International Conference on Biology Education, Natural Science, and Technology
Vol. 3 No. 1 (2025)
E-ISSN : 3026-5428

Efficiency of Jeruju (*Acanthus illicifolius*) as a Bioindicator of Copper Pollution in Surabaya Mangrove Waters

Adelia Wulandari[1]*, Eva Agustina[2], Irfan Hadi[3], Esti Tyastirin[4], Roni Irawanto[5], Rizki Dwi Lestari[6]

[1234]Universitas Islam Negeri Sunan Ampel Surabaya
Jl. Ahmad Yani, No. 117, Surabaya, 60237, Jawa Timur, Indonesia

[5]Pusat Riset Lingkungan dan Teknologi Bersih, Badan Riset dan Inovasi Nasional (BRIN)
Jl. Cisitu Lama – Jl. Sangkuriang, Dago, Coblong, Bandung, 40135 Jawa Barat, Indonesia

[6]Universitas Islam Syarifuddin Lumajang
Jl. Kyai Syarifuddin No.1, Wonorejo, Kedungjajang, Lumajang, 67358 Jawa Timur, Indonesia
*Corresponding Author. E-mail address: adeliaw05@gmail.com

KEYWORDS:
Acanthus illicifolius, phitoremediation, bioindicator, Copper (Cu), Mangrove Surabaya

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ABSTRACT

Environmental pollution, especially heavy metal contamination, has become a major threat to aquatic ecosystems. This study aimed to investigate the efficiency of Jeruju (Acanthus illicifolius) as a bioindicator and phytoremediator of copper (Cu) pollution in mangrove waters of Surabaya. Sampling was conducted in three locations: Gunung Anyar Tambak, Surabaya Mangrove Botanical Garden, and Wonorejo Mangrove. Each location consisted of two sampling points: dock and estuary. Water and Jeruju leaf samples (upper, middle, and lower parts) were analyzed for Cu concentration using Atomic Absorption Spectroscopy (AAS). Environmental parameters were also measured. The results showed that Cu concentration in water samples was very low and only detected at Gunung Anyar dock (0.001 ppm). However, Cu accumulation in Jeruju leaves varied, with the highest concentration (3.16 ppm) found in lower leaves at Gunung Anyar dock. The correlation between water quality parameters, particularly pH and TDS, and Cu concentration indicated that Jeruju can effectively accumulate Cu and serve as a potential phytoremediator and bioindicator in polluted Mangrove ecosystems.

1. INTRODUCTION

The increasing human demand for natural resources has led to environmental degradation, particularly water pollution caused by industrial, Mining, and transportation activities. Liquid waste that is directly discharged into the environment without treatment contributes significantly to aquatic pollution. One of the ecosystems most affected by pollution is the Mangrove ecosystem (Purnobasuki, 2011).

According to the Surabaya Environmental Status Report (SLHD, 2011), the mangrove ecosystem in Surabaya is critically threatened. The Wonorejo Mangrove area experienced 27% degradation, while Gunung Anyar conservation area saw 18.5% degradation. Wulandari (2016) found that heavy metals in the sediments, waters, and biota in the eastern coast of Surabaya exceeded FAO/WHO thresholds, indicating chronic toxicity risks to marine life.

Among these pollutants, copper (Cu) is a common and hazardous heavy metal. It originates from industrial activities such as textile and electroplating industries. In aquatic environments, excessive Cu accumulation poses serious threats to organisms. To remediate such contamination, phytoremediation using plants capable of absorbing heavy metals has been proposed (Rahayu, 2021).

Acanthus ilicifolius (Jeruju) is a mangrove species with high potential for heavy metal accumulation. Irawanto et al. (2015) reported that Cu primarily accumulates in the roots of Jeruju.

This study explores the potential of Jeruju as a phytoremediator and bioindicator of Cu pollution in Surabaya's Mangrove waters.

2. MATERIALS AND METHODS

This field research was conducted in three mangrove areas in Surabaya: Gunung Anyar Tambak, Surabaya Mangrove Botanical Garden, and Wonorejo Mangrove. Each location had two sampling points: the dock and estuary. Samples collected included water and Jeruju leaves from three parts of the plant: upper, middle, and lower. Measurements of environmental parameters were conducted, and heavy metal content was analyzed using Atomic Absorption Spectroscopy (AAS). The data were analyzed descriptively.

Figure 1. Sampling Locations in the Mangrove Areas of Surabaya (Gunung Anyar Tambak, Surabaya Mangrove Botanical Garden, and Wonorejo Mangrove)

Instruments Used: pH meter, TDS Meter, thermometer, nets, scissors, plastic bottles, analytical balance, blender, trays, oven, aluminum foil, Measuring glasses (10 ml), stir rods, beakers (100 ml), jeldals, funnels, crucibles, volumetric flasks (50 ml & 100 м), erlenmeyer flasks (100 ml), sample bottles (100 ml). furnace, Microwave extractor, AAS. Materials Used: Jeruju leaves, river water, distilled water, Cu standard solution, filter paper, Nitric Acid (HNO3), and H202. Data Analysis: Descriptive analysis was used to Summarize observational and laboratory test data. Data presented include Cu concentrations in plant tissues and water, and environmental quality parameters.

3. RESULTS AND DISCUSSION

3.1. Result 1 Cu Concentration in Water and Leaves

Table 1. Copper (Cu) Concentrations in Water and Jeruju Leaves in Three Mangrove Areas of Surabaya

No.	Research Location	Copper (Cu) Concentration Water (mg/L)	Jeruju Leaves (mg/kg)		
			Upper	Middle	Lower
1	Mangrove Waters of Gunung Anyar Tambak	<0.001	0.001	1.75	3.02
		0.001	1.03	2.42	3.16

No.	Research Location	Copper (Cu) Concentration Water (mg/L)	Jeruju Leaves (mg/kg)		
			Upper	Middle	Lower
2	Mangrove Botanical Garden Surabaya (Kebun Raya Mangrove)	<0.001	1.11	1.73	1.05
		<0.001	2.38	0.91	0.02
3	Mangrove Waters of Wonorejo	<0.001	0.04	0.01	0.015

Cu was only detected in the water sample from Gunung Anyar dock (0.001 ppm), which is below the threshold of 0.02 ppm (PP RI No.82/2001). In contrast, Cu concentration in Jeruju leaves was higher, with the highest value (3.16 ppm) found in lower leaves at Gunung Anyar dock. This is still below the 5.0 ppm threshold for safety in medicinal plants (Ditjen POM Depkes No: 03725/B/SK/VII/89). This indicates that Cu tends to accumulate in plant tissues rather than in water, as supported by Nabila (2023). Cu accumulation occurs through a multi-step physiological process including rhizospheric interaction, absorption, translocation, sequestration, and complexation (Hidayati, 2020). The presence of phytochelatins, synthesized under heavy metal stress, facilitates this accumulation. Low Cu values (<0.001 ppm) were observed in upper leaves at the Gunung Anyar estuary and both upper and middle leaves at Wonorejo dock. Environmental factors such as high pH and low TDS values likely contribute to these lower concentrations.

3.2. Result 2 Correlation of Cu and Environmental Quality Parameters

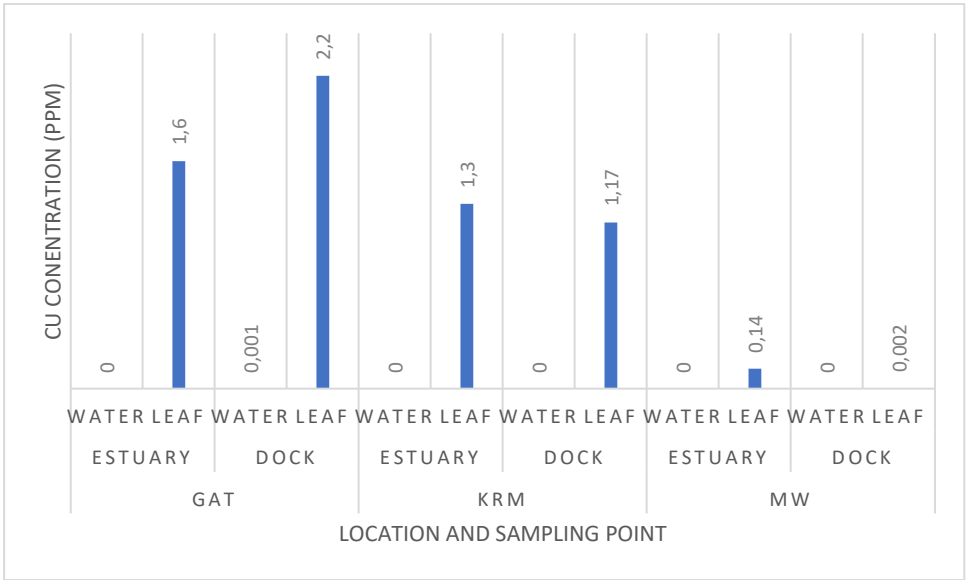

Figure 2. Correlation of Copper (Cu) Concentration in Water Samples and *Acanthus illicifolius* Leaves in Surabaya Mangrove Waters

Cu levels in leaves correlated with environmental quality data. Gunung Anyar dock, which had the highest Cu concentration, also showed the lowest PH (6.73) and highest TDS (9268 mg/L). These conditions support higher metal solubility and bioavailability, as reported by Suryan et al. (2015) and Ganiyu et al. (2021). In contrast, Wonorejo's higher pH and lower TDS values corresponded with lower Cu accumulation, reinforcing the influence of these environmental parameters on metal bioavailability and uptake.

4. CONCLUSIONS

Jeruju (Acanthus ilicifolius) demonstrated the ability to accumulate copper (Cu) in its tissues, with the highest concentrations found in leaves from Gunung Anyar dock, where environmental conditions supported higher Cu presence. The correlation between environmental parameters (pH and TDS) and Cu concentration further supports the role of Jeruju as an effective phytoremediator and bioindicator of Cu contamination in mangrove ecosystems. This study suggests the application of Jeruju in environmental Monitoring and phytoremediation efforts in polluted coastal areas.

5. ACKNOWLEDGMENTS

The author would like to thank those who helped in terms of writing and financial support for the research.

6. REFERENCES

Hidayat, D., Suprianto, R., & Dewi, P. S. (2016). Penentuan kandungan zat padat (total dissolve solid dan total suspended solid) di perairan Teluk Lampung. Analit: Analytical and Environmental Chemistry, 1(1).

Irawanto, R. dan S. Mangkoedihardjo. (2015). Fitoforensik Logam Berat (Pb Dan Cd) Pada Tumbuhan Akuatik (Achantus ilicifolius dan Coix lacryma-Jobi). Jurnal Purifikasi. 15 (1) : 55 – 66

Nabila, S., Agustina, E., Purnamasari, R., & Irawanto, R. (2023). Efektivitas Tanaman Daun Tombak (Sagittaria lancifolia) dalam Fitoremediasi Linear Alkylbenzene Sulfonates (LAS) pada Media Air. BIOMA: Jurnal Biologi dan Pembelajarannya, 5(1), 27-35.

Purnobasuki, H. (2011). Ancaman terhadap hutan mangrove di Indonesia dan langkah strategis pencegahannya. Bulletin PSL Universitas Surabaya, 25(2011), 3-6

Rahayu, F. R. (2020). Efektifitas Tumbuhan Jeruju (Acanthus ilicofolius) dalam Mengabsorbsi Zat Pencemar LAS (Linier Alkylbenzene Sulfonate dengan Adanya Logam Berat (Pb dan Cd).

Wulandari, S. H. E., & Hariadi, B. (2016). LPM: Smart Mangrove, IbM Pantai Timur Surabaya untuk mendukung Konservasi Mangrove.