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ORANGE AND STRAWBERRY SKINS FOR ECO-ENZYME: EXPERIMENT AND BIBLIOMETRIC ANALYSIS

M. MUKTIARNI[1,2,*], NUR INDRI RAHAYU[1], RINA MARYANTI[1]

[1]Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229 Bandung, Indonesia
[2]TVET RC, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229 Bandung, Indonesia
*Corresponding Author: muktiarni@upi.edu

Abstract

Oranges and strawberries are fruits that are widely grown by the community on both a large and local scale. Waste from fruit peels can be utilized to create eco-enzyme liquid by mixing it with water and brown sugar. Eco enzyme is a developing trend that transforms waste into a useful liquid. To determine the analysis of eco-enzyme fermentation outcomes, this study focused on the results of eco-enzyme conversion utilizing orange and strawberry fruit peels. This study was also completed with bibliometric analysis. Orange and strawberry peels are mixed with a ratio of three parts organic matter, one ratio of brown sugar, and ten ratios of clean water. The fermented samples were taken and analysed to determine the parameters in the form of pH and TDS using the established testing procedures. The three parts of organic matter, one ratio of brown sugar, and ten ratios of fresh water were combined with orange and strawberry peels. Using the approved testing techniques, the fermented samples were collected and analysed to ascertain the parameters in the form of pH and TDS. The findings indicated that the pH parameters for the two fruits, namely 3,4, and 3,3, tended to be acidic. For TDS, the findings indicated that 1,560 for citrus peels and 1,650 for strawberries have relatively close trends.

Keywords: Eco-enzyme, Fermentation, Organic waste.

1. Introduction

Generally, oranges and strawberries are popular fruits; these fruits can be eaten raw or processed into a variety of processed foods. The high consumption of this fruit produces waste in the form of fruit peels and rotten fruit; this waste can be used to make the eco- enzyme. Eco-Enzyme is an organic compound. It is a complex solution produced by the fermentation of fresh kitchen waste such as vegetable and fruit peels. It is a type of homebrew vinegar, reduced from alcohol by fermentation of kitchen waste as substrate with sugar [1, 2]. Eco enzyme is a product that is simple to make and environmentally friendly [3].

The process of creating eco enzymes is simple, and the tools and materials required are plentiful and easy to obtain [4]. Water, sugar as a carbon source, and fruits and vegetables (or leftover fruits and vegetables) are the materials used. Eco enzyme is a product created by fermenting organic food ingredients (vegetables and fruit), sugar, and water in a 3:1:10 ratio [5]. A chemical reaction occurs during the fermentation process for making an eco-enzyme, which is as follows: $CO_2 + N_2O + O_2 \rightarrow O_3 + NO_3 + CO_3$.

Eco enzymes can be used for a variety of daily tasks, including organic liquid fertilizer for plants, detergent mixtures for washing clothes, cleaning floors, cleaning pesticide residues on food products, and cleaning scale and dirt that is difficult to remove. Furthermore, this eco-enzyme product can be used as a spa ingredient to aid in blood circulation to produce enzymes that are useful in the utilization of fruits and vegetables [6]. The fermentation process takes three months to complete. The fermentation liquid has a dark brown colour and a strong aroma that is both sour and sweet. If the product already has an aroma and physical characteristics, it is ready to use.

The use of fruit peels as an eco-enzyme material has numerous advantages. They can be used as cleaning fluids, fertilizers, and liquid disinfectants. They have a strong aroma which is the characteristic of fermentation from orange and strawberry peels [7]. Eco enzymes can be used for a variety of daily tasks, including organic liquid fertilizer for plants, detergent mixtures for washing clothes, cleaning floors, cleaning pesticide residues on food products, and cleaning scale and dirt that is difficult to remove. Furthermore, this eco-enzyme product can be used as a spa ingredient to help in blood circulation [8].

The success rate of eco enzymes derived from orange peels, strawberries, and a combination of orange peels and strawberries can be determined if the fermentation time has reached 90 days [9]. The pH, TDS, alcohol content, colour, aroma, and volume of eco-enzyme products can be used to calculate success parameters. Based on this, research on eco-enzyme products derived from orange peels, strawberries, and a combination of orange and strawberry peels is required [10]. This research aimed to examine the differences in eco-enzyme products based on incubation time and raw material differences. This study was expected to serve as a model for reducing organic waste in households in general.

2.Method

This experimental study uses raw materials such as orange and strawberry peels mixed with brown sugar and clean water. Each is made up of three parts organic waste, one-part brown sugar, and ten parts clean water. Figure 1 depicts eco-enzyme ingredients and formulations.

Figure 1 illustrates a comparison of the materials used in the production of eco enzyme: three arts organic waste (300 grams of orange and strawberry peels), one of ration brown sugar (100 grams), and 10 parts water (1000 millilitres).

Fig. 1. Ingredients and formulations of eco enzyme.

The tools used to support this research were divided into two categories: tools for making eco-enzyme products and tools for conducting analysis. The tools for making eco enzymes include 20-liter containers or jars, stirrers, scales, knives, and gloves. Pipettes, measuring cups, funnels, filter cloths, pH meters, universal indicators, and TDS meters are used to analyse eco-enzyme products.

3. Results and Discussion

3.1. Bibliometric analysis

The bibliometric was done by Google Scholar using keywords “eco-enzyme” and “organice waste”. Search results are stored in two files, *.ris and *.csv. Data processing uses automatic analysis using the VOSviewer application and manual analysis using Microsoft Excel. Data mapping is done after the data selection process. Data mapping is analysed to find developments, research trends, and other fields and terms often associated with the study material in research. The data that has been mapped is then analysed to see how the development of research regarding eco enzyme.

3.1.1. Eco enzyme publication development

The results of searching publication data regarding eco enzymes and organic waste found 499 article data. The title and abstract are used as a reference for adjusting the data with the chosen research topic, namely "Eco enzyme and Organic Waste." The research matrix concerns the number of citations for eco enzyme and organic waste research indexed in Google Scholar. The research year taken is 4 years, from 2018 to 2022. The number of research citations is 12365 citations. The average citation per article regarding this research is 24.73 and the average citation per year is 3091.25. Articles about eco enzymes and organic waste have an h-index of 53 and a g-index of 86. The h-index value indicates the level of productivity and the impact of the research [11]. The greater the H-index value, the more advanced the research in that field [12]. Table 1 shows the articles with the most significant number of citations. The article with the highest number of citations is "hydrogen production from biomass using dark fermentation” with 328 citations.

Figure 2 shows the development of research published in Google Scholar-indexed journals regarding eco enzymes and organic waste. Research on eco enzymes and organic waste has experienced a significant increase between 2018 and 2021, but in 2022 it experienced a decline. The decline in the number of publications can be seen in Fig. 2. The highest number of publications regarding eco enzymes and organic waste was in 2021 with 123 articles published. In 2018 the number of publications was 82 articles. In 2019 the number of publications was 98 articles. In 2020 there were 107 articles. In 2021 there will be 123 articles, and in 2022 the number of publications regarding eco enzymes and organic waste will only be 88. The development of eco enzyme and organic waste research can be considered for research on eco enzyme and organic waste, which will be carried out in the future. The consideration that can be made is whether the research trend regarding eco enzymes and organic waste is still relevant.

Table 1. Publications on eco enzyme and organic waste with the highest number of citations.

No.	Cites	Title	Year	Ref.
1	328	Hydrogen production from biomass using dark fermentation	2018	Łukajtis et al. [13]
2	231	Bioengineering of anaerobic digestion for volatile fatty acids, hydrogen or methane production: A critical review	2019	Wainaina et al. [14]
3	223	Hierarchically Engineered Mesoporous Metal-Organic Frameworks toward Cell-free Immobilized Enzyme Systems	2018	Li et al. [15]
4	210	Methanogenesis	2018	Lyu et al. [16]
5	173	Carbon dioxide and organic waste valorisation by microbial electrosynthesis and electro-fermentation	2019	Jiang et al. [17]
6	165	Anaerobic digestion of food waste: A review focusing on process stability	2018	Li et al. [18]
7	165	Eco enzymatic stoichiometry and microbial nutrient limitation in rhizosphere soil in the arid area of the northern Loess Plateau, China	2018	Cui al. [19]
8	152	Leucine Signals to mTORC1 via Its Metabolite Acetyl-Coenzyme A	2019	Son et al. [20]
9	152	Improving the stability and efficiency of anaerobic digestion of food waste using additives: A critical review	2018	Ye et al. [21]
10	139	Free ammonia enhances dark fermentative hydrogen production from waste activated sludge	2018	Wang et al. [22]

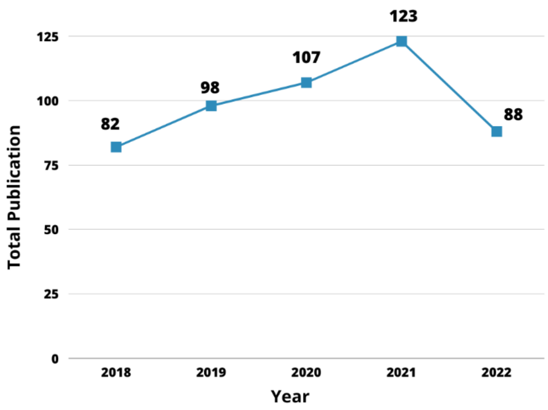

Fig. 2. Eco enzyme and organic waste publication development.

3.1.2. Eco enzyme and organic waste publication mapping visualization

Based on the results of the mapping found 499 related terms in research on eco enzymes and organic waste. We determined the number of occurrences of the term at least 5 times so that 134 terms were found. We selected the most relevant 60% of terms, resulting in 80 terms found. We verified the selection of terms so that 80 terms were found for mapping visualization by paying attention to their linkages with eco-enzyme research.

Figure 3 shows a visualization of the publication network regarding Enzyme and Organic Waste from 2018 to 2022. Network visualization shows the linkages and strength of relationships through the value of the term link strength [23]. The greater the link strength value, the stronger the relationship between terms.

The colour size of the nodes in the visualization network represents the number of occurrences of terms [24]. The larger the nodes in the network visualization image, the larger the terms appear [25]. The thicker the links between nodes, the stronger the relationship between terms [25, 26]. Network visualization divides each term into several groups or clusters. Terms regarding research regarding eco-enzyme and organic waste are divided into 6 clusters. Table 2 shows the distribution of clusters in the research analysis mapping on eco enzymes and organic waste.

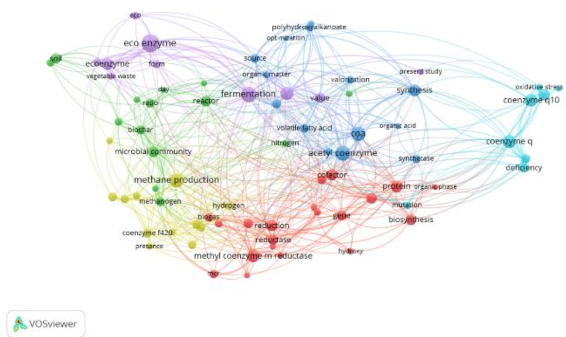

Fig. 3. Network visualization of eco enzyme and organic waste publication.

Table 2. Cluster mapping analysis.

Clusters	Color	Total items	Items
1	red	20	Acid residue, amino acid residue, biogas, biohyrhane production, biosynthesis, cofactor, gene, group, hydroxy, mcr, mcra, methane, methyl coenzyme, methyl coenzyme m, methyl coenzyme m reductase, organic phase, organic residue, protein, reductase, reduction
2	Green	14	Anaerobic reactor, biochar, comparison, day, ecoenzymatic stoichiometry, enzyme activity, inoculum, methanogen, microbial community, nitrogen, organic layer, ratio, reactor, soil
3	Blue	14	Acetyl coa, acetyl coenzyme, coa, coenzyme a, optimization, organic acid, organic matter, pha, polyhydroxyalkanoate, source, synthesis, synthetase, valorization, volatile fatty acids
4	Yello w	12	Acetate kinase, anaerobic fermentation, coenzyme f420, dark fermentation, hydrogen, hydrogen production, key enzyme, methane production, presence, protease, reasearch
5	purple	5	Eco, eco enzyme, ecoenzyme, fermentation, form, fruit, present study, value, vegetable waste
6	cyan	10	Coenzyme q, coenzyme q10, coq, coq 10, deficiency, mutation, organic solvent, oxidative stress

Figure 4 shows a publication overlay visualization regarding eco enzymes and organic waste. The visualization overlay shows the distribution of research years to see updates on using terms in related research [26]. Figure 4 shows that most eco enzyme and organic waste research was carried out in 2019 and 2020. As can be seen, the dominant colour of the nodes in Fig. 4 is a green to the yellow gradient colour.

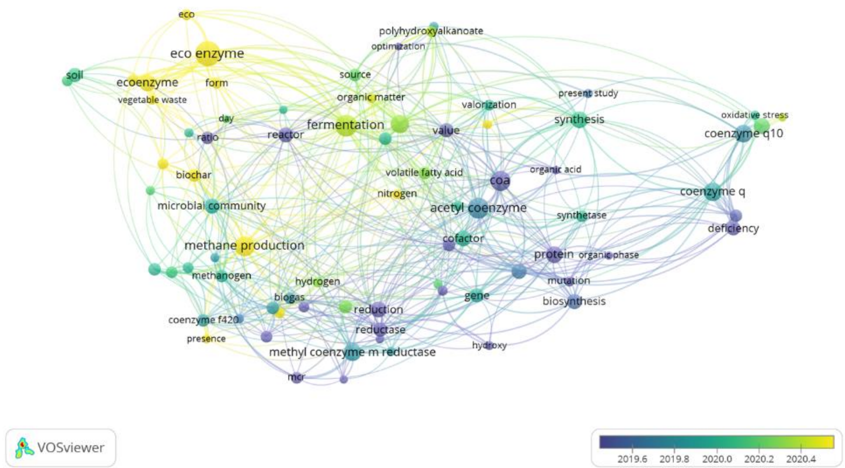

Fig. 4. Overlays visualization of eco enzyme and organic waste publication.

The visualization of research density oneco enzyme and organic waste is shown in Fig. 5. The density visualization's colour indicates that the brighter the yellow colour and the larger the circle diameter of a term, the more frequently the term appears [27]. That is, interest in the term is growing. The number of studies on the term decreases as the term's colour fades and approaches the background colour [27]. According to Fig. 5, there have been many studies on the term’s acetyl coenzyme, fermentation, methane production, eco enzyme, and reduction. Acetyl coenzyme has the highest number of occurrences, appearing 61 times. This shows that research on eco enzymes is mainly associated with acetyl coenzyme.

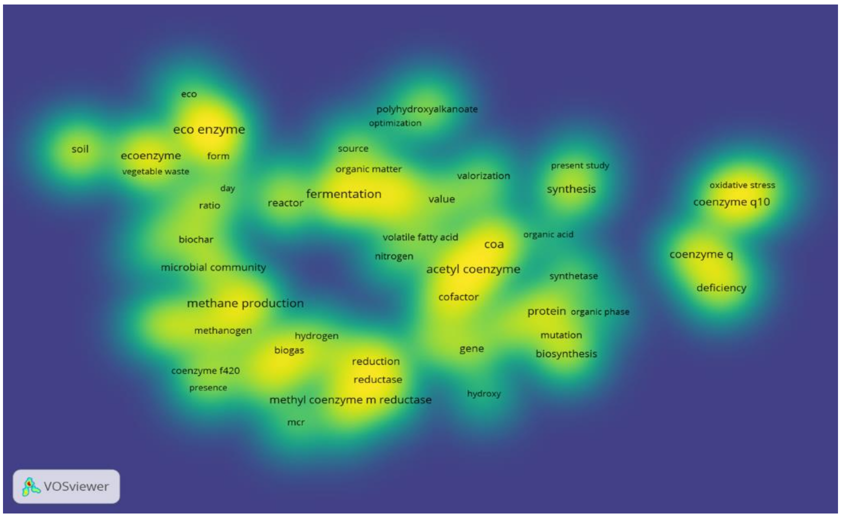

Fig. 5. Density visualization of eco enzyme and organic waste publication.

3.2. Eco enzyme manufacturing process

Eco enzyme is a product created by fermenting organic foods (vegetables and fruit), sugar, and water in a ratio of 3:1:10. Dr. Rosukon Poompanvong, the founder of the Organic Agriculture Association in Thailand, was the first to introduce eco enzymes. The concept behind this project is to use organic waste that is typically thrown into trash cans to create enzymes as Magic liquids (household cleaners, insecticides, antiseptics, fertilizers, and so on). Orange and strawberry peels were used as ingredients in the production of eco-enzyme products in this study. Figure 6 depicts the manufacturing process for the eco enzyme.

Figure 6 demonstrates the process of creating eco-enzyme products from orange and strawberry peels. The following presentation shows the steps for creating eco-enzyme products:

(i) Pour 10 ratio of water into the container, making sure the container is larger than the amount of water. The container is almost 60% full of water, 20% of which is organic waste, and the remaining 20% is space for air.

(ii) Add 1 ratio of finely chopped brown sugar to a bottle filled with water.

(iii) Place three ratios of organic waste (fruit skins, non-fresh fruits, and vegetables) in a bottle containing a mixture of water and brown sugar/molasses. Containers filled with water and organic waste account for nearly 80% of the total volume, with the remaining 20% reserved for air.

(iv) Close the container tightly and store it for three months (in the first month, the container is opened every day to release the gas that comes out of the fermentation results)

(v) After three months, the eco enzyme produced by fermentation liberated the white fungus.

(vi) Using a filter, separate the fermented organic waste from the water.

(vii) The fermented organic waste can be reused by adding ingredients and water or used as a compost fertilizer for plants.

(viii) Eco enzyme products come in bottles and are ready to use.

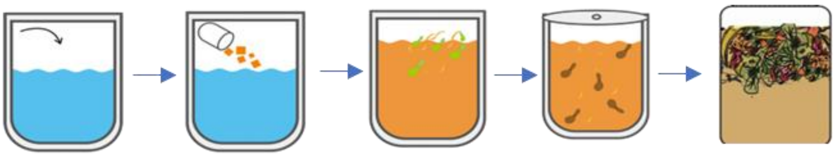

Fig. 6. Demonstrates the process of creating eco-enzyme.

The physical form of eco-enzyme products fermented for three months demonstrates their success. Dark brown is the ideal colour resulting from the fermentation process in eco enzyme products [28]. You can see the progress during the fermentation period; if white mushrooms appear and smell fresh, it means your eco enzyme is working. However, if black mold appears and smells rotten, it indicates failure. If it fails, throw it away immediately and bury it.

3.3. Characteristics of eco enzyme from citrus and strawberry peels

Eco enzyme has different properties depending on the material used; to find out, a test of a successful eco enzyme solution is performed. The test was carried out by collecting 200 ml of eco enzyme solution for further examination and analysis. Eco enzymes are filtered before being analysed. pH and TDS levels are the biochemical parameters examined.

The results of the eco enzyme product analysis using orange and strawberry peels show that eco enzyme products are acidic with a low pH value, and the pH of each product is obtained. pH 3,4 for eco-enzyme products containing orange peel as the primary ingredient, and pH 3,3 for eco-enzyme products containing strawberry as the primary ingredient. Table 3 shows a comparison of the two organic materials used in the production of eco-enzyme products containing orange peel and strawberry peel ingredients.

Table 3. Test parameters for eco enzyme product solutions from citrus and strawberry peel material.

Organic Ingredients	Test Parameters	
	pH	TDS (mg/I)
Orange Peel	3.4	1.560
Strawberry	3.3	1.650

The analysis results show that eco-enzyme products made from organic ingredients in the form of fruit are acidic and have a low pH value. Organic acid ingredients are critical in the production of high-acidity eco-enzyme products. This affects the pH value of eco-enzyme products, the higher the organic acid content, the lower the pH value [29, 30]. According to the findings, eco-enzyme products derived from orange and strawberry peels have a high organic acid content because the organic matter in citrus and strawberry fruit courses is high in acetic acid and citric acid [31, 32]. The analysis results show that the TDS value of eco-enzyme products made from orange and strawberry peels is high. This is because the enzyme solution is made from organic materials such as fruit waste or organic solid waste, as well as molasses, which is used as a substrate in the fermentation process. However apart from the ingredients used, the time spent in the fermentation process has an impact on eco-enzyme products. Except for the pH, parameter values will decrease as fermentation time passes due to the degradation of organic matter caused by microorganisms in the eco enzyme solution [33]. Other studies' findings indicate that the use of molasses and brown sugar affects the final result, with molasses producing lower parameter values than brown sugar [34]. Molasses is a residual substance from the sugar production process that contains active microorganisms, so its use in eco enzyme products results in low parameter values. Aside from pH, the colour of the fermentation process affects the colour produced. According to the results of the analysis, the co-enzyme produced using the basic ingredients of orange and strawberry peels has a light brown colour and a strong sour aroma [35, 36]. Eco enzyme is considered successful if it has a light to dark brown colour, a distinct and fresh sour aroma, and a high-water content [37].

4. Conclusions

Eco enzymes work by accelerating biochemical reactions to produce enzymes that are useful in the utilization of organic wastes; the organic wastes used in this study are orange and strawberry peel waste. The fermentation process in eco enzyme products lasts three months, and the liquid produced has a dark brown colour and a strong fermented aroma that is both sour and sweet. The fermentation results of orange and strawberry peels show that the eco enzyme products produced are acidic with a low pH. The colour, aroma, moisture content, and pH of the resulting coenzymes are affected by the combination of fruit peel waste used as raw material for making coenzymes. All eco-enzyme variants have a fresh sour aroma.

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