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RESEARCH ARTICLE

Eco-enzyme Aplication Based on Siamese Kintamani Orange (*Citrus nobilis)* Peels waste for *Pemindangan* Waste Treatment

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ABSTRACT:

Pemindangan is one of the traditional fish preservation efforts by boiling and salting methods that are mostly carried out by the people of Indonesia, especially in Bali. *Pemindangan* process does not only produce products in the form of *pindang*, but also produces residual products or waste that pollutes the environment. Eco-enzyme is a solution of complex organic substances produced from the fermentation process of organic waste, sugar, and water. Until now, research on eco-enzyme with the basic ingredients of orange peels is still very little. Differences in raw materials will of course produce different products. In addition, research to see the application or effect of eco-enzyme on waste, especially *pemindangan* waste has never been carried out. The research used an experimental method includes the manufacture of eco-enzyme and treatment of *pemindangan* waste with an eco-enzyme. A total of 6kg of samples of Siamese Kintamani Orange (*Citrus nobilis*) peels waste used for the manufacture of eco-enzymes were selected by purposive sampling. The eco enzyme was made by mixing Siamese Kintamani orange peels, water, and sugar in a ratio of 3:10:1, afterwards, the mixture was put in a closed container. Fermentation was carried out for 3 months. The treatment was given to the pemindangan liquid waste taken from Kusamba village as the centre of *pemindangan* in Bali and separated into 3 containers based on the treatment, namely treatment A without eco-enzyme, treatment B with addition of eco-enzyme 10%, and treatment C with addition of eco enzyme 50%. Eco-enzyme based on Siamese Kintamani orange peels waste can reduce the levels of TSS, TDS, PH, and ammonia levels in *pemindangan* waste, both at 10% and 50% dilution. However, the eco-enzyme is not able to reduce the BOD and COD parameters in the *pemindangan* waste. Eco-enzyme requires a longer therapeutic time to be an alternative chemical treatment for *pemindangan* waste.

KEYWORDS: Pemindangan, Eco-enzyme, Siamese Kintamani Orange, Orange peel, Waste Treatment.

INTRODUCTION:

Along with the increase in Indonesian fishery production, more modern and traditional fish processing methods and techniques are also being used in Indonesia. *Pemindangan* is one of the traditional fish preservation efforts by boiling and salting methods that are mostly carried out by the people of Indonesia, especially in Bali. Bali has one of the largest fish processing centers in Indonesia, which is located in Dawan Village, Klungkung.

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The *pemindangan*process basically consists of several processes. After the fish are cleaned, the fish are placed in a bamboo basket, salted, and boiled in boiling water for 30 minutes[1,2]. The *pemindangan* process does not only produce products in the form of *pindang*, but also produces residual products or waste that pollutes the environment[3].

Waste is the result of human daily activities or natural processes that can be in the form of solid or semi-solid, organic or inorganic, which can be decomposed or not decomposed, and is considered useless, so it is disposed of into the environment[4]. Fishery waste, especially liquid waste discharged into rivers, can cause pollution or environmental disturbances, such as disrupting water

ecosystems, lowering oxygen demand in the aquatic environment, disturbing human health, and causing unpleasant odors[5]. Waste originating from fish processing usually contains a lot of protein and fat, resulting in high levels of nitrate and ammonia[6]. The high content of organic matter can deplete oxygen dissolved in the waste, as well as cause unpleasant odors, and are toxic to aquatic biota if directly discharged into rivers or into the sea[7]. Based on an observational study in 2018, the *pemindangan* process in Kusamba Village produces several types of waste. Solid waste is in the form of pieces of fish heads or bodies, scales, and fish bones as well as liquid waste that comes from blood, washing water, cooking water, and melting ice blocks. The waste is usually dumped into a ditch which is near the *pemindangan* block so that the flow of the ditch is often clogged and thus causes an unpleasant odor[2].

Eco-enzyme is a solution of complex organic substances produced from the fermentation process of organic waste, sugar, and water. This eco-enzyme is dark brown in color and has a strong fresh sour aroma[8]. Eco-enzyme products are environmentally friendly products that are very functional, easy to use, and easy to make. Eco-enzyme itself can be used as a floor cleaner, disinfectant, insecticide, and sewer cleaning fluid. The function of the eco-enzyme as a disinfectant is due to the alcohol and acetic acid content in the liquid which comes from the fermentation process[9,10].

Eco-enzymes that have been studied so far come from various kinds of household waste, such as pineapple and papaya peels[4], orange peels, avocado peels, watermelon peels, and papaya peels[10], orange peels only[11–15], and so on. Most of the previous studies used pineapple peels as raw materials for making eco-enzymes. Basically, all or any fruits and vegetables left over can be used as raw materials for making eco-enzymes. Pineapple is widely used for the reason that pineapple contains high amylase, caseinase, and protease enzymes. In research conducted by Sambaraju *et al.* (2020), an eco-enzyme made with orange peels for 4 weeks was found to have a pH of 3.8; Total Dissolved Solid (TDS) of 1053mg/l; Biological Oxygen Demand (BOD) of 75mg/dl; and Chemical Oxygen Demand (COD) of 148mg/dl. Eco-enzyme derived from orange peels has an acidic pH and higher organic content, so it has a higher BOD level[11].

Oranges are included in the leading fruit commodities in Bali, in addition to bananas, mangoes, and watermelons. The highest citrus production is in Bangli Regency, which is 93,162.3 tons per year. Currently, citrus plantations in Bali are not only in the form of fruit production but have also developed as agro-tourism. Kintamani citrus fruit-based agro-tourism is not only located in Kintamani, but also in Payangan[16,17]. The production of eco-enzyme based on orange peels can later become one of the implementations of developing citrus plantations based on zero waste system.

Until now, research on eco-enzyme with the basic ingredients of orange peels is still very little. Differences in raw materials will of course produce different products. In addition, research to see the application or effect of eco-enzyme on waste, especially *pemindangan* waste has never been carried out. This study was aimed to determine the application of eco-enzyme based on orange peels to changes in physical and chemical parameters in the *pemindangan* waste.

MATERIALS AND METHODS:

The research used an experimental method which includes the manufacture of eco-enzyme and treatment of *pemindangan* waste with an eco-enzyme. The research was carried out at the Biomedical Laboratory, Faculty of Medicine and Health Sciences, Warmadewa University. A total of 6kg of samples of Siamese Kintamani Orange (*Citrus nobilis*) peels waste used for the manufacture of eco-enzymes were selected by purposive sampling. Good (not infected by fungus or disease) and fresh orange peels were selected. Before used, the orange peels were cleaned first with fresh water so that they were free from dirt or sand. The eco-enzyme was then made by mixing Siamese Kintamani orange peels, water, and sugar in a ratio of 3:10:1, afterwards, the mixture was put in a closed container. Fermentation was carried out for 3 months. After 3 months, the eco-enzyme was filtered before use[18,19].

The treatment was given to the *pemindangan* liquid waste taken from the Kusamba village, the largest *pemindangan* centerin Bali in the form of the last boiled water at 5 pm and separated into 3 containers based on the treatment. Treatment A was 300cc of *pemindangan* waste without the addition of eco-enzyme. Treatment B was 10% dilution, namely 30cc of eco-enzyme and 270cc of *pemindangan* waste. Treatment C was 50% dilution, namely 150cc of eco-enzyme and 150 cc of *pemindangan* waste. The treatment process was carried out in a closed clear container at room temperature and laboratory analysis was carried out including physical and chemical parameters such as TSS, TDS, PH, BOD, COD, and Ammonia at the Bina Medika Public Health Laboratory. Measurements were repeated 3 times. The results in the form of an average will be displayed in the form of tables and graphs for comparison.

RESULT:

Samples of the *pemindangan* waste from the Kusamba' s*pemindangan* center at 5pm were the last boiled water of the day. The eco-enzyme used was made from Siamese Kintamani orange peels waste, water, and sugar as molasses with a ratio of 3:1:10 and the duration of

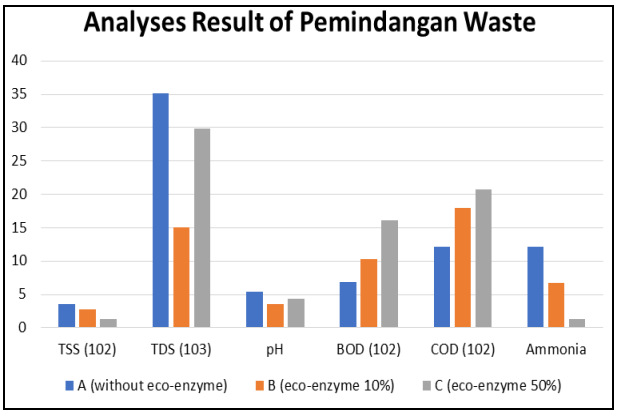
fermentation was 3 months. The eco-enzyme is used as a treatment for *pemindangan* waste. The treatments given in this study were:
A. 300 cc of *pemindangan* waste (without the addition of eco-enzyme)
B. 10% dilution = 30 cc of eco-enzyme and 270 cc of *pemindangan* waste
C. 50% dilution = 150 cc of eco-enzyme and 150 cc of *pemindangan* waste

The treatment was given in a closed clear container at room temperature and analyzed for TSS, TDS, PH, BOD, COD, and Ammonia. Measurements were carried out 3 times and the average was obtained. The analysis was carried out at the Bina Medika Public Health Laboratory, with the results as shown in Table 1 and Graph 1.

Table 1. Analyses Result of *Pemindangan* Waste

S. No	Parameter	Unit	Maximum concentration*	Measurement Result		
				A	B	C
1	TSS	Mg/L	100	354,62	277,31	128,04
2	TDS		-	35200,41	15000,07	29800,21
3	pH		6-9	5,4	3,6	4,4
4	BOD	Mg/L	100	683,20	1025,40	1610
5	COD	Mg/L	100	1220,43	1790,80	2075
6	Ammonia	Mg/L		12,12	6,76	1,29

*Based on Bali Governor Regulation No. 16/2016.



Graph 1. Analyses Result of *Pemindangan* Waste

DISCUSSION:

Fishery waste discharged into rivers or waters is usually in the form of liquid waste containing a lot of protein and fat which can result in high nitrate and ammonia values. In addition to damaging the environment, the high ammonia content in *pemindangan* waste also causes an unpleasant odor[7]. In this study, untreated *pemindangan* waste as shown in table 4 was found to have physical and chemical parameters that did not meet the quality standards of liquid waste according to Bali Governor Regulation No. 16/2016[20], with high levels of TSS, TDS, BOD, COD, and Ammonia. and a slightly acidic pH of 5.4. Through these results, the waste generated from the centre of *pemindangan* Kusamba needs to be managed so that it can produce better and environmentally friendly waste.

The purpose of liquid waste treatment is to achieve maximum efficiency with constant development with minimal resources, both time and cost. Additives can be added to the treatment system[21,22,] so pollutant parameters can be degraded at a higher rate in less time. Chemical additives are often considered harmful to the environment and tend to be avoided because of their strong acidic pH, the toxic composition of compounds, and the possibility of damaging soil structure and soil water quality, while biological additives usually do not have a harmful impact[23,24].

Eco-enzyme is included in the treatment of waste with chemical additives. Eco-enzyme is a fermented product that comes from household products such as fruit peels, water, and sugar with a fermentation duration of 3 months[19]. In this study, eco-enzymes were used using the waste of Kintamani Siamese orange (*Citrus nobilis*) peels which are widely cultivated in Bali, precisely in Kintamani District[16]. The research of Sambaraju *et al.* in 2020 stated that eco-enzymes made from orange peels have high citric acid compounds, so they are able to release higher hydrolytic enzymes. In this experiment, eco-enzyme was said to be able to increase the decrease in TSS[11]. Similar results were obtained in this study, namely as the concentration of eco-enzyme made from Kintamani orange *(Citrus nobilis*) peels increased, in addition, there was also a decrease in TSS. Meanwhile, in TDS, it was found that the decrease in TDS was greater at lower eco-enzyme concentrations. This could be due to the higher TDS content in the eco-enzyme with a higher concentration[25].

The *pemindangan* waste has a PH level of 5.4. After the addition of eco-enzyme, there was a decrease in PH levels. This is similar to the research of Tang and Tong (2011) that the addition of eco-enzyme lowers PH levels due to the high acid content in eco-enzyme. With the addition of 10% eco-enzyme dilution, the PH level of the waste increased on the 4th day, while on the 25% eco-enzyme dilution, after 4 days the PH level did not change[23].

In this study, high levels of BOD and COD were found immediately after mixing the *pemindangan* waste and eco-enzyme. An increase in BOD and COD levels was also obtained along with an increase in eco-enzyme dilution. The increase is thought to be because the eco-enzyme itself contains high organic content due to being made from domestic waste and sugar that induces fermentation. In other words, eco-enzyme is considered not good enough to reduce BOD and COD[23]. However, another study stated that a decrease in BOD will occur on day 5 after mixing with eco-enzyme. It was said that eco-enzyme has the ability to inhibit microorganisms. Various hydrolytic enzymes present in eco-enzymes increase the ability of hydrolytic enzymes to enter bacterial cells, resulting in an inhibitory effect on bacterial growth. In addition, eco-enzyme has an acidic pH so that it has an effect on lysing bacteria[8,26].

The very pungent smell of *pemindangan* waste is caused by high levels of ammonia. In this study, eco-enzyme was able to reduce ammonia levels as dilution increased. In a study conducted by Tang and Tong (2011), it was found that ammonia levels in the waste can be completely lost on day 4 after the addition of eco-enzyme[23].

Previous studies stated that 10% is the best dilution of eco-enzyme as a treatment for waste. Several organic parameters increased due to testing carried out immediately after the addition of eco-enzyme as happened in this study. In previous studies, organic parameters such as BOD and COD will experience a gradual decrease over time. The duration of fermentation also greatly influences the ability of eco-enzyme to treat waste[27].

Eco-enzyme basically can be an alternative to chemical treatment for *pemindangan* waste, although it requires a longer treatment time. However, eco-enzyme is considered safer to use than other chemical agents such as Ethylenediaminetetraacetic acid (EDTA). These chemical agents are carcinogenic and require special handling when used so as not to harm the user[28].

CONCLUSION:

Eco-enzyme based on Siamese Kintamani orange (*Citrus nobilis)* peels waste can reduce the levels of TSS, TDS, PH, and ammonia levels in the *pemindangan* waste, both at 10% and 50% dilution. However, the eco-enzyme is not able to reduce the BOD and COD parameters in the *pemindangan* waste. Eco-enzyme requires a longer therapeutic time to be an alternative chemical treatment for *pemindangan* waste. In this study, the test was carried out immediately after mixing the eco-enzyme and *pemindangan* waste, so that it did not give a maximum effect on organic parameters in *pemindangan* waste. Further research should be conducted by following the time of therapy after mixing eco-enzyme and *pemindangan* waste.

CONFLICT OF INTEREST:

The authors have no conflicts of interest regarding this investigation**.**

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