JPPIPA 12(11) (2026)

Jurnal Penelitian Pendidikan IPA

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The Effect of Liquid Waste from Traditional Sasirangan Textile Production on Water Quality and Aquatic Organisms to Support SDGs 6 Action

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Received: July 25, 2026
Revised: October 21, 2026
Accepted: November 23, 2026
Published: November 30, 2026

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DOI: 10.29303/jppipa.v12i11.16111

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Abstract: The Sasirangan textile industry, a vital cultural heritage of South Kalimantan, frequently discharges untreated liquid waste containing synthetic dyes that threaten local aquatic ecosystems. This study evaluated the impact of traditional Sasirangan textile wastewater on water quality parameters and the responses of aquatic organisms using a quasi-experimental laboratory approach at Universitas PGRI Kalimantan. Waste samples collected from Sasirangan Village were applied at three concentrations: 20% waste, 50% waste, and 80% waste, alongside a control group. Water quality parameters (pH, DO, and temperature) were measured before and after treatment, while responses of *Hydrilla* sp., *Eichornia crassipes*, and *Oreochromis niloticus* were monitored visually and behaviorally. Results showed progressive water quality degradation with increasing waste concentration, characterized by declining pH and dissolved oxygen. Aquatic plants demonstrated greater tolerance than fish. *Hydrilla sp*. exhibited yellowing leaves at Treatment A, stunted growth at Treatment B, and partial wilting at Treatment C. *Eichornia crassipes* showed active root growth stimulation at Treatment A, slight leaf tip yellowing at Treatment B, and severe wilting with root sloughing at Treatment C. *Oreochromis niloticus* demonstrated the highest sensitivity, showing compensatory hyperventilation and stress at Treatment A, rapid physiological collapse and death at Treatment B, and acute lethal toxicity at Treatment C. These findings confirm that unprocessed Sasirangan textile waste significantly degrades aquatic water quality and threatens aquatic biodiversity, with *Oreochromis niloticus* serving as a more sensitive bioindicator.

Keywords: Aquatic organisms; Dissolved oxygen; pH; Sasirangan waste; Water quality

Introduction

Clean and sustainability managed water is recognized as a fundamental aspect in global development, formalized under Sustainable Development Goals (SDGs) number 6, which calls for ensuring the availability and sustainable management of water and sanitation for all (Biswas et al., 2022; Ortigara et al., 2018). Among the targets, SDG 6.3 specifically call for improving water quality by reducing pollution, and minimizing the release of chemicals hazardous into water bodies (Puijenbroek et al., 2023). Freshwater ecosystems continue to face mounting pressure from textile production industries waste, particularly from sectors that rely on water and chemicals dyes during the production process (Lellis et al., 2019; Stone et al., 2020; Wiryawardhana et al., 2026). In Indonesia, the textile production waste not only from large-scale industries, but also from small-scale industries (home industry), that mostly didn't have adequate waste treatment infrastructure (Purwaningrum et al., 2023). These smaller textile producers, while economically vital at local level, frequently discharges the textile waste without treatment, compounding pollution pressures on rivers. This gap between global water quality commitments and local industrial practice is particularly

How to Cite:
Nefianthi, R., Adawiyah, R., & Lestari, N. C. (2026). The Effect of Liquid Waste from Traditional Sasirangan Textile Production on Water Quality and Aquatic Organisms to Support SDGs 6 Action. *Jurnal Penelitian Pendidikan IPA*, *12*(11), 121–128. https://doi.org/10.29303/jppipa.v12i11.16111

evident in traditional, culturally rooted textile industries, which received comparatively little scientific attention relative to their large-scale industrial counterparts (Zakaria et al., 2023).

The textile industry produces liquid waste that degrades water quality due to the presence of synthetic dyes and other chemicals that are difficult to decompose naturally (Astuti et al., 2023; Sudarshan et al., 2023). This waste often has an unstable pH, high levels of dissolved solids, and toxic substances to aquatic organisms (Astuti et al., 2023; Periyasamy, 2024). Textile dyes can also increase oxygen demand in water, affecting the water's physical and chemical conditions and the availability of oxygen for living organisms (Wei et al., 2020). These conditions pose a real threat to healthy and sustainable aquatic ecosystems.

Changes in water quality parameters such as pH, dissolved oxygen (DO), and temperature are key indicators for assessing pollution levels and the functioning of aquatic ecosystems (Hamuna et al., 2018; Kurniawan et al., 2026; Mosi et al., 2024; Supardiono et al., 2023). When the textile waste enters water bodies, these parameters often experience sharp fluctuations, exceeding the tolerance levels of aquatic organisms. For example, a decrease in DO due to increased pollutants can cause physiological stress in aquatic organisms and reduce the habitat's capacity to support aquatic life (Mahajan et al., 2019; Mojiri et al., 2023).

Exposure to textile wastewater can also accumulate hazardous materials in organisms' tissues through bioaccumulation, which can then impact higher trophic levels, including humans, through the food chain. This bioaccumulation indicates that the impact of wastewater not only occurs at the individual organism level but can also have broader ecological and health implications if contaminated organisms are consumed (Hoque et al., 2024). Therefore, controlling and treating textile wastewater is an important step to prevent long-term risks to aquatic ecosystems and human health.

The relationship between changes in water quality and the responses of aquatic organisms is a crucial aspect to understand in assessing the overall ecological impact of textile wastewater, as changes in the physical and chemical conditions of water are often directly related to the survival of test organisms (Ceretta et al., 2021). Research that combines analysis of environmental parameters with organismal responses allows for a more holistic interpretation of how pollution impacts the entire aquatic ecosystem, including organism health and community structure (Durojaiye et al., 2024).

The novelty of this research lies in its focus on the wastewater from traditional sasirangan textiles, which are based on local traditional dyeing practices but also produce wastewater that can pollute local water bodies. This type of wastewater has not been widely investigated in a scientific context compared to wastewater from large textile industries, so this study fills an important gap in the scientific literature while providing context for local wisdom. The problem-solving approach in this research is experimental, measuring the physical and chemical parameters of water before and after exposure to sasirangan wastewater, as well as systematically observing the responses of aquatic organisms. This experimental method allows for scientific interpretation of the research findings and provides a concrete picture of the impacts of this wastewater.

This research will address the stated research questions: analyzing changes in water quality, understanding the physiological responses and conditions of aquatic organisms to traditional sasirangan textile wastewater, and identifying the relationship between water quality changes and organism responses. The results are expected to contribute to scientific understanding of the impacts of traditional wastewater on aquatic ecosystems and to recommendations for management policies relevant to the local context, and to support SDG 6 action about improving water quality by reducing pollution and minimizing hazardous chemical releases.

Methods

This study employed a laboratory experimental approach with a quasi-experimental design. This approach was chosen to determine the effect of exposure to traditional sasirangan cloth wastewater on water quality and the responses of aquatic organisms under controlled conditions (Manenti et al., 2015; Yaseen & Scholz, 2018). The study design experiment treatments with varying concentrations of sasirangan wastewater. The independent variable in this study was the concentration of sasirangan wastewater (20; 50; and 80%) (Nurhalisa et al., 2023), while the dependent variables included water quality parameters and the responses of aquatic organisms.

The research was conducted in the Biology laboratory at Universitas PGRI Kalimantan, Banjarmasin. The Biology Laboratory is located at Universitas PGRI Kalimantan (UPK). Meanwhile the sasirangan textile waste samples are being collected from Sasirangan Village (the sasirangan textille production area). This location was selected because this is the center of sasirangan textile production in Banjarmasin. The sasirangan waste used came from the traditional sasirangan cloth dyeing process and was used without further processing.

The subjects of this study included aquatic organisms, the aquatic organisms that being used are

Eichhornia crassipes and *Hydrilla* sp. and *Oreochromis niloticus*. The research object was water quality and the biological responses of aquatic organisms to exposure to sasirangan wastewater. The research samples were selected using purposive sampling. The data obtained were analyzed using quantitative and qualitative descriptive analysis. Water quality data were presented in tabular form to demonstrate trends in changes resulting from waste treatment. Aquatic organism responses were analyzed descriptively based on the patterns of change observed in each treatment. The relationship between changes in water quality and aquatic organisms' responses was logically interpreted using theories of environmental toxicology and aquatic ecology.

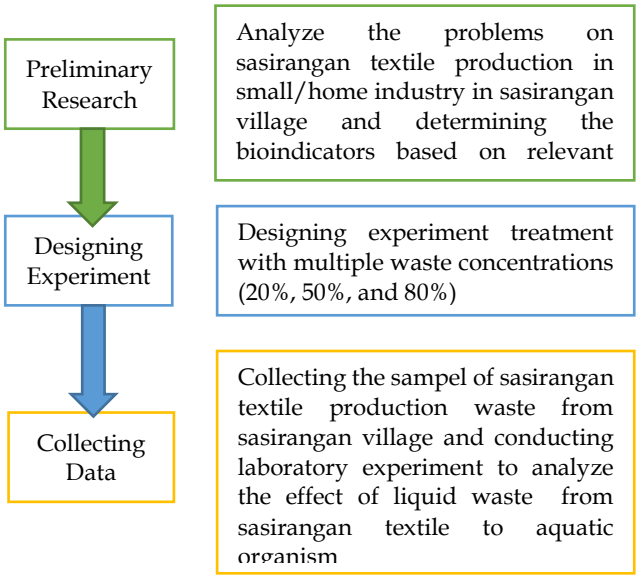

Figure 1. Research flowchart

Result and Discussion

This research objective was to analyze the effect of liquid waste from sasirangan textile production without further processing on aquatic organisms such as *Hydrilla* sp., *Eicchornia Crassipes*, and *Oreochromis Nilocticus*. Sasirangan textile production is a traditional batik from Banjarmasin. Every day, there are a lot of home industries producing sasirangan through dyeing processes that use chemicals, which also generate a lot of waste. The sasirangan textile waste is directly disposed of without further processing, which can endanger the river ecosystem and affect the aquatic organisms. In this research, the aquatic organisms are used as experiment subject to analyze the effect that caused by the sasirangan waste.

Before experimenting in the laboratory, the researcher first went to the sasirangan textile production area, namely Sasirangan Village in Banjarmasin City. The researcher observed the production process from the early stages until the dyeing process and finishing. The researcher also conducted an interview with one of the sasirangan home industry owners. When the owner was asked about the main problem of processing the waste from sasirangan production, it was about the high cost of waste treatment and also the maintenance cost. Which become a big problem for small industries because of the limited home industry funds. The city government should be more aware and address this problem more seriously. It would be better if there's a direct education action of the waste hazardous effect to environment and subsidies for supporting this waste further processing for home industries. The following figure will show the activity during observation and interview process with one of the home industry owners.



Figure 2. Sasirangan colouring process



Figure 3. Interview with home industries owner

After collecting the waste sample, the researcher continues the research into a laboratory activity to conducting the experiment with waste samples and its effect to the aquatic organisms. In this research, the researcher divided the experiment treatment into three different concentrations; 20% waste, then 50% waste, and 80% waste concentrations and one control treatment. Observed water quality parameters included

pH, dissolved oxygen (DO), and temperature. The aquatic organisms' responses were observed through changes in the plants' physiological and the fish behavior during the treatment process.

Hydrilla sp. Observation

Table 1. *Hydrilla sp*. observation result

Exp.	Phase	pH	DO	Temp.	Condition
Control	Pre	7.20	6.81	25.5	Fresh plant
	Post	7.45	7.62	25.6	Normal growth
A	Pre	6.50	5.82	25.5	Fresh plant
	Post	5.80	4.20	25.7	Yellowing leaves
B	Pre	5.20	4.53	25.5	Fresh plant
	Post	4.30	2.82	25.8	Stunted growth
C	Pre	4.10	3.20	25.6	Fresh plant
	Post	3.40	1.56	25.7	Partially wilted

Based data on Table 1 observation result of *Hydrilla* sp., the control treatment show stable pH value and DO from the water, while in the treatment A, B, and C showed the waste affected the pH into a very acidic, while the dissolved oxygen also decreased into a very low value during the experiment. The higher concentrations of waste, the lower value of pH and dissolved oxygen. In the A treatment with 20% waste concentrations, pH values drop from 6.50 into a 5.80, DO values also drop from 5.82 into 4.20. While, the *Hydrilla* sp. experienced a yellowing leaf. Then, in the B treatment with higher concentration of 50% waste, pH value drops from 5.20 into 4.30, DO value drop from 4.53 into 2.82. While, the *Hydrilla* sp. experienced stunted growth. After that, in treatment C with 80% waste concentration, pH value drops from 4.10 to 3.40, DO value drop from 3.20 to 1,56 and during the process the *Hydrilla* sp, experienced a partially wilted.

The decreasing of pH values in all waste treatments indicate the acidic compounds in sasirangan waste. This process can be damaged the aquatic plants and microorganisms due to chemicals from textile dyes which affected the nutrient that absorbs by the plant and also damaged the cell membranes and tissues (Al-Tohamy et al., 2022). The decrease in dissolved oxygen levels in treatments A, B, and C indicates increased oxygen consumption by microorganisms during the degradation of waste. High microbial respiration activity can reduce oxygen availability for aquatic plants (Al-Tohamy et al., 2022; Sari et al., 2026). Changes in the visual condition of *Hydrilla* sp. Yellowing leaves, stunted growth, and partial wilting indicate a physiological stress response due to changes in water quality. Aquatic plant stress is often associated with oxygen limitation and the accumulation of toxic compounds in aquatic environments (Dubey et al., 2022; Lestari & Aminatun, 2018; Sari et al., 2026). These conditions indicate that although *Hydrilla* has phytoremediation potential, its tolerance remains limited to certain waste concentrations, based on this data 50% concentrations of waste are the limit of *Hydrilla* sp. tolerance. Because at 50% concentrations indicates that the plant remains alive but its growth is stunted, whereas an 80% level results in partially wilting, indicating more permanent tissue damage.

Eicchornia crasippes Observation

Table 2. *Eicchornia crassipes* observation result

Exp.	Phase	pH	DO	Temp.	Condition
Control	Pre	7.15	8.10	25.5	Fresh plant, healthy roots
	Post	7.18	7.81	25.8	Fresh plant, healthy roots
A	Pre	6.50	6.41	25.5	Fresh plant
	Post	6.00	5.82	25.7	Fresh plant, active root growth
B	Pre	5.80	5.13	25.5	Fresh plant
	Post	4.90	4.51	25.8	Slightly yellow leaf tips, roots intact
C	Pre	4.30	3.20	25.6	Fresh plant
	Post	3.60	1.80	26.0	Severe wilting, brown leaves, root sloughing

Based data on Table 2 observation result of *Eicchornia Crassipes*, the control treatment show stable pH value and DO from the water, while in the treatment A, B, and C showed the waste affected the pH into a very acidic, while the dissolved oxygen also decreased into a very low value during the experiment same with the other experiments with *Hydrilla*. The higher concentrations of waste, the lower value of pH and dissolved oxygen. In the A treatment with 20% waste concentrations, pH values drop from 6.50 into a 6.00, DO values also drop from 6.41 into 5.82. While, the plant remains fresh and didn't shows any stress responses. Then, in the B treatment with higher concentration of 50% waste, pH value drops from 5.80 into 4.90, DO value drop from 5.13 into 4.51. While, the plant experienced a slightly yellow leaves but the roots still intact. After that, in treatment C with the highest concentrations of 80% waste, pH value drops from 4.30 to 3.60, DO value drop from 3.20 to 1,80 and during the process the plant, experienced a severe wilting with brown leaves and root sloughing.

The accumulation of toxic compounds from sasirangan waste can damage leaf tissue and root systems. This condition reduces the plant's ability to absorb nutrients and maintain metabolic balance (Ghanaim et al., 2025; Ogugbue & Sawidis, 2011). The response of *Eichhornia crassipes* to sasirangan waste indicates that this plant has phytoremediation potential at low to moderate concentrations. Excessively high waste concentrations actually cause tissue damage and plant death.

Oreochromis niloticus Observation

Table 3. *Oreochromis niloticus* observation result

Exp.	1st min	3rd min	5th min	Cond.
Control	Active normal	Active and operculum stable	Active and Fresh	Alive
A	Initially active (±12x/min)	Slow movement and gasping (±41x/min)	Very weak (±31x/m)	Alive (stress)
B	Restless and rapid operculum movement (±42x/min)	Lethargis (±5x/min)	Not moving	Dead
C	Very restless	Not moving	Not moving	Dead

Based on Table 3., the response of *Oreochromis niloticus* showed clear differences between treatments exposed to traditional sasirangan cloth wastewater. In the control treatment (0% wastewater), fish continued to swim actively with a stable operculum frequency until the end of the observation, and the fish survived. In the treatment with a 20% wastewater concentration, fish began to show signs of discomfort. It can be seen from the changes swimming patterns in early minutes. Then, after the third minutes the fish movement become slower and start gasping with operculum rate ±41x/min. After that, in the fifth minutes the fish looked very weak, and the operculum rate become slower into ±31x/min, but until the end of A treatment the fish remain alive despite showing signs of stressed. This delayed hyperventilation pattern is consistent with sub-lethal adaptive responses documented in Oreochromis niloticus exposed to industrial wastewater (Abdel-Tawwab et al., 2019; McBryan et al., 2013). Textile waste chemicals are known to disrupt gill function and reduce gas exchange efficiency, contributing to progressive respiratory stress (Al-Tohamy et al., 2022).

In the treatment B with higher concentrations of sasirangan waste with 50%, the fish instantly show signs of distress after swimming in the higher sasirangan waste concentrations. In the first minutes, the fish looked restless and rapid operculum movement with ±42x/min. Then, after the third minutes, the fish looked lethargic and operculum movement very weak with only ±5x/min, indicating rapid physiological collapse. After that, in the fifth minutes the fish looked did not move, and in the end, experiment process the fish dead. The dramatic decline in operculum rate from ±42x/min to ±5x/min within two minutes demonstrates the rapid progression from acute stress to respiratory failure at near-lethal concentrations.

Meanwhile, in the highest concentrations of sasirangan waste on treatment C the fish showed more severe responses. In the first minutes, the fish looked very restless after experiencing a deteriorating water quality with higher waste concentrations, which caused pH and DO values drop that can affecting the fish respiratory systems failure. After the third minutes, the fish completely motionless at the bottom, consistent with acute narcosis at lethal concentrations. And after the fifth minutes, the fish dead. Fish subsequently died before the end of the observation period, confirming that 80% waste concentration represents an acutely lethal environment for *Oreochromis niloticus*. The following figure will show some laboratory documentation during experiment process.



Figure 4. Preparation



Figure 5. Mixing Sasirangan waste and water



Figure 6. *Oreochromis niloticus* experiment

Based on this research data findings, it can be seen that between the aquatic organism (*Hydrilla* sp.,

Eicchornia Crassipes, and *Oreochromis Niloticus)* revealed a consistent dose response pattern to low water quality due to sasirangan textile contaminations. The higher concentrations of waste produced progressively greater physiological stress and damage. These water quality changes into acidification and oxygen depletion represent the primary mechanisms through which sasirangan textile affect the aquatic ecosystem. However, the degree of sensitivity differed markedly between each species. Between these three aquatic organisms, *Eicchornia Crassipes* showed more tolerance to the sasirangan waste during the experiment. During the experiment from low to moderate level concentrations the plants only experienced slightly yellow leaves but the roots still intact. One of the reasons is because this plant didn't fully submerged into the water. While, *Hydrilla* sp. fully submerged into the water that contained sasirangan waste that can cause damaged into the entire plant body. *Eicchornia Crassipes* as a floating plant, keeps the leaves and photosyntetic tissues above the water surfaces.

Meanwhile, *Oreochromis Niloticus* showed the highest sensitivity compared to the plants, confirming that the fish more responsive as bioindicators to the low water quality due to sasirangan waste contaminations (Iskandar et al., 2024; Nurhalisa et al., 2023). It can be explained by several factors, the waste contaminations can disrupt fish respiratory gas exchanges through gill structures, making them immediately vulnerable to chemicals that contained in sasirangan waste (Al-Tohamy et al., 2022). Even more, the declined in dissolved oxygen caused by the sasirangan waste, directly threatens fish survival through hypoxia (Abdel-Tawwab et al., 2019; McBryan et al., 2013), whereas aquatic plants still can partially compensate through photosynthesis or using atmosferic oxygen access in *Eicchornia Crassipes* case. In the end, the responses from the three aquatic organisms confirm that untreated sasirangan waste even at the low level concentrations can damage aquatic organisms. These results reinforce the urgent need for waste treatment implementation in traditional Sasirangan textile production before discharge into water bodies, directly supporting SDG 6 Target 6.3 on reducing water pollution from industrial sources.

Conclusion

Based on the research data, it can be concluded that the untreated sasirangan textile production waste cause a progressive, dose-dependant degredation fo water quality (acidification and dissolved oxygen depletion) and corresponding physiological stress across three aquatic organisms. Based on the research data, *Oreochromis niloticus* is the most sensitive aquatic organisms followed by *Hydrilla* sp. and *Eicchornia crassipes*. The fish showing acute stress mortality even at the low level concentrations with 20% of sasirangan waste. While, *Eicchornia crassipes* shows greater tolerance due to its floating morphology and atmosferic oxygen access. These research findings demonstrate that even dilluted sasirangan textile waste poses measurables ecological risks across trophic levels, highighting the urgent need for waste treatment before discharge into water bodies in traditional sasirangan textile industries in Banjarmasin.

Acknowledgments
The author would like to express sincere gratitude to the team from Universitas PGRI Kalimantan who have contributed a lot this research until it can be completed. The author also gratefully acknowledges the support and encourage that provided by the family and friends throughout the research process.

Author Contributions
R.N: literature review, methodology; R.A.: writing original draft preparation, review, and editing; and N.C.L.: collecting data, data analysis.

Funding
No external funding.

Conflicts of Interest
The authors declare that there's no conflict of interest regarding the publication of this paper.

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