamani District, located in Bangli, is the largest producer of Siamese oranges in Bali, with production reaching 93,162.3 tons per year (Bali, 2019), so the eco enzyme based on Siamese Kintamani orange peel waste is also an application of zero waste system in waste treatment that can also provide added value to domestic agricultural production.

This study aims to analyze the characteristics of eco enzyme based on orange peel waste at the fermentation duration of 10 days, 30 days, 60 days and 90 days. Characteristics assessed include organoleptic, PH levels, BOD (Biological Oxygen Demand), COD (Chemical Oxygen Demand), TSS (Total Suspended Solid), and TDS (Total Dissolved Solids). This research will be the basis for determining the best fermentation duration in the manufacture of one-ingredient-based eco enzyme and will form the basis for further research on the application of eco enzyme as a natural disinfectant.

## Method

This research is included in an experimental study covering the manufacture of eco enzyme from Kintamani orange peel as raw material. 10 kg of oranges were taken from the Kintamani orange production center in Bayung Gede Village, Kintamani District, Bangli Regency. Orange fruits were selected by purposive sampling method. Orange fruits were checked to ensure they were fresh and not affected by fungus or disease. From 10 kg of oranges, 1500 grams of Kintamani orange peels were ready to be made into eco enzyme. Before use, the orange peel was cleaned first with water to remove dirt or adhering sand. Eco enzyme was then made by mixing orange peel, sugar and water in a ratio of 3:1:10. Fermentation was carried out at a duration of 10 days, 30 days, 60 days and 90 days. Tests, namely PH, TDS, TSS, BOD, and COD levels, were carried out for each fermentation duration. For each parameter, measurements were repeated 3 times. The test results will be presented in narrative form and in tabular form.

## Result and Discussion

In each group of fermentation duration, eco enzyme was made by mixing 150 grams of Siamese Kintamani orange peel, 50 grams of sugar, and 500 ml of water. The mixture was then fermented in a closed container and not exposed to direct sunlight. The eco enzymes prepared were divided into 4 groups based on the duration of the fermentation, namely 10 days, 30 days, 60 days and 90 days. Testing of chemical parameters, namely PH, BOD, COD, TDS and TSS, was conducted at the Bina Medika Laboratory, Denpasar with 3 times replication. The test results can be seen in Table 1.

Eco enzyme is a complex organic solution derived from the fermentation of organic waste, sugar and water. The principle of making eco-enzyme is basically similar to making compost, but in eco-enzyme, water is added so that water is formed in the form of a solution that is easier to use 10. Eco enzyme can be made by mixing organic waste such as fruit and vegetable scraps with sugar and water in a simple ratio of 3:1:10. In this study, each group of eco enzyme were prepared using 150 grams of orange peel waste, 50 grams of sugar, and 500 ml of water. The use of materials needs to be considered beforehand because it will affect the end result of the eco enzyme product itself. The recommended sugar for making eco enzyme solutions is brown sugar, while for organic waste, it is recommended that the waste and fruit vegetables are not too dry 6.

**Table 1.** Measurement Result of Chemical Analyzes of Eco Enzyme with Different Fermentation Duration

| Parameter | Maximum Concentration | Fermentation Duration | | | |
|---|---|---|---|---|---|
| | standard* | 10 days | 30 days | 60 days | 90 days |
| TSS | 100 mg/L | 416 | 376 | 291 | 196 |
| TDS | - | 720 | 470 | 321 | 287 |
| PH | 6-9 | 3.3 | 3.3 | 3.3 | 3.3 |
| BOD | 100 mg/L | 1206 | 1194 | 1173 | 1123 |
| COD | 100 mg/L | 2148 | 2133 | 2120 | 2102 |

The fermentation process is the process of decomposing organic compounds to produce energy produced by microorganisms such as fungi, yeast or bacteria. Microbes that carry out fermentation require energy which is generally obtained from glucose. In the eco enzyme production process, the addition of sugar is intended as an energy source for microbes in carrying out fermentation (Arun & Sivashanmugam, 2015; Viza, 2022). During that process, a white mushroom-like layer called Pitera will form. Pitera is formed naturally in eco enzymes due to fermentation. Pitera mushroom is often used for skin beauty products because it contains amino acids, peptides, proteins, carbohydrates, organic acids, and other micronutrients such as vitamins and minerals (Natasya et al., 2023).

During the first month of fermentation, alcohol will be released so that one will smell alcohol from the eco enzyme solution. In the second month, it will smell sour, which is the smell of acetic acid. With many compounds, such as minerals and vitamins, it will continue to experience damage that produces enzymes in the third month (Joseph et al., 2021). In the first week of making eco enzyme, a gas release process is required due to the fermentation process, in the form of air bubbles. According to Muarief et al. (2023), the eco enzyme fermentation process can produce ozone and oxygen equivalent to that produced by 10 trees (Aulia & Handayani, 2022; Yuliana & Handayani, 2022).

The minimum fermentation duration required for eco enzyme is 3 months. However, according to research by Kamarrudin et al.in 2019, the eco enzyme fermentation process only takes 8-10 days and can produce an ideal PH of below 4.0 (Kamaruddin et al., 2019). In this study, the fermentation duration of 10 days was able to produce an ideal eco enzyme PH of 3.3, and this PH value remained the same at the fermentation duration of 30, 60 and 90 days. The low PH value is caused by the high organic content possessed by eco enzymes (Sambaraju & Lakshmi, 2020). The duration of fermentation is said to affect the chemical parameters of the eco enzyme due to the degradation of organic matter by microorganisms present in the enzyme solution. The PH indicators obtained will be higher if analyzed after 3 months (Nazim & Meera, 2013), as in Patel et al. (2021), that could produce eco enzymes with a PH of 3.1 from orange peels, which were fermented for 3 months.

This lower PH value can be caused by the use of molasses sugar compared to brown sugar. Molasses sugar is referred to as an unwanted substance that comes from the sugar production process that contains microorganisms. The presence of these microorganisms causes the organic compounds in the waste to decompose more so that the parameters obtained are lower (Rasit et al., 2019). A lower PH level of 2.86 was also found in the eco enzyme from Rasit et al. (2019) research with orange fruits. This is probably because orange fruits contain higher levels of citric acid than orange peels (Jamil et al., 2015).

Eco enzyme is said to be ideal if it has a fresh sour aroma, PH is below 4, and is dark brown in color (Natasya et al., 2023). In this study, the fresh sour aroma was clearly smelled at the 10-day fermentation duration, but the color change to brown only appeared approaching the 60-day or 2-month fermentation duration. In addition to the fermentation process, the eco enzyme product's color also depends on the waste raw material used (Dewi et al., 2022; Hikmatriana et al., 2022; Viza, 2022).

As mentioned by Nazim & Meera (2013), eco enzyme parameters such as TSS, TDS, BOD, and COD will decrease with the duration of fermentation due to degradation of organic compounds by microorganisms present in the eco enzyme solution.

In this study, it was found that these parameters decreased with the lengthening of the fermentation duration, but this decrease did not appear to be significant. The use of organic waste and brown sugar in eco enzymes results in high BOD and COD values. The use of these materials also causes eco enzyme to have high levels of TSS and TDS. The unique characteristics of eco enzymes are what causes eco enzymes to be used as cleaning agents, disinfectants (Permatananda et al., 2019), antiseptics, antibacterial (Permatananda & Widhidewi, 2021), insecticides, as well as in agriculture as fertilizers (Natasya et al., 2023).

## Conclusion

Teen days of fermentation was able to produce eco enzymes with an ideal PH, fresh sour aroma, and high organic content, however, the fermentation did not produce a dark brown color. This research will help in providing reference for the best fermentation duration that need to make eco enzyme. Further research is needed to study the effectiveness of eco enzymes with different fermentation duration.

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**Author Contributions**
All authors contributed the study conception and design. Material preparation were performed by Pande Ayu Naya Kasih Permatananda. I Gede Suranaya Pandit did data collection and analysis. All authors read and approved the final manuscript.

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**Conflicts of Interest**
No Conflicts of interest.

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