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Potential of *Moringa oleifera* saponins as a preventive of water pollution from the *linear compound alkylbenzene sulfonate* (LAS)

Potensi saponin Moringa oleifera sebagai preventif pencemaran air akibat senyawa linear alkylbenzene sulfonate (*LAS*)

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ABSTRAK

Peningkatan konsumsi detergen di masyarakat berdampak pada peningkatan volume limbah yang berpotensi pencemaran ekosistem air. Penelusuran Data *TOP Brand* tahun 2021 menyatakan bahwa masyarakat dunia lebih tertarik menggunakan detergen anti noda membandel. Perusahaan bidang industri Indonesia semakin tinggi memproduksi detergen berbahan kimia. Tujuan penelitian adalah mendeskripsikan potensi saponin *Moringa oleifera* sebagai upaya pencegahan pencemaran air dari senyawa Linear Alkylbenzene Sulfonate (LAS). Metode penelitian menggunakan esperimen rotary dengan uji organoleptik. Hasil yang ditemukan pada saponin *M. oleifera* mempunyai bau khas dari senyawa isothiocyanate, berwarna hijau kekuningan, pH dalam 25°C (konsentrat 6), bahan aktif saponin (enzim protease) daun *M. oleifera* sebesar 8,5%, dan bobot jenis (2,5%) dengan konsentrat 1,2. Penelitian ini menunjukkan bahwa deterjen cair dihasilkan memenuhi Standar Nasional Indonesia (SNI) dan kualitas deterjen baik. Kandungan saponin *M. oleifera* menjadi alternatif bagi perusahaan industri dan sebagai upaya preventif pengolahan ekosistem air yang lebih baik.

Kata kunci: daun *moringa oleifera*, ekosistem air, lingkungan, limbah, noda

ABSTRACT

Increasing detergent consumption in society has an impact on increasing the volume of waste, which has the potential to pollute water ecosystems. TOP Brand Data Search for 2021 states that people worldwide are more interested in using detergents to combat stubborn stains. Indonesian industrial companies are increasingly producing chemical-based detergents. The research aimed to describe the potential of *Moringa oleifera* saponin as an effort to prevent water pollution from the Linear Alkylbenzene Sulfonate (LAS) compound. The research method uses a rotary evaporator with organoleptic tests. The results found in *M. oleifera* saponin have a distinctive odour from isothiocyanate compounds, yellowish green colour, pH within 25°C (concentrate 6), the active ingredient of saponin (protease enzyme) of *M. oleifera* leaves was 8.5%, and specific gravity (2.5%) with a concentrate of 1.2. This research shows that the liquid Detergent produced meets Standar Nasional Indonesia (SNI), and the detergent quality was good. The saponin content of *M. oleifera* was an alternative for industrial companies and a preventive measure for better water ecosystem processing.

Keywords: *Moringa oleifera* leave, environment, water ecosystem, waste, stains

INTRODUCTION

These days, one of the main issues facing every nation is water contamination. Water contamination, including the living environment, is a world highlight in several sectors (Soto-Rios et al., 2023). The household industry can influence the quality of environmental quality assurance (Mujan et al., 2019). In recent years, the household industry has been one of the fastest-growing industries in the world. (Pathmananathan et al., 2021). Population growth can increase the consumption of household raw materials and food without considering its content (Rismawati & Sya'aban, 2023). The increasing needs of every household make the producer look every way to be met. Competing manufacturers of household products make huge profits without seeing the negative impact.

Detergent is an important ingredient in daily needs in every household, such as using soap (detergent) (Tang & Dirawan, 2023). Given the world's population, even the Indonesian people need soap. Soap producers are looking for solutions to produce economic goods. One practical way of producing soap (Detergent) is to make soap using chemicals. The components of the soap are still predominantly chemical. A chemical that produces abundant foam is designed to save the use of soap and remove stains quickly (Askari et al., 2021). The chemical content in non-natural detergents includes surfactants of the type Alkyl Benzene Sulfonates (ABS) and Linear Alkylbenzene Sulfonate (LAS) which are difficult to break down by organisms, so they can accumulate in waters and soil and can reduce water quality.

Surfactants derived from petroleum are difficult to decompose by decomposing bacteria and can damage the mucus layer and gills of fish, as well as disrupt the reproductive ability of aquatic organisms. Phosphate is a detergent auxiliary ingredient that functions to bind calcium and magnesium ions which cause water hardness. Phosphates can cause eutrophication, which is a condition where there is excessive growth of algae and aquatic plants which reduces oxygen and sunlight in the waters. Bleach is a detergent additive that functions to make clothes whiter and cleaner. Bleach can be chlorine, hydrogen peroxide, or sodium perborate. Bleach can cause poisoning, burns, and tissue damage if swallowed, inhaled, or in contact with skin and eyes.

One of the aspects of soap that has a negative impact is the quality of the water. This is because each use of the soap produces soap water (foam) and is thrown into the water (river, lake, sea, and so on). This has led to a decline in the diversity of aquatic life, including the death of some species of fish that are in the aquatic ecosystem and harm the environment. Increasing foam in the waters can threaten water biota up to human health (Nizioł-ŁUkaszewska et al., 2020; Vergara-Jimenez et al., 2017). *Linear Alkylbenzene Sulfonate* (LAS) is a chemical raw material that serves as both a foam producer and a stain remover. LAS compounds are the cause of the accumulation of household waste in rivers and the sea. LAS composites in soap (Detergent) have a concentration of about 22-30% as anionic surfaces (Purnamasari, 2014). Increased household waste from the LAS compound becomes a water pollution factor. Therefore, there is a need for environmentally friendly (Detergent) soap innovation (Chirani et al., 2021). One of the natural ingredients that can replace the function of LAS compounds is the leaves of *Moringa oleifera*.

The potential of *Moringa oleifera* leaf saponins has a staining role (Rachmawati & Suriawati, 2019; Riyadi et al., 2021) and a foam producer so that there is no accumulation of hazardous waste in the waters (Kashyap et al., 2022) and water biota life is unaffected (Reda et al., 2023). The replacement of soap material with natural materials is expected to prevent water pollution from household waste (Brilhante et al., 2017). The purpose of the study was to describe the potential of *Moleifera* saponins as an effort to prevent water pollution from the Linear Alkylbenzene Sulfonate compound. (LAS).

MATERIALS AND METHODS

The implementation method was divided into 3 stages, starting from the preparation, implementation and data analysis stages.

Preparation Phase

The production of this detergent begins with the production of biosurfactants and a mixture of detergents. This detergent production begins with the production of biosurfactants and detergent mixtures. Biosurfactant uses *M. oliefera* leaves as raw materials, which were ground into powder and then processed using 70% methanol as a solvent in a ratio of 1:10 (Maranggi et al., 2020).

Implementation

The maceration process was adapted from the research carried out by Maranggi et al. (2020). The result of this maceration process will produce a thick maserat, which was then filtered and evaporated by separating it from the solvent. After the evaporation process, the meserat that has been incubated and filtered was then diluted with the addition of aquades and activated using HCL solution. After being inhabited for about one day, it will be a biosurfacing leaf. (larutan 1). Meanwhile, in the mixture of detergent raw materials, MES (Methyl Ester Sulfonate) was used as a secondary surface agent that was homogenized with Na_2SO_4, glucose, and water. The stages of the biosurfactant and detergent production process could be seen in Figure 1 and Figure 2.

In the mixing phase with other detergent compounds like MES, Eco Enzym, Na_2SO_4, and glucose, the process was carried out by heating the biosurfactant mixture of the leaves of the dough into the detergent compound. The process will produce a second solution. The heating process was done in conjunction with the process of combustion for one hour. After a one-hour process, it was subsequently humidified for 12 hours so that the solution was separated from its adhesive. The more detailed stages were described in Figure 2 below.

Data Analysis

The analyses used were organoleptic tests, pH tests, and antibacterial tests. Organoleptic test to determine the physical appearance of liquid detergent preparations by looking at shape, odor, and color. pH test to determine the effect of detergent when it comes into contact with skin so that it was safe to use in washing clothes. An antibacterial test was also carried out to see the antibacterial power of the *M. oliefera* detergent.

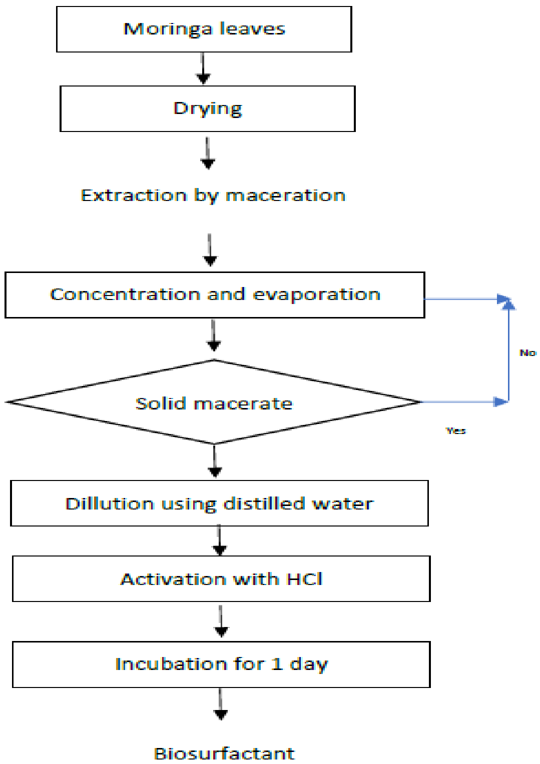

Figure 1. Methods of biosurfactant production from kelor (*M.oleifera*) Leaves

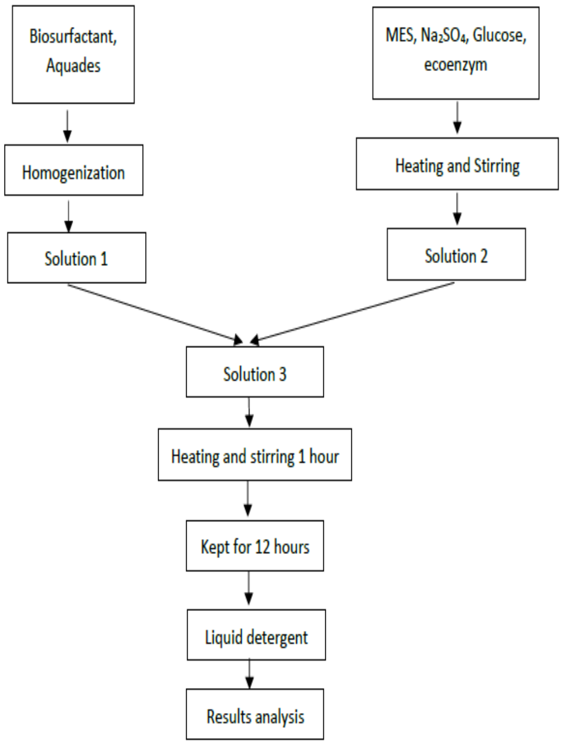

Figure 2. Method of mixing biosurfactant with detergent

RESULTS

Organoleptic Result

The results obtained have been conducted on several tests of biosurfactant and liquid detergent preparations, namely organoleptic tests, pH tests, and antibacterial tests of liquid detergence, and type weights by comparing them with commercial detergents. Here was Table 1 of organoleptic test results as followed.

Table 1. Organoleptic test results

Criteria	Situation	Concentrate
Leaf Saponins (*M.oleifera)*	Fragrance	Special leaves of *M.oleifera*
	Shape	Homogeneous liquid
	Colour	Yellow-green
	pH	6
Liquid Detergent (*M.oleifera)*	Fragrance	Special leaves of *M. oleifera*
	Shape	Homogeneous liquid
	Colour	Transparent green
	pH	11
SNI Criteria (06-4075-1996)	Fragrance	Specific
	Shape	Homogeneous Liquid
	Colour	Specific
	pH	10-12

Liquid detergent testing based on SNI refers to the standards set by the Indonesian National Standards Agency (BSN) to ensure the quality and safety of liquid detergents circulating on the market. This test aimed to ensure that the liquid detergency meets the requirements set in SNI to be used safely by consumers.

The results of the organoleptic tests were performed by observing the smell, shape, and colour of the detergent preparation using the preference test (hedonic method). Obtained a liquid homogeneous shape, transparent green colour and characteristic smell.

Detergent pH Value

In this study, the liquid detergent that has been made was used for the process of washing manually first, using hands. In the washing process, the pH value affects the skin's response to direct contact with liquid detergents. According to SNI 06-4075-1996, the pH value of the liquid detergent ranges from 10.0 to 12.0. The results of the test of the biosurfactant fluid detergents obtained a pH of 11, with the resulting pH being basal.

Antibacterial Test Analysis

Based on the antibacterial test results obtained on positive controls, negative controls, and biosurfactants. Some data that positive controls were commercial detergents obtaining barrier zones of 12.6 mm, 12.4 mm, 11.4 mm and 12.2 mm belonging to strong antibacterial power. That means there was no antibacterial activity on the liquid detergent preparation because of the absence of an active ingredient that acts as an antibacterial. Antibacterial biosurfactant test results were 15.9 mm, 14.6 mm, and 15.2 mm, which were categorized as strong antibacterial strengths (Table 2).

Table 2. Antibacterial test results

Sample	Barrier Zone (mm)				
	Test 1	Test 2	Test 3	Average	Category Antibacterial
Positive Control	12.7	12.7	12.7	12.23	Strong
Negative Control	0	0	0	0	Empty
Biosur-face	15.9	14.6	15.2	15.23	Strong

DISCUSSION

Organoleptic Analysis of Detergent Products

The research results in connection with organoleptic biosurfactant analysis have shown that, in accordance with the results of the SNI criteria, this detergent is safe and suitable for use. The leaves produce saponins, which can be used as biosurfactant detergents. This is due to the content of saponins in the *Moringa* leaves, which is 7.19%. Based on previous research conducted by Susanti (2014), saponin levels were highest in 10 types of leaves; one of them is *M. oliefera* leaves. The high content of leaves containing saponines was found in high-quality greenhouses (Sudarmi et al., 2017). The saponin content in these leaves is an alternative substitute for eco-friendly detergent surfaces, a foam producer, and an antibacterial ingredient (Maranggi et al., 2020). Saponins are natural foam-producing compounds that can be used in the detergent, soap, and shampoo industries (Vergara-Jimenez et al., 2017). The saponins identified with the high determination of foam are obtained at a stable foam height.

This is because the foam formed has physical properties that are soluble in water and will create foam when crushed. Based on a study by Suharto (2012) that studied saponins on the simplicity of a banana rod, the pot produces a 20 mm foam height for 30 seconds. The higher the saponin content produced in the biosurfactant, the higher the material's potential to be used as a natural detergent (Widayati et al., 2012). These saponins can also lower water tension and remove dirt or stains on clothes. (Susanti & Marhaeniyanto, 2014).

Based on organoleptic tests, Moringa oleifera leaves have a greater saponin content. The benefits of the leaf content of the *M.oleifera* can be used in chemical compound retention of Linear Alkylbenzene Sulfonate (LAS) in the manufacture of soap (detergent) that can trigger water pollution (Nizioł-ŁUkaszewska et al., 2020; Vergara-Jimenez et al., 2017). In addition, wastewater from soap products material (detergen) can be more environmentally friendly for water quality (rivers, seas, and others(Rachmawati & Suriawati, 2019; Riyadi et al., 2021; Kashyap et al., 2022).

Detergent pH Value

The pH value obtained indicates the overall pH value of the sample of 11, which has entered the range specified by SNI. The pH value is a property to be observed because it directly relates to the skin's response. At a pH that is relatively basal or acidic, the adsorption strength of the skin will be higher so that it can cause skin irritation. Based on SNI liquid detergent, detergents can work effectively on the base atmosphere because they can neutralize dirt and help dirt remain suspended in the solution (Dinurrohmah et al., 2022). The results are in the range of 10-11, which is in the standard quality range. The resulting pH level is basal, so it does not interfere with the ecosystem in the waters.

The leaves are believed to have strong antibacterial activity (Rachmawati & Suriawati, 2019). This research has proven that the coriander leaves have antibacterial activity against Escherichia coli bacteria in the form of biosurfactants and detergent preparations. Basic detergent preparations without biosurfactants and eco enzymes do not produce barrier zones at negative control. This means there is no antibacterial activity in the preparation of liquid detergents because of the absence of active ingredients that act as antibacterial. This is because the mechanism of work of saponins as antibacterial is by performing protein denaturation. After all, the surface of the active substance saponin is similar to a detergent, so it can be used as an antibacterial where the pressure on the bacterial cell walls will be lowered, and the permeability of bacteria will be decreased.

Antibacterial Test Analysis

Antibacterial biosurfactant test results were categorized as strong antibacterial strength. This happens because the mechanism of action of saponins as antibacterials is by denaturing proteins. This is caused by the surface-active substance saponin, which is similar to detergent and can be used as an antibacterial, where the pressure of the bacterial cell wall is reduced and the permeability of the bacterial membrane is damaged (Riyadi et al., 2021).

This research has demonstrated the potent antibacterial activity of *M. leaves against* Escherichia coli germs in the form of biosurfactants and detergent formulations. *Moringa* leaves have a strong antibacterial action and contain secondary metabolites. The capacity of a material to either stop or eradicate bacterial growth is known as antibacterial activity.

Moringa leaves contain substances that can damage bacterial enzymes, cell walls, membranes, and cell membranes, including flavonoids, saponins, terpenoids, and tannins, they have antibacterial potential (Riyadi et al., 2021). By measuring the diameter of the inhibitory zone containing *Moringa* leaf extract on medium bacteria that have overrun, one can determine the antibacterial activity of *Moringa* leaves (Kashyap et al., 2022).

CONCLUSION

Studies indicate that *Moringa* leaf saponin-based detergent has the potential to combat water pollution is caused by linear alkylbenzene sulfonate (LAS). This detergent not only effectively removes stains from clothes but also possesses powerful antibacterial properties.

Furthermore, organoleptic tests conducted on 80 individuals confirmed the validity of the detergent, which exhibited a uniform liquid consistency, a transparent green color, and a unique fragrance. These findings demonstrate that environmentally friendly organic substances can replace LAS on commercial surfaces, thereby reducing impurities on the substrate.

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