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Reduction of Dispersant Pollutant (Linear Alkylbenzene Sulfonate) by Mangrove Plant (*Rhizophora mucronata*)

Reduksi Polutan Dispersant (Linear Alkylbenzen Sulfonat) oleh Tanaman Mangrove *(Rhizophora mucronata)*

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ABSTRACT

Linear alkylbenzene sulfonate (LAS) is the main component of dispersants that function as cleaners of various materials. The increasing use of LAS causes this compound to dominantly pollute coastal waters. Phytoremediation is the most environmentally safe alternative to physical and chemical methods. One of the potential plants as a phytoremediator is *Rhizophora mucronata*. This research is an experiment as an application of LAS pollutant control by *R.mucronata* plants in waters. After acclimatization and preliminary tests, the implementation of LAS phytoremediation tests by *R. mucronata* plants in seawater media was carried out at concentrations of A1: 25 mg/L, A2: 100 mg/L, A3: 175 mg/L, A4: 250 mg/L, and A5: 325 mg/L and control (Control without plants) as a simulation of the presence of pollutants in coastal waters. The method used was a completely randomized design (CRD) with one treatment and 3 replications. The reduction of LAS concentration in the test media and its effect on *R.mucronata* leaf chlorophyll and dissolved oxygen were analyzed at week 2 to week 4. The analysis results showed that LAS compounds could be reduced to 91.48% at week 2 and 97.40% at week 4. Plant Water quality parameters (dissolved oxygen, temperature and pH) were measured daily. Based on the study results, LAS can be reduced by *R.mucronata* plants 87-90.4% in week 2 and 95.1-97.4% in week 4. LAS exclusion by plants had a significant impact on the reduction of leaf chlorophyll content until week 4. LAS reduction by *R.mucronata* in the media can increase dissolved oxygen content as an indication of improved water quality. *R.mucronata* plants can be used as an alternative to control LAS pollution in waters

Keywords: Reduction, LAS, *R.Mucronata*, Chlorophyll, Dissolved Oxygen

ABSTRAK

Linear alkylbenzene sulfonate (LAS) merupakan kompoten utama dispersant yang berfungsi sebagai pembersih berbagai material. Peningkatan pemakaian LAS menyebabkan senyawa ini dominan mencemari perairan pantai. Fitoremediasi merupakan alternatif penanggulangan pencemaran yang paling aman bagi lingkungan dibandingkan metode fisika dan kimia. Salah satu tanaman yang potensial sebagai fitoremediator adalah *rhizophora mucronata*. Penelitian ini merupakan eksperimen sebagai aplikasi pengendalian polutan LAS oleh tanaman *R. mucronata* di perairan. Setelah dilakukan aklimatisasi dan uji pendahuluan maka pelaksanaan uji fitoremediasi LAS oleh tanaman *R. mucronata* di media air laut dilakukan pada konsentrasi A1:25 mg/L, A2:100 mg/L, A3:175 mg/L, A4:250 mg/L, dan A5: 325 mg/L serta kontrol (Kontrol tanpa tanaman) sebagai simulasi keberadaan polutan di perairan pantai. Metode yang digunakan adalah Rancangan Acak Lengkap (RAL) satu perlakuan dan 3 ulangan. Reduksi konsentrasi LAS di media uji dan pengaruhnya terhadap klorofil daun *R.mucronata* serta oksigen terlarut dianalisis pada minggu ke-2 hingga minggu ke-4. Hasil analisis menunjukkan bahwa senyawa LAS dapat tereduksi hingga 91,48 % pada minggu ke-2 dan 97,40% pada minggu ke-4. tanaman Parameter kualitas air (oksigen terlarut, suhu dan pH) diukur setiap hari. Berdasarkan hasil studi, LAS dapat direduksi oleh tanaman *R. mucronata* 87-90.4 % pada minggu ke 2 dan 95,1-97,4% pada minggu ke-4. Redukai LAS oleh tanaman berpengatuh signifkan terhadap penurunan kandungan klorofil daun hingga minggu ke-4. Reduksi LAS oleh *R. mucronata* di media dapat meningkatkan kandungan oksigen terlarut sebagai indikasi meningkatnya kualitas air. Tanaman *R. mucronata* dapat digunakan sebagai alternatif pengendalian pencemaran LAS di perairan.

Kata Kunci: Reduksi, LAS, *R.Mucronata*, Klorofil, Oksigen Terlarut

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INTRODUCTION

Coastal waters are vulnerable to pollution from industrial and domestic activities. Oil pollutants (vegetable and hydrocarbons) are the main pollutants causing water pollution (Nedi et al., 2023). The use of dispersants is the most effective effort to reduce the impact of dispersion and accumulation of hydrocarbon pollutants and accelerate their biodegradation. The application of dispersants in waters does not fully have a positive impact, because it still leaves residues that are not friendly to the environment, especially for aquatic organisms, and damage to aquatic ecosystems. Detergent formulas generally consist of surfactants, additives, builders, and fillers. The most important element of the total detergent formulation is surfactants with an amount of about 15%-40%. The most common ingredient used in detergent manufacturing is the anionic surfactant LAS (linear alkylbenzene sulfonate) (Raissa & Tangahu, 2017).

Linear alkylbenzene sulfonate (LAS) compounds are the main components of dispersants that have the ability to cleaners including oil. Degradation of some LAS components (50%) takes >9 days and the residue of these components can interfere with ecosystems, including aquaculture. Alternative control of LAS pollutants in waters can be done through phytoremediation using plants. Phytoremediation is the use of plants for the process of decontaminating pollutants or environmental pollution problems (Andriana et al., 2022). One type of aquatic plant that can act as a phytoremediator in degrading LAS pollutants in waters is the mangrove plant (*Rhizophora mucronata)*.

Rhizophora mucronata is one type of mangrove that is commonly found in coastal waters and has resistance to the influence of tides (Hadiyatma et al., 2023). Mentari et al. (2022), stated that mangrove plants have strong roots and can function as sediment traps and function as an ecological function to absorb heavy metals in the environment. In research by (Luthansa et al., 2021) the presence of mangrove ecosystems can control Pb (lead) and Cu (copper) pollutants. Mangrove *Rhizophora* sp. is often studied as a plant that can accumulate heavy metals, so it can be used as a phytoremediator (Paz-Alberto et al., 2014; Supriyantini et al., 2017; Kumar et al., 2021; Babak et al., 2022).

Based on this, research is needed on the ability to reduce pollutant dispersant (Linear Alkylbenzene Sulfonate) by mangrove plant phytoremediators (*Rhizophora* sp) experimentally in the field laboratory. This research aims to study the ability of *R. mucronata* to reduce LAS dispersant in seawater media and the effect of LAS dispersant reduction on chlorophyll and media water quality.

MATERIALS AND METHOD

Time and place

This research was conducted in June 2023 at Lagio Field Laboratory, Jl. Srikandi Pekanbaru. *R.mucronata* plants were taken from the coast of Dumai and Linear Alkylbenzene Sulfonate compounds: LAS were purchased from the laboratory.

Procedure

This research is experimental research conducted in 3 stages, namely the preparation stage, the acclimatization stage, and the implementation stage. Before the implementation stage, preliminary tests were carried out to determine the range of LAS concentrations used in the test implementation stage to be suitable for plant growth and not cause growth disorders and plant death. The preparation stage was carried out by taking seawater in the Dumai Sea as a liquid medium and *R.mucronata* plants that had been grown in fleback. The acclimatization stage is an adaptation stage so that *R. mucronata* plants can live and grow well in a controlled test environment. The implementation stage includes the maintenance of plants in the test media with variations in concentration that have been determined (preliminary test results). At this stage of the test, carried out: a) LAS concentration analysis (ASTM FTIR) at week 2 and week 4, b) Chlorophyll measurement of *R. mucronata* leaves (chlorophyll meter type KWF) at week 2 and week 4, c). Water quality measurement with dissolved oxygen (DO) as an indicator.

The test conditions were controlled and the daily water quality of the media (temperature, pH, and salinity) was monitored daily using a water checker.

Table 1. Treatment of LAS concentration by plant phytoremediator *R. mucronata*

Plants	LAS pollutant concentration (mg/L)	Repeat
R mucronata (M)	M1 = 25 M2 = 100 M3 = 175 M4 = 250 M5 = 325	3 times
K= control (no plant)	K1= 100, 175 and 250	

Data analysis

LAS analysis data, chlorophyll content of *R.mucronata* leaves, and dissolved oxygen were collected and tabulated into tables, statistically analyzed using SPSS version 26, and discussed descriptively to study the effect of LAS reduction on *R.mucronata* leaf chlorophyll and dissolved oxygen.

RESULT AND DISCUSSION

The presence of *R.mucronata* plants can reduce LAS in the test media. LAS residues in the test media continued to decrease over time. The higher the concentration of LAS as a treatment in the test media, the higher the residue at week 2 and week 4 in the plant media decreased, as shown in Figure 1.

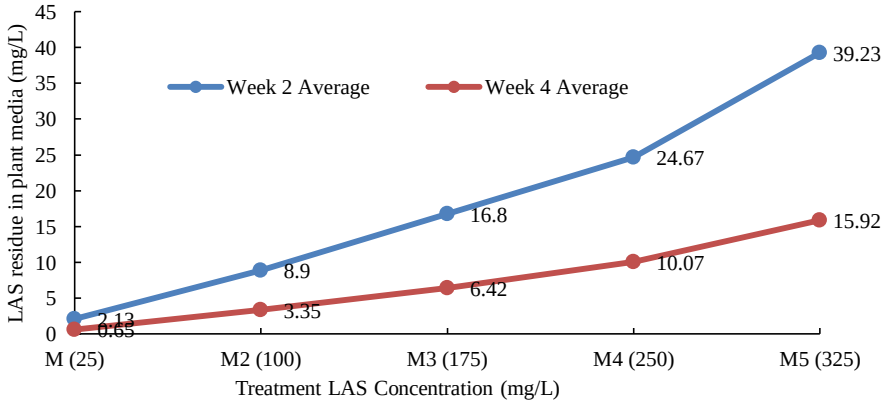

Figure 1. Reduction of LAS by *R. mucronata* plants

Figure 1 show, in the treatment of LAS concentration of 25 mg/L, in week 2 the residue was 2.13 mg/L and in week 4 it decreased to 0.65 mg/L. In the treatment of LAS concentration 325 mg/L, the residual LAS in week 2 was 39.23, and in week 4 became 15.92 mg/L The rate of LAS reduction by *R.mucronata* plants can be seen in Figure 2.

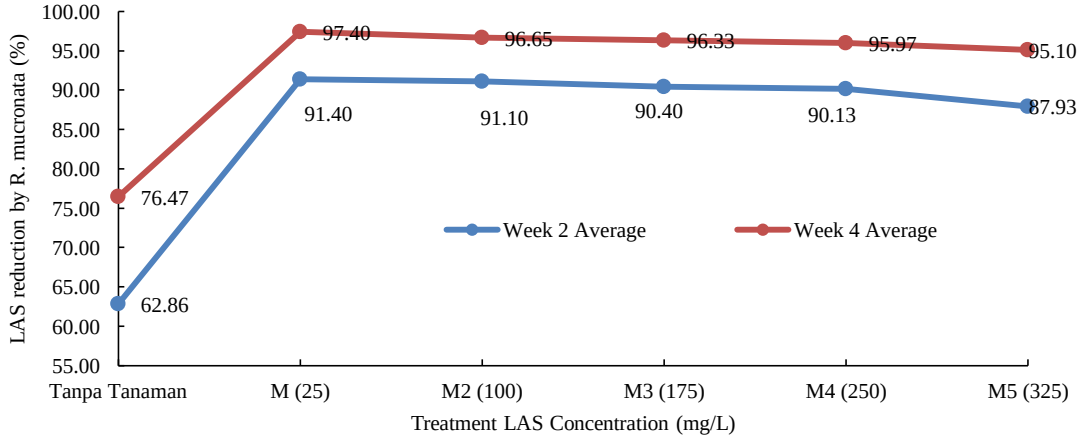

Figure 2. Percentage reduction of LAS by *R.mucronata* and without *R.mucronata*

In Figure 2, LAS concentration can be reduced even without *R.mucronata* plants. Without phytoremediator plants, LAS can be reduced by 62% in week 2 and 76.47%. *R.mucronata* plants optimally have been able to increase the reduction of LAS from 91.4 week 2 to 97.4% in week 4. The highest reduction rate

occurred at a LAS concentration of 25 mg/L. Reduction of LAS by *R.mucronata* plants affects the chlorophyll of the leaves. The higher the LAS reduction by plants, the greater the decrease in chlorophyll of the plant leaves (Figure 3).

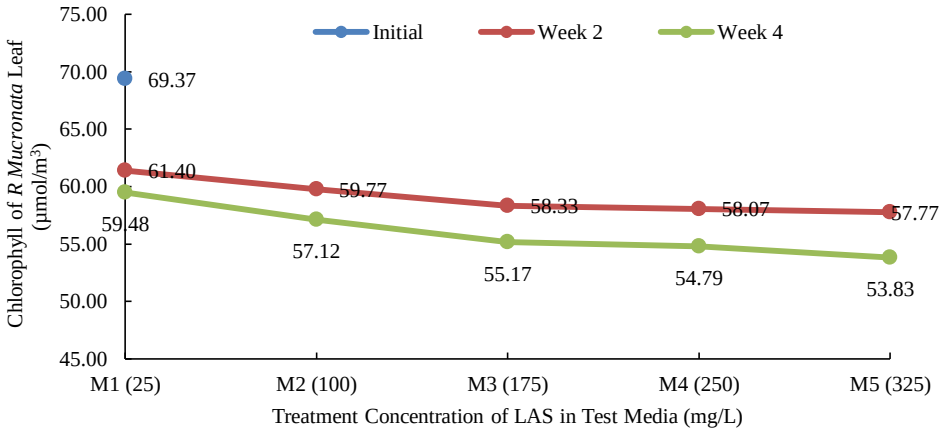

Figure 3. The chlorophyll content of *R. mucronata* leaves at the beginning of week 2 & week 4

Initially, the chlorophyll concentration of *R.mucronata* leaves was 69.37 (µmol/m^3) and decreased to 57.77 (µmol/m3 in week 2 to 53.83 (µmol/m^3) in week 4. The presentation of the rate of decline in leaf chlorophyll can be seen in Figure 4.

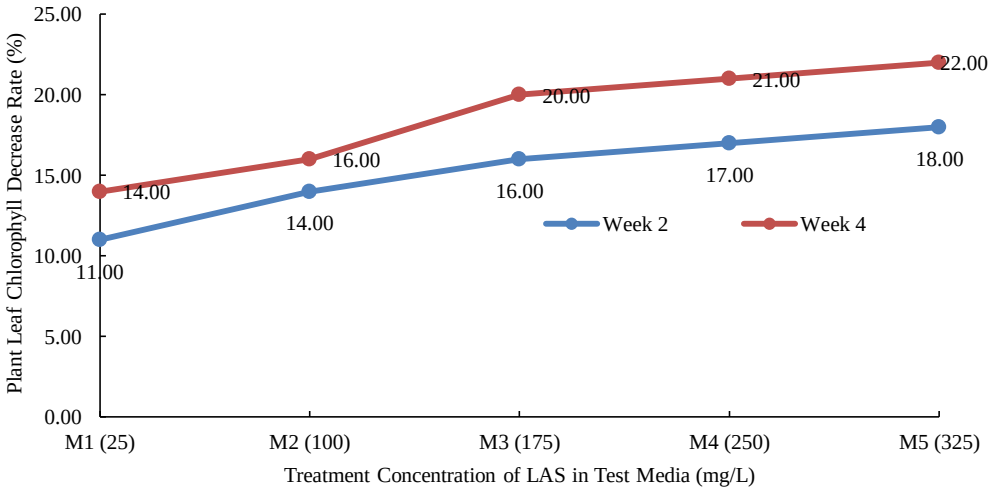

Figure 3. Percentage of the rate of decrease in chlorophyll of *R.mucronata* chlorophyll leaves

Reduction of LAS by *R.mucronata* influences leaf chlorophyll. Reduction of LAS by *R.mucronata* has a strong influence on the chlorophyll content of *R.mucronata* leaves (R^2 >0.85). LAS reduction by *R. mucronata* plants also influenced the water quality of the media, especially the dissolved oxygen content at week 2 and week 4 as shown in Table 2.

Table 2. Dissolved oxygen measurement results in each treatment

Measurement	Treatment and Dissolved Oxygen Measurement Results					
	K (LAS 175 Without Plant)	M1 (25)	M2 (100)	M3 (175)	M4 (250)	M5 (325)
Initial	3	3	3	3	3	3
Week 2	3,3	4,3	4,2	4,1	4	3,8
Week 4	3,5	4,9	4,8	4,7	4,5	4,4

Table 2 shows that the presence of *R.mucronata* plants can restore the water quality of the test media through an increase in dissolved oxygen content as an indicator

CONCLUSION

Based on the research that has been done, it can be concluded that *R.mucronata* plants can reduce Linear Alkylbenzene Sulfonate (LAS) pollutants in waters, LAS reduction by *R.mucronata* has a strong influence on the chlorophyll content of *R.mucronata* leaves ($R^2 > 0.85$), and control of LAS pollutants by the phytoremediator plant *R.mucronata* can restore the quality of the water medium.

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