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Synthesis of *Eco Enzyme* as a Technology for Making Biodegradable Detergent Moringa Leaves (*Moringa oleifera*) in Supporting Green Antibacterial Products

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Abstract— **The organic waste from plants is currently increasing and has not been optimally processed. One of the solutions to save the earth from waste by processed the organic waste into eco enzymes. Eco enzyme is processed through fermentation of a mixture of leftover organic waste which can be used in the manufacture of biodegradable detergents. The manufacture of biodegradable detergents requires natural surfactants as materials that are safe for the environment and humans to replace the chemical compounds. Moringa leaves contain saponins as surfactants which have function as antibacterial and antioxidants. The purpose of this research is to produce biodegradable detergents which are processed through the synthesis eco enzymes and mix the moringa leaf surfactants, as well as to determine the antibacterial compounds found in biodegradable detergent. The method used is experimental research. Detergent biosurfactant is obtained from the process of maceration and evaporation of moringa leaves. The result of mixing detergent with eco enzyme is light brown color, has a distinctive fruity scent, and has a pH value of 10. The liquid detergent produced is according to SNI standard with strong antibacterial power. The results showed that biodegradable detergent can effectively remove bacteria and stains on clothes.**

***Keywords*—** *Liquid detergent, Eco enzyme, evaporation, fermentation.*

INTRODUCTION

Around 80% of the total amount of waste generated by big cities in Indonesia is organic waste, which is only seen as waste and has no economic value [1]. Organic waste is one of waste type that is often produced by human activities. Organic waste such as food scraps, fruits, and vegetables generated by households are simply thrown away without segregation. Many people just throw it away without thinking about the impact for the environment. If organic waste is not managed properly, it can cause serious environmental problems such as the spread of disease and soil contamination [2]. Therefore, it is also very important to conduct education and campaigns to increase public awareness about good organic waste management.

Environtmentally friendly and effective management of organic waste needs to be noticed recently. One solution that can be done is to make eco enzyme. Eco enzyme is an environmentally friendly product that is easy to make using organic kitchen waste, sugar, and water using a certain ratio [3]. The process used is by fermenting organic kitchen waste, sugar and water for three months. During the fermentation process, the bacteria in organic kitchen waste will decompose the waste into a liquid that has various benefits [4]. Eco enzyme contains a number of useful bacteria to break down organic waste such as lactic acid bacteria, bacillus, and lactobacillus. The benefits of eco enzyme can be used as a household cleaner, one of which is detergent. Eco enzyme contains the enzymes lipase, amylase, and trypsin. These enzymes have biocatalyst properties that can be used to reduce the concentration of waste water contaminants [5]. Previous studies on reducing pollutant concentrations using eco enzymes were able to reduce chemical oxygen demand (COD) concentrations in domestic waste [3].

Based on Dita's research, 2018 states that 50 grams of detergent contains 9.6 grams of harmful active substances such as linear alkylbenzene sulfonate[6]. The increase in detergent consumption in Indonesia per year reaches 720 tons [7]. This increase is directly proportional to the increase in the volume of detergent waste, which has the potential to pollute the aquatic ecosystem[8]. Ecosystem pollution is caused by the harmful ABS and LAS compounds that contained in commercial detergents, so these two are non-biodegradable materials [9]. In addition, synthetic detergents that are commonly found in cleaner formulas include *Sodium Lauryl Sulfate* (SLS), *Sodium Lauryl Ether Sulfate* (SLES), and *Linear Alkyl Benzene* (LAB). This detergent is difficult to decompose in the environment and can cause skin irritation to consumers who have sensitive skin [10].

Therefore, the use of natural detergents have began to be develop, namely, detergents from eco enzyme and moringa leaves to remove stains and as an environmentally friendly and biodegradable anti-bacterial agent. Biodegradable detergents require alternative sources of surfactants to replace chemicals that are safe for the environment and humans. Alternative sources of biosurfactant production can use plants such as moringa leaves. Moringa leaves contain active saponins as a surfactants which have function as an antibacterial and antioxidant [11]. Maranggi [9] said that moringa leaves has a large percentage of 7,19% sapponins. The large percentage of saponin shows that moringa leaves could produce biodegradable eco-friendly foam. In addition, moringa also has many benefits because it contains secondary metabolite consist of flavonoids, polyphenols, ascorbate, and carotenoids [10]. As a biosurfactant, The manufacture of liquid detergent uses a rotary evaporator as an extraction tool with the principle of separating the extract from the filter liquid by heating that accelerated by the rotation of the flask [12]. The purpose of this research is to produce biodegradable detergents which are processed through the synthesis of eco enzymes and moringa leaf surfactants, as well as to determine the antibacterial content found in detergents.

METHOD

Tools and Materials

The main raw material is moringa leaf powder which was macerated using 70% methanol as a solvent, and the resulting macerate was then activated with HCl. Added MES *(Methyl Ester Sulfonate)* as a secondary surfactant used in the process of making liquid detergent by homogenizing with Na2SO4, glucose, and water. The tools used are pH paper to measure the pH of detergent preparations, a measuring tube to measure foam stability, a stove as a heater. Moringa leaf powder was extracted using 70% methanol solvent with a ratio of 1:10 [9] by maceration method. The maceration process will produce solid macerate which is then incubated and filtered.

Solid maceration that has been incubated and filtered is then diluted with the addition of distilled water and activated by adding HCl solution, after standing it produces biosurfactant. In the process of making liquid detergent, it is done by melting MES and then mixing it with moringa's biosurfactant until it is homogeneous, which we call solution 1. At the same time, glucose and Na2So4 solutions are made until homogeneous, which is then called solution 2. Solution 1 and solution 2 are ready then homogenized, this solution is then called solution 3. this solution 3 is then heated and stirred until a liquid detergent is obtained.

The formulation (F) used consisted of 4 formulations with the composition summarized in Table 1 below.

Table 1. Liquid Detergent Formulation Of Moringa Leaf Extract And Ecoenzym

Material	F1	F2	F3	F4
Biosurfactant	100 g	150 g	300 g	350 g
Aquades	590ml	490 ml	390 ml	340 ml
MES	100g	100g	100g	100g
Na2SO4	100g	100g	100g	100g
Glucose	100g	100g	100g	100g
Eco enzym	100g	100g	100g	100g
Water	600ml	600 ml	600 ml	600 ml

Manufacturing Procedure

The manufacture of biosurfactants and liquid detergents follows the steps in the flow chart according to Figure 1 and Figure 2 below.

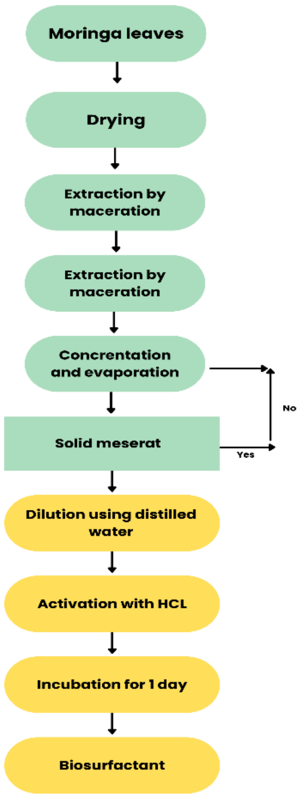

Figure 1. Flow chart for the manufacture of biosurfactants

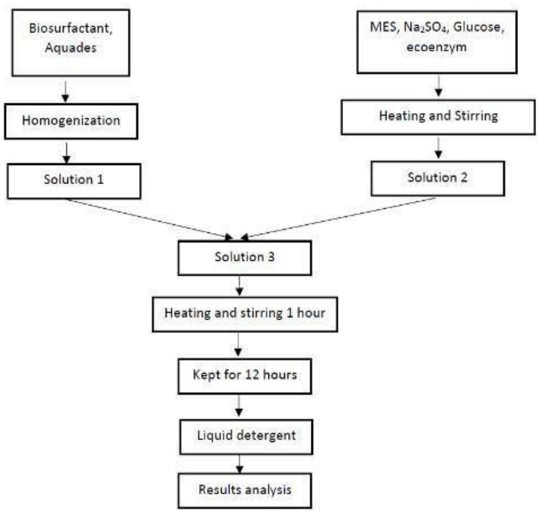

Figure 2. Flow chart for the manufacture of liquid detergen

RESULT AND DISCUSSIONS

To test biosurfactant preparations and liquid detergents, namely organoleptic tests, pH tests, and liquid detergent antibacterial tests by comparing them with commercial detergents. Based on SNI, the pH value for liquid laundry detergent is in the range of 10-12 (SNI 06-4075-1996). The results obtained were at pH 10 which was in the range of quality standards. The resulting pH level is alkaline so it does not cause disturbance to the ecosystem in the waters.

In Table 2, these are the results of the organoleptic test for liquid detergent from moringa leaves. With 4 samples accompanied by different volumes of biosurfactant and distilled water. It was found that the 1st sample with a biosurfactant volume of 100 grams produced a light brown color. This is different from sample 4 which has a biosurfactant volume of 340 grams, resulting in a darker brown color. The greater the volume level of biosurfactant used, the darker the color of the liquid will be, this is because the extract content from moringa leaves has gone through a greater meseration process. Apart from that, the basic color of Moringa leaves themselves is dark green, which in this condition still contains a lot of saponin [16].

Table 2. Liquid Detergent Organoleptic Test

Sample	Form	Color	Odor
F1	Homogen liquid	Light brown	Characteristic odor
F2	Homogen liquid	Yellowish-brown	Characteristic odor
F3	Homogen liquid	dark yellowish brown	Characteristic odor
F4	Homogen liquid	Dark brown	Characteristic odor

The antibacterial test in this study aims to determine the antibacterial activity of biosurfactants against Escherichia coli bacteria in liquid detergent preparations. In Table 3, it is found that the inhibition zone for sample F1 is 7.27 mm, F2 is 7.63 mm, F3 is 8 mm, and F4 is 8.3 mm. From sample F1 to sample F4 experienced an increase in the zone of inhibition.

Table 3. Liquid Detergent Anti-Bacterial Testing

Sampel	**Obstacles Zone (mm)**				
	U1	U2	U3	**Average**	**Antibacterial Category**
F1	7,4	7,0	7,4	7,27 ± 0,2309	Currently
F2	7,8	7,3	7,8	7,63 ± 0,2887	Currently
F3	8,1	7,8	8,1	8,00 ± 0,1732	Currently
F4	8,5	8,1	8,5	8,37 ± 0,2309	Currently

According to Davis and Stout (1971) there are four categories of antibacterial power based on the resulting inhibition zones, namely the very strong category with an inhibition zone of ≥20 mm, the strong category with an inhibition zone ranging from 10-20 mm, the medium category with an inhibition zone ranging from 5-10 mm and weak category with inhibition zone ≤ 5 mm [13]. The antibacterial power of the four liquid detergent preparations from Moringa leaves and eco enzymes against Escherichia coli bacteria was categorized in the medium category (5-10 mm). The result from the resulting inhibition zone ranged from 7 mm to 8.5 mm.

Brooks et al. (2007) explained that the inhibition zone for bacterial growth will be greater when the higher concentration is added. The difference in the inhibition zone at each concentration is due to the large difference in the active ingredients contained in that concentration. The greater the concentration, the greater the active ingredients contained, so that the resulting inhibition zone is greater [14].

In Table 4 are the results of bacterial tests on Moringa liquid detergent as a biosurfactant sample, commercial detergent as a positive control and detergent preparations without biosurfactants and ecoenzymes as a negative control. Antibacterial test results were obtained on positive control (KP), negative control (KN) and biosurfactant.

Table 4. Anti-Bacterial Tests For Kp, Kn, And Moringa Leaf Biosurfactants

Sample	**Obstacles Zone (mm)**				
	U1	**U2**	**U3**	**Average**	**Antibacterial Category**
Positive Control	12,6	12,4	11,4	12,2 ± 0,6083	Strong
Negative Control	0	0	0	0 ± 0,0000	Blank
Biosurfactant	15,9	14,5	15,3	15,07 ± 1,8009	Strong

In the positive control which is a commercial detergent obtained inhibition zones of 12.6 mm, 12.4 mm, 11.4 mm and 12.2 mm which are categorized as strong antibacterial power. In the negative control in the form of basic detergent preparations without biosurfactants and ecoenzymes, no inhibition zones were produced. This means that there is no antibacterial activity in the liquid detergent preparation because there is no active ingredient that functions as an antibacterial agent. The results of the biosurfactant antibacterial test itself were 15.9 mm, 14.5 mm, 15.3 mm and 16.3 mm which were categorized as strong antibacterial strength. This happens because the mechanism of action of saponins as antibacterial is by denaturing proteins, because the surface active substances of saponins are similar to detergents so they can be used as antibacterials where the pressure of the bacterial cell wall will be lowered and the permeability of the bacterial membrane damaged [15].

To test how much foam the detergent that has been made produces, we compared it with commercial detergent regarding the amount of foam produced by both detergents when applied to wash dirty fabrics. The foam produced by moringa leaf detergent is apparently less than commercial detergent. This means that the detergent has low foam properties and is safe for the environment. This is in accordance with the detergent quality standards set by SNI 064075-1996, which requires a maximum liquid detergent foam stability of 70%. As seen in Figure 3, after washing, the fabric becomes cleaner, which is due to the power of the cleaning agent from moringa leaf saponin and ecoenzyme which removes stains on clothes. Without enzyme technology, stubborn stains are difficult to remove and require more detergent [17].

Figure 3. Comparison with commercial detergents

Moringa leaves are believed to have antibacterial activity, in this study it has been proven that Moringa leaves have antibacterial activity against *Escherichia coli* bacteria both in the form of biosurfactants and in the form of detergent preparations. Based on SNI, the pH value for liquid laundry detergent is in the range of 10-12 (SNI 06-4075-1996). The results obtained are in the range 10-11 which is in the range of quality standards. The resulting pH level is alkaline so it does not cause disturbances to aquatic ecosystem.

CONCLUSION

Based on the results of this research, biodegradable detergents processed through the synthesis of eco enzymes and moringa leaf surfactants work effectively and have strong antibacterial properties in removing stains on clothes. This research hasn’t perfectly done, therefore further research besides antibacterial test is still needed regarding future tests.

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