DIVERSITAS HAYATI ISSN: 3025-2237
Volume 01, Number 02, Desember 2023
Pages: 7-17

A Study on the Content of Eco Enzyme from Pineapple Peel (Ananas comosus L.) and Watermelon (Citrullus lanatus)

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Manuscript received: 8 August 2023. Revision accepted: 14 Sept 2023

Abstract. Fruits widely consumed and cultivated by the Indonesian community include pineapple (Ananas comosus L.) and watermelon (Citrullus lanatus). The utilization of both fruits generates waste in the form of fruit peels. Pineapple and watermelon peels can be utilized as raw materials for eco enzyme production with the addition of water and molasses. Several functions of eco enzyme include serving as a floor cleaner, vegetable and fruit cleaner, insect repellent, and plant fertilizer. Additionally, it functions as a disinfectant due to its alcohol and acetic acid content. The objective of this research is to analyze the eco enzyme product using parameters such as pH, TDS, alcohol content, color, aroma, and final volume. The raw materials for eco enzyme are divided into three groups: 1) pineapple peels; 2) watermelon peels; 3) a mixture of pineapple and watermelon peels. The method involves mixing water, fruit peels, and molasses in a ratio of 10:3:1 and incubating for 30, 60, and 90 days. Based on the research results, the pH values range from 3.4 to 3.6. The TDS values increase for all raw materials except in the group of pineapple peel raw materials. The alcohol content in the eco enzyme product remains unchanged after incubation. The eco enzyme produced exhibits a cloudy brown color on the 90th day of incubation. The aroma produced is characteristic of fermentation, consistent with the concentration of raw materials used. The highest final volume of the eco enzyme product is observed on the 90th day of incubation.

Key words: eco enzyme, fruit peels, pineapple, watermelon, fermentation.

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INTRODUCTION

Pineapple is one of Indonesia's superior fruit commodities, ranking fourth in production after banana, mango, and sweet orange [1]. The pineapple plant originates from tropical America, such as Brazil, Argentina, and Peru. Currently, pineapples are distributed worldwide, especially in tropical regions located around the equator between 250 N and 250 S. Pineapple is a crucial trading commodity in the food crop subsector of the agricultural sector. It is a prominent regional commodity and is extensively cultivated by farmers. Pineapple plants in Indonesia are grown in lowland to highland terraced fields [2]. Labuhanbatu also has pineapple-producing areas located in Panai Hilir village. The productivity of pineapples in Panai is among the highest compared to other districts in North Sumatra.

In addition to pineapples, another traded commodity is watermelon. According to Food Consumption Statistics, the average per capita watermelon consumption in Indonesia increased from 2014 to 2016, with an average per capita growth rate of 6.14% from 2014 to 2018. Watermelon is easily found everywhere in Indonesia, from traditional markets to modern markets. According to BPS data, watermelon production in Indonesia in 2020 was 523,335 tons, and the province of Sumatra contributed the most to watermelon production in Indonesia, with 148,803 tons. Inefficient utilization of watermelon rinds results in their disposal as waste. Watermelon rinds can be processed into eco-enzymes, which can be used as disinfectants, floor cleaners, and liquid organic fertilizers [3].

The consumption of pineapples and oranges in various food preparations generates waste in the form of fruit peels. Waste from pineapple and orange peels can be utilized as raw materials for eco-enzyme production. The utilization of waste from pineapple and orange peels for eco-enzyme production can provide additional benefits to society, such as floor cleaning or serving as a distinctive-scented disinfectant through fermentation. Eco-enzyme or garbage enzyme is a liquid resulting from the fermentation of organic waste. Some functions of eco-enzyme fermentation include serving as a floor cleaner, vegetable and fruit cleaner, insect repellent, and plant fertilizer. The benefits of eco-enzyme fermentation as a disinfectant stem from its alcohol and acetic acid content. Eco-enzyme is a product of the enzymatic activity contained within bacteria or fungi [4].

The success of pineapple peel eco-enzyme, orange peel eco-enzyme, and the combination of pineapple and orange peel eco-enzyme can be analyzed after a harvest

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period of 90 days [5]. Success parameters can be analyzed based on pH value, total dissolved solids (TDS), alcohol content, color, aroma, and the volume of eco-enzyme products produced. Based on these considerations, research on eco-enzyme products from pineapple peels, Berastagi orange peels, and the combination of pineapple and orange peels is necessary. This research aims to analyze the differences in eco-enzyme products based on incubation time and raw material variations. This study is expected to serve as a reference for reducing waste from pineapple and orange peels in Berastagi and organic waste from households in general.

Dr. Rosukon Poompanvong from Thailand was the first person to develop eco-enzyme. Eco-enzyme production is simple, and the resulting product is multifunctional and easy to use. Eco-enzyme is environmentally friendly as it originates from household waste such as vegetable scraps and fruit peels typically discarded by the public. Eco-enzyme is a dark brown liquid with a strong acidic aroma, resulting from the fermentation of fruit peels or vegetable scraps [6]. The fermentation process of eco-enzyme production involves chemical reactions: CO2 + N2O + O2 → O3 + NO3 + CO3. Enzyme content includes lipase, trypsin, and amylase, which can prevent or kill germs, viruses, and bacteria. Economically, the production of eco-enzyme can reduce spending on purchasing floor cleaners or insecticides [6]. The results of eco-enzyme fermentation can be applied in various fields. The functions of eco-enzyme include decomposition, arrangement, transformation, and catalysis. Eco-enzyme can be used for household purposes such as floor cleaning due to its acidic nature. It is used for air purification or eliminating soluble accumulated odors. Additionally, it serves as a food preservative containing effective propionic acid against microbial growth. Eco-enzyme also contains acetic acid, which can destroy organisms, making it suitable as an insecticide and pesticide [7].

The application of eco-enzyme can be used for the preservation of strawberries and tomatoes. Fruits that undergo decomposition experience a change in texture, becoming soft and mushy. Untreated strawberries show a decrease in quality by the third day, while those treated with 100% eco-enzyme experience a quality decline by the fifth day, and those treated with 50% eco-enzyme experience a quality decline by the fourth day. Tomato decay occurs on the fourth day, and after applying 100% eco-enzyme, a decline in quality is observed on the sixth day, while a concentration of 50% leads to a quality decline by the fifth day [8].

Materials Utilized in Eco-Enzyme Production

In the production of eco-enzymes, the materials required are readily accessible. The primary ingredients needed include water, brown sugar, and leftover fruits or vegetables [6]. In the fermentation process of eco-enzymes, molasses can also be utilized as a substitute for brown sugar. Molasses is an industrial waste product of the sugar industry, which is economically more affordable. It is a byproduct of sugarcane and sugar production. Carbohydrates in molasses are ready for direct fermentation without any pre-treatment, as they are in the form of sugar [9].

Research on eco-enzyme testing was conducted using organoleptic methods with several variations. The variations explored in this study are as follows: variable 1, consisting of 100 grams of orange peel and 50 grams of papaya peel; variable 2, with 100 grams of orange peel and 50 grams of avocado peel; variable 3, including 100 grams of pineapple peel and 50 grams of watermelon peel; variable 4, with 150 grams of orange peel. The results obtained indicate a predominantly sour aroma from the used fruit peels, while variable 5 exhibits a rotten fruit-like odor. The resulting product color is murky brown for variables 1 to 3, orange-brown for variable 4, and slightly greenish for variable 5. The highest volume is observed in variable 5, totaling 600 mL [10].

Content in Watermelon Fruit and Peel

Pineapple fruit contains numerous beneficial components in almost all its parts. The contents of pineapple fruit include vitamin C, thiamine, riboflavin, niacin, pantothenic acid, vitamin B-6, folic acid, choline, betaine, vitamin A, beta-carotene, vitamin K, serotonin, and bromelain enzyme [5]. On the other hand, the contents of orange fruit, such as carbohydrates, calcium, phosphorus, thiamine, high levels of vitamin B6 and vitamin C, magnesium, phosphorus, niacin, copper, pantothenic acid, among others [11]. The utilization of pineapple fruit flesh is highly sought after due to its numerous benefits for the human body. Tropical fruit content contains high levels of antioxidants and vitamin C [12].

Pineapple peel contains vitamin C, carotenoids, and flavonoids. Additionally, the peel of pineapple fruit contains tannins, saponins, steroids, phenols, carbohydrates, terpenoids, alkaloids, phenols, anthraquinones, and amino acids (Rini, 2016). Whereas, the peel of orange fruit contains vitamins and minerals such as vitamin C, protein, amino acids, nitrogen (N), calcium (Ca), magnesium (Mg), potassium (K), and sulfur (S), with the highest concentration found in the orange

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peel compared to the fruit pulp or juice of the orange [13].

MATERIALS AND METHODS

Setting and Time

This research was conducted at the Basic Laboratory of the Faculty of Science and Technology, Labuhanbatu University, from March 2022 to June 2023.

Materials and Equipment

The materials used in this study include 10 liters of clean water, 1,500 grams of pineapple peel, 1,500 grams of watermelon peel, and 1 liter of molasses. The proportion of the materials in terms of water, fruit peel, and molasses was maintained at a ratio of 10:3:1 [8]. The equipment employed comprised a scale, knife, blender, a 5-liter-sized container, spatula, 1-liter-sized measuring glass, cloth strainer, funnel, eco-enzyme product bottles, pH meter, TDS meter, and an alcohol meter.

Research Design

This research was conducted experimentally. The variation in each treatment lies in the fruit peel utilized in the study. The design employed in this research involved homogenizing the samples with molasses/sugar cane and water provided with the sample codes as follows:

P1 = 200 g pineapple peel P2 = 200 g orange peel

P3 = 100 g pineapple peel and 100 g orange peel

P4 = 150 g pineapple peel and 50 g orange peel

P5 = 50 g pineapple peel and 150 g orange peel

In experiments P1 and P2, 1 L of water will be mixed with 100 mL of molasses and 200 grams of fruit peel. Meanwhile, for P3, P4, and P5, the ratio of water, fruit peel material, and molasses is the same, but with variations in the ratio of fruit peel as mentioned above.

Observation Parameters

The parameters observed in this study are pH, TDS, alcohol content, final volume, color, and aroma. These parameters are examined on day 0, after 30 days of incubation, on day 60, and on day 90 after the incubation period concludes. The measured parameters include pH, TDS, alcohol content, and volume.

Data analysis

The data analysis employed in this research is descriptive analysis. The descriptive analysis utilized aims to depict the results of the study based on the predetermined test parameters. Each parameter, encompassing pH, TDS, alcohol content, color, aroma, and final volume of eco enzyme products derived from pineapple and orange peels, is described to differentiate each treatment and the duration of the incubation period.

RESULTS AND DISCUSSION

Fermentation in the field of biochemistry signifies a catabolic process that generates energy. However, in the realm of microbiology, it assumes a broader connotation compared to the domain of biochemistry, encompassing the generation of novel products by leveraging the metabolic activities of microorganisms or their components, yielding superior quality. Therefore, fermentation can encompass the production of cells, enzymes, metabolites, recombinant products, and transformed products [14].

Throughout the fermentation process, the metabolic activities of microorganisms from the utilized waste peel material transpire. The fermentation process employed in this study incorporates the addition of molasses. Indirectly, this fermentation process imparts physicochemical and microbiological qualities to the fermented product, under controlled conditions of spoilage microorganisms [15]. Microorganisms present in the waste peels of pineapple and watermelon emit an acidic aroma due to the formation of acetic acid, subsequently serving as a medium for the growth of bacteria, molds, and yeast [16].

Table 1. Table 1. Results of pH testing for eco-enzyme

Variable	H-0	H-30	H-60	H-90
P1	4,2	3,4	3,5	3,5
P2	4,3	3,4	3,4	3,4
P3	4,2	3,4	3,4	3,5
P4	4,8	3,4	3,4	3,6
P5	4,5	3,4	3,4	3,5

Note: H-0 represents the test before incubation, H-30 represents incubation for 30 days, H-60 represents incubation for 60 days, and H-90 represents incubation for 90 days.

From Table 1, it can be observed that the pH values of the eco-enzyme products obtained underwent a reduction during the fermentation process. A significant decrease in pH is noticeable after an incubation period of 30 days. However, products incubated for 60 and 90 days did not demonstrate a significant decline in pH. No discernible variations in pH values were noted across different incubation periods and variable conditions. Eco-enzymes that have undergone complete fermentation typically exhibit pH levels below 4, a phenomenon commonly observed after three months [6]. In this investigation, a pH below 4 was achieved during the 30-day fermentation period. This outcome suggests that by the H-30 measurement point, the alcohol formed had converted into acetic acid, resulting in a

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reduction of the tested product's pH to 3.5. Furthermore, this transformation is substantiated by the raw materials used, which initially had a low pH value (around pH 4 at H-0), facilitating a relatively rapid decrease in pH to below 4.

Upon examination of each variable used, at H-30, no differences are apparent, and the pH values are identical. Similarly, at H-60, each variable also exhibits the same pH, indicating no variation. Meanwhile, during the H-90 incubation, the highest level of acidity is observed in P2, which is 3.4, and the lowest is in P4, which is 3.6. For P1, P3, and P5, the pH remains the same, namely 3.4. This suggests that, overall, the type of fruit peel waste used has minimal impact on acidity or pH. Moreover, it indicates that, based on the pH values obtained, the raw materials used can produce quality eco-enzyme products. This low pH value is influenced by the presence of acetic acid in the eco-enzyme liquid [11]. Organic acids such as acetic acid are naturally found in fruits [17].

Table 2. TDS Test Results of Eco-Enzyme Product (ppm)

Variable	H-0	H-30	H-60	H-90
P1	3.670	2.160	1.430	1.410
P2	1.170	2.180	2.170	2.190
P3	1.680	2.200	2.170	2.140
P4	1.690	2.530	2.470	2.100
P5	1.860	2.480	2.990	2.150

Note: H-0 pre-incubation test, H-30 incubation for 30 days, H-60 incubation for 60 days, H-90 incubation for 90 days.

Based on Table 2, it can be observed that among the five raw material variables, the decrease in TDS values is evident in P1, which utilizes only pineapple peel waste. Conversely, other variables containing watermelon peel waste show an increase in TDS values. With the low TDS values produced, eco-enzyme products made from pineapple peel appear visually more appealing due to greater clarity compared to those containing a watermelon peel mixture. This is presumed to occur because pineapple peel, with its tougher texture compared to orange peel, is less soluble in the eco-enzyme production process. Consequently, more pineapple peel settles than dissolves, resulting in a clearer eco-enzyme product. For comparison, Nazim and Meera [8] obtained a TDS value of 1,120 mg/l for eco-enzyme from organic waste after three months of incubation, while Arun and Sivashanmugam [18] obtained a TDS value of 1,040 mg/l for eco-enzyme from organic waste after three months of incubation.

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Table 3. Alcohol Content Test Results of Eco-Enzyme Product

Variable	H-0	H-30	H-60	H-90
P1	0%	0%	0%	0%
P2	0%	0%	0%	0%
P3	0%	0%	0%	0%
P4	0%	0%	0%	0%
P5	0%	0%	0%	0%

Note: H-0 pre-incubation test, H-30 incubation for 30 days, H-60 incubation for 60 days, H-90 incubation for 90 days

Alcohol content testing was conducted on eco-enzyme products after fermentation and before fermentation. However, no alcohol was detected in the eco-enzyme, both before and after fermentation for 30 days, 60 days, and 90 days. This testing employed an alcohol meter. It is suggested that this lack of detection may be due to the timing of the test, as during testing, the eco-enzyme production process had entered the acetic acid formation phase from previously formed alcohol. This is indicated by the pH value dropping to 3.5, indicating a high content of organic acids in the tested product. According to [19], the highest alcohol formation occurs on days 8-10. Consequently, alcohol content could not be detected on day 30 of testing.

Table 4. Volume Measurement Results of Eco-Enzyme Product (liters)

Variable	H-0	H-30	H-60	H-90
P1	2,65	2,44	2,45	2,52
P2	2,65	2,15	2,13	2,28
P3	2,65	2,19	2,31	2,40
P4	2,65	2,45	2,38	2,4
P5	2,65	2,22	2,12	2,20

Note: H-0 pre-incubation test, H-30 incubation for 30 days, H-60 incubation for 60 days, H-90 incubation for 90 days

Data in Table 4 indicates a decrease in the volume of eco-enzyme products after fermentation for 30 days, 60 days, and 90 days. According to Larasati, et al., [11], the increase or decrease in volume is dependent on the waste used to obtain the eco-enzyme product. From the data, all variations of variables P1, P2, P3, P4, and P5 experience a decrease in volume. The volume of eco-enzyme products is not influenced by the type of fruit peel waste used. However, the most significant decrease in volume occurs in V2, attributed to the higher sediment formation from orange peel waste. This final volume is compared with the initial volume before fermentation. On day 90 of incubation, the most significant volume decrease is observed in P5, which is a combination of 25% pineapple peel and 75% watermelon peel.

CONCLUSION

The eco enzyme product generated exhibits a pH value ranging between 3.4-3.6, with the lowest value observed in P4 at 3.4. The Total Dissolved Solids (TDS) value, when compared to pre-fermentation levels, experiences an increase in TDS values, except for P1. Alcohol content, both prior to and post-fermentation, remains undetected by the utilized testing apparatus. The color outcomes obtained at H-30 tend towards clear brown, H-60 displays a clear and turbid brown, while H-90 exhibits a turbid brown. The aroma of the produced eco enzyme at H-30 and H-60 is reminiscent of the fruit peel used, whereas H-90 emanates a distinctive fermentation aroma along with the scent of the utilized fruit peel. The volume of the eco enzyme product decreases compared to its pre-fermentation state.

The results of the eco enzyme product for each variable demonstrate a reduction in pH from pre-fermentation levels. The TDS values of variable P1 experience a decline, while values for variables other than P1 increase after fermentation. Alcohol content across all variables remains unchanged. Color variations across variables show no significant differences. The aroma of the eco enzyme differs for each variable in accordance with the type of fruit peel waste utilized. The volume for each variable exhibits no significant differences and undergoes a decrease.

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