# Temperature and Mass Variations in the Utilization of Water Hyatong with and without Processing as an Adsorbent for Textile Dyes (Yellow) Y FG R

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## ABSTRACT

Every human activity produces liquid waste or solid waste or gas, small-scale waste does not cause problems but large-scale waste that will cause problems that can disrupt environmental balance, including liquid waste that can disrupt aquatic ecosystems both in rivers and at sea. The purpose of this study is to obtain the optimum conditions for absorption capacity against the influence of temperature and concentration as well as the absorption capacity of processed water hyacinth plants. Because in industries such as the woven fabric industry in the city of Palembang, it produces liquid waste in the form of residual water from soaking textile dyes which are sometimes discharged directly into residents' waters or also discharged into rivers which ultimately has a negative impact on the surrounding environment which makes water that functions as the main source of daily life can be problematic because the water may have been contaminated by waste, therefore the purpose of this study can at least reduce water pollution in residents' waters and even river water. The data collected comes from the dye analysis method based on the theory developed by Yassir (2011). The purpose of this study is to use textile dye Y FG R (yellow) and the testing will be carried out every 0, 1 and 7 hours for a maximum time with an HCL concentration of 0.5 with each sample of water hyacinth 2, 3, 4 grams as an absorbent material with the addition of temperature variables of 40 oC and 50 oC so as to obtain the results.

## INTRODUCTION

Judging from the condition and potential of Indonesia's natural resources, it is clear that Indonesia possesses a diverse range of natural resources that can be managed. For example, marine resources, rivers, forests, and resources found within the earth's crust. In this regard, the water hyacinth plant can be beneficial. However, in reality, water hyacinth is often considered a weed that grows abundantly in small rivers and swamps, often seen in our homes. Water hyacinth has been widely used as a material for making bags and handicrafts, and research has been conducted into the potential use of water hyacinth fiber as an adsorbent.

Traditional weaving, highly sought after by the community, is a source of income that can boost regional revenues in South Sumatra. The traditional weaving process also produces liquid waste containing dyes that can pollute the environment, especially aquatic environments, creating problems that require careful management (Tangendj aya, 1998).

Several scientific studies have shown that water hyacinth can neutralize heavy metals in water, providing shelter for fish, spawning grounds, and other uses. Technologically, water hyacinth has a high fiber content. This fiber can be used commercially, from traditional to sophisticated industries. Water hyacinth is a raw material for folk crafts and is highly sought after by foreign tourists. Industrial studies have shown that water hyacinth can be used as a raw material for fiberboard, pulp, and paper industries.

Thus, it is hoped that water hyacinth can also absorb textile dyes from wastewater from the weaving industry. Water hyacinth is abundant in riverbanks and swamps on the outskirts of Palembang, such as the Jakabaring River basin in Palembang. Among the variables influencing the adsorption process are contact time and the

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concentration of activating agents, such as HCl and S2SO4. The sample used was wastewater from the dyeing process of the woven fabric industry in Palembang.

The results showed that 1 gram of water hyacinth as an adsorbent can adsorb 0.9–1.2 mg of dye at 20 ppm per 100 ml. This demonstrates that water hyacinth can adsorb even small concentrations. The maximum adsorption time was reached after 7 hours, with 0.9–1.2 mg adsorbed per hour, reaching a maximum adsorption time of 7 hours. The greater the acid concentration, the better it is for absorption and the longer the absorption time, the more it will be absorbed until it cannot absorb any more (Yassir, 2011).

**Einchonirnia Crassipes**

Water hyacinth is a plant that floats on water and sometimes roots in the soil. It grows to a height of about 0.5 meters.

Due to its significant growth rate, water hyacinth can be considered a pollutant in aquatic ecosystems. This plant easily spreads along the water surface through currents. If water hyacinth can grow and spread above water containing waste from factories or farms, its growth will increase. Consequently, the extent of water hyacinth in an area is often an indicator of pollution.

Figure 1. Water hyacinth (Einchonirnia Crassipes)

**Water Hyacinth Cleans Heavy Metal Pollutants**

Water hyacinth is often known as a weed. However, water hyacinth actually has the ability to absorb heavy metals. The Citarum River, as well as the Saguling and Cirata reservoirs in Bandung Regency, are polluted with heavy metals. Mercury (Hg), copper (Cu), and zinc (Zn) were found in the flesh of carp and tilapia living in these reservoirs at dangerous levels. These heavy metals were found to be concentrated in the stomachs, fat, and flesh of the fish.

**Cellulose**

Cellulose is a long-chain polysaccharide carbohydrate polymer based on beta-glucose. Cellulose is the main structural component of plants and cannot be digested by humans. Cellulose is the most abundant organic compound on Earth, made directly from glucose units. Glucose undergoes chemical modification by removing one water molecule from each unit, forming glucose anhydride, which then bonds with each other. Cellulose then forms the fibrous component of plant cell walls. The rigidity of cellulose is due to its overall structure.

The following are results from the Center for Research and Development of the Cellulose Industry, showing the lignin and cellulose content of various plants.

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Table 1 Cellulose and Lignin Content of Several Plants

| No. | Tanaman | Lignin (%) | Selulosa (%) |
|---|---|---|---|
| 1. | Eceng Gondok | - | 62,8 |
| 2. | Pisang Abaka | 9,70 | 63,90 |
| 3. | Jerami | 11,49 | 35,44 |
| 4. | Ampas Tebu | 19,70 | 44,70 |
| 5. | Akasia | - | 55,69 |

Source: Joedodibrota,R.

**Dyes**

Dyes are organic compounds consisting of a color-carrying group (chromophore) and a color-intensifying group (auxochrome). Organic compounds containing these two groups can absorb light at specific wavelengths and reflect their complementary colors (Peter, 1975). Therefore, the color seen by the eye is not the color absorbed by the dye, but rather its complementary color.

Table 2. Wavelength Division of Visible Colors and Their Complementary Colors

| A(nm) | Warna | Wama Komplementer |
|---|---|---|
| 400-424 | Ungu | Hijau-Kuning |
| 424-491 | Biru | Kuning |
| 491-570 | Hijau | Merah |
| 500-585 | Kuning | Biru |
| 585-647 | Jingga | Hijau-Biru |
| 647—700 | Merah | Hijau |

Source: Fessenden R.J and Fessenden 1989, "Organic Chemistry" Volume 2, Edition

**Natural Dyes**

Natural dyes are traditionally obtained through the extraction/boiling of locally available plants. Plant parts that can be used for natural dyes include bark, twigs, leaves, roots, flowers, seeds, or sap.

**Textile Dyes**

The discovery of synthetic dyes began in 1856, when William Perkins discovered mauvein, a compound obtained by oxidizing impure aniline. This dye is a basic dye that can dye animal fibers directly.

**Dyes Composition**

Based on their chemical composition, dyes can be divided into 1 type, namely:

1. Acid dyes are sodium salts of organic acids such as carboxylic acids and are used in acidic environments. The color-carrying group (chromophore) in these dyes is an anion, so they are called anionic dyes.
2. Basic dyes are chloride or oxalate salts of organic bases such as ammonium. Because the primary carrier group is a cation, these dyes are sometimes called cationic dyes.
3. Direct dyes consist of azo compounds commonly used to dye cellulose fibers.
4. Mordant and metal complex dyes. These dyes do not penetrate textile fibers, but can combine with metal oxides to form water-insoluble compounds.
5. Sulfur dyes are complex organic compounds containing sulfur in their chromophore and auxochrome systems. The colors produced by dyeing with these dyes are usually suramic.
6. Vapor dyes are water-soluble dyes that react with reducing compounds such as NaOH and NaHS03.

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7. Disperse dyes are used to dye hydrophobic fibers.
8. Reactive dyes can react with textile fibers, especially cellulose and protein fibers, resulting in excellent colorfastness. The reactivity of these dyes varies; some can be used at low temperatures, while others require high temperatures.
9. Naphthol dyes are commonly used to dye cellulose fibers with bright colors.
10. Pigment dyes are dyes that can color textile fibers after being mixed with resin as a binder. Due to the presence of resin, the resulting materials and dyeing with these dyes are usually stiff and less effective.
11. Oxidation dyes are compounds with low molecular weight which are dyed in an acidic environment to form larger, insoluble colored molecules.

**Waste Sources**

The starch removal solution is usually disposed of directly and contains starch and starch-depleting chemicals, PVA, CMC, enzymes, and acids. Starching typically produces the highest BOD compared to other processes.

Table 3 Characteristics of Dyeing Wastewater

| PARAMETER | JUMLA KANDIJNGAN | SATUAN( C) |
|---|---|---|
| Suhu | 29-35 | C |
| | 6,8 | |
| COD | 1712,7- 1793 | Mg/liter |
| BOD | 159,7- 168 | Mg/liter |
| TTS | 1233,7 1373 | Mg/liter |

Source: Textile Waste Pollution Control Prototype

Table 4 Standard Wastewater Quality Criteria

| | SATUAN | 1 | 11 | 111 | |
|---|---|---|---|---|---|
| | Mutu air | Baik | Sedang | Kurang | Kurang Sekali |
| Fisika :<br>Residu<br>Kimia :<br>COD<br>Biologi •<br>BOD | Mg/liter<br>Mg/liter<br>Mg/liter | 100<br>20<br>6-9<br>40 | 200<br>100<br>5-9<br>200 | 400<br>300<br>4,5-9,5<br>500 | 500<br>500<br>4—10<br>1000 |

Source: Textile Waste Pollution Control Prototype

**General Adsorption**

Adsorption, in general, is the process of agglomerating a dissolved substance in a solution onto the surface of an absorbent substance or object, where a physical-chemical bond forms between the substance and the adsorbent. Adsorption can be divided into two categories:

a. Physical adsorption, which is related to van der Waals forces and is a reversible process. If the attractive force between the solute and the adsorbent is greater than the attractive force between the solute and the solvent, the dissolved substance will be adsorbed on the surface of the adsorbent.
b. Chemical adsorption, which is: a reaction that occurs between a solid and the adsorbed solute.

**UV/VIS Spectrophotometer**

Spectrophotometry is a chemical analysis method based on the interaction between electromagnetic radiation and matter. This interaction takes the form of absorption followed by color phenomena.

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This relationship is stated as follows:

Log (10)/(1) = k,bc =

A .Damana :

Lo dan O = intensitas sinar awal

dan akhir k tetapan karakteristik

dari terlarut b = Tebal sel (cm)

C = Konsentrasi

A = Serapan

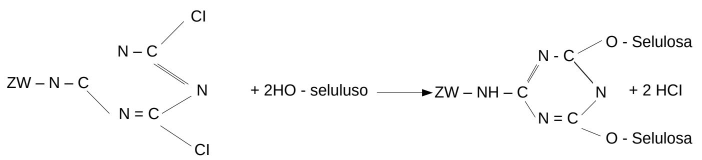
The equation becomes A E.b.c, where E is the molar absorptivity (Sudjadi, 1983)

**Mechanism of Textile Dye Absorption by Water Hyacinth**

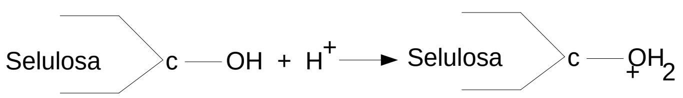
Water hyacinth contains cellulose, which contains hydroxyl groups (-OH) in its molecular structure.

The mechanism by which textile dyes are absorbed by the cellulose in water hyacinth can be explained as follows:

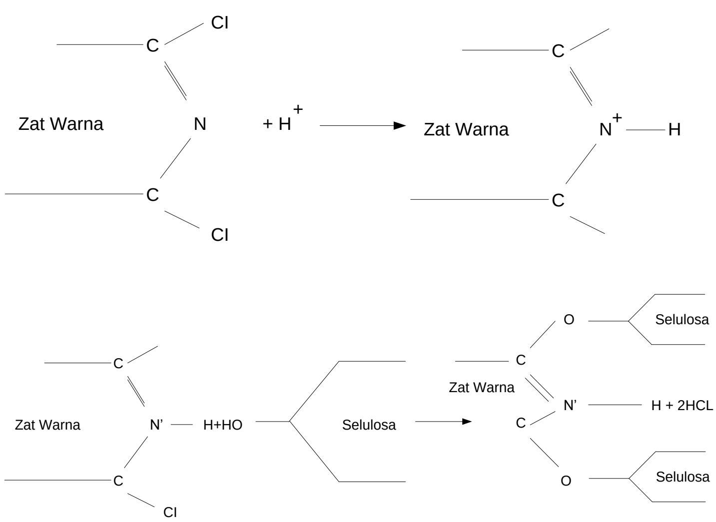
(1) The active group in the dye reacts with the OH group of cellulose in water hyacinth. The reactive dye contains a reactive chloride group, which can react with the 011 group of cellulose so that an exchange reaction occurs between the OH group and the reactive group of the dye.




(1) in an acidic environment




(1) In an acidic environment



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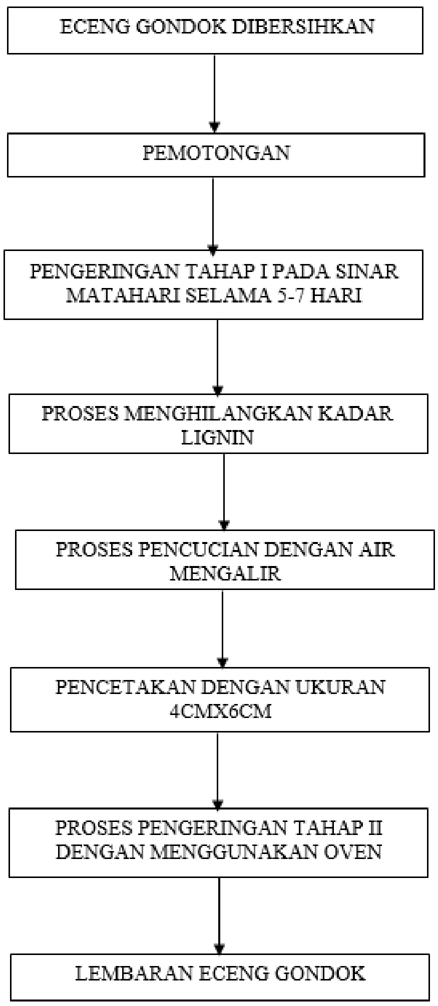
**Experimental Procedure**

1. Preparation of a 20 ppm Yellow FG R dye stock solution in 500 ml.
2. Preparation of a 100 ml 0.5 M HCl acid solution.
3. Preparation of a Yellow FGR calibration curve with a wavelength of 420 nm.
4. Determination of the absorption capacity of processed water hyacinths with varying masses.
5. Water hyacinths weighing 2, 3, and 4 grams were soaked in 100 ml of a 20 ppm dye solution, mixed with 10 ml of 0.5 M HCl acid solution, and soaked for 7 hours. The absorption was measured using a UV/VIS spectrophotometer. 5. Determination of the adsorption capacity of water hyacinth treated with varying temperatures
6. Two grams of water hyacinth activated with 0.5 M HCl was immersed in a 20 ppm Y FG R textile dye solution in 100 ml increments every 7 hours at 40°C and 50°C. The adsorption capacity was then measured using a UV/VIS spectrophotometer.
7. Determination of the adsorption capacity of untreated water hyacinth with varying masses
8. Water hyacinths weighing 2, 3, and 4 grams were immersed in 100 ml of a 20 ppm dye solution, mixed with 10 ml of 0.5 M HCl acid solution, and soaked for 7 hours. The adsorption capacity was measured using a UV/VIS spectrophotometer.
9. Determination of the absorption capacity of unprocessed water hyacinth with temperature variations
10. 2 grams of water hyacinth that has been activated with 0.5 M HCl is added to a solution of textile dye Y FG R 20 ppm in 100 ml every 7 hours at a temperature of 40 °C and 50 °C., then measured using a UV/VIS Spectrophotometer.




Gambar 1. Diagram Alir Proses Pengolahan Eceng Gondok

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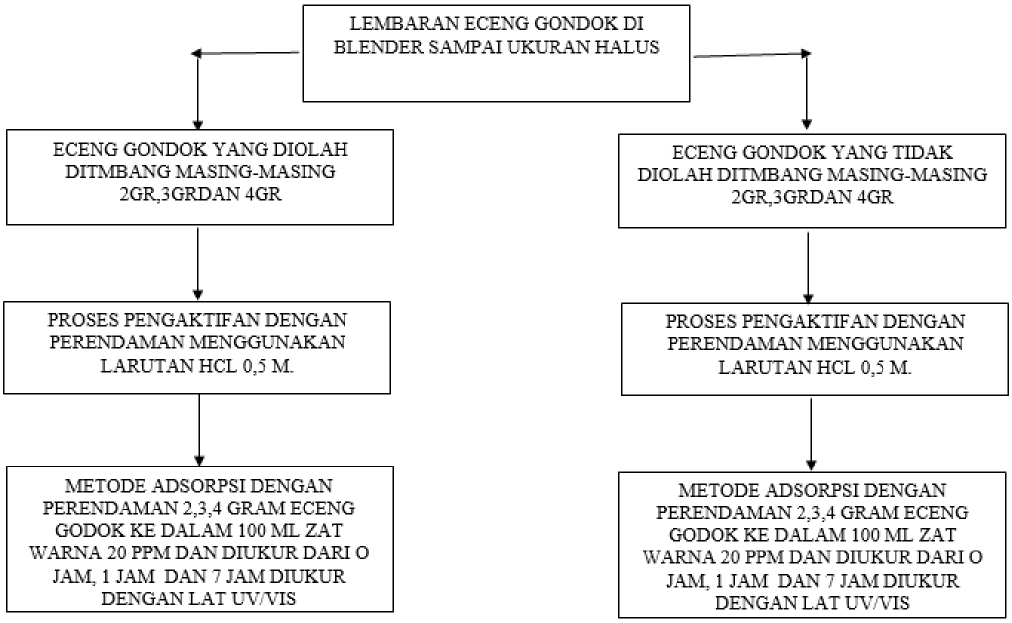
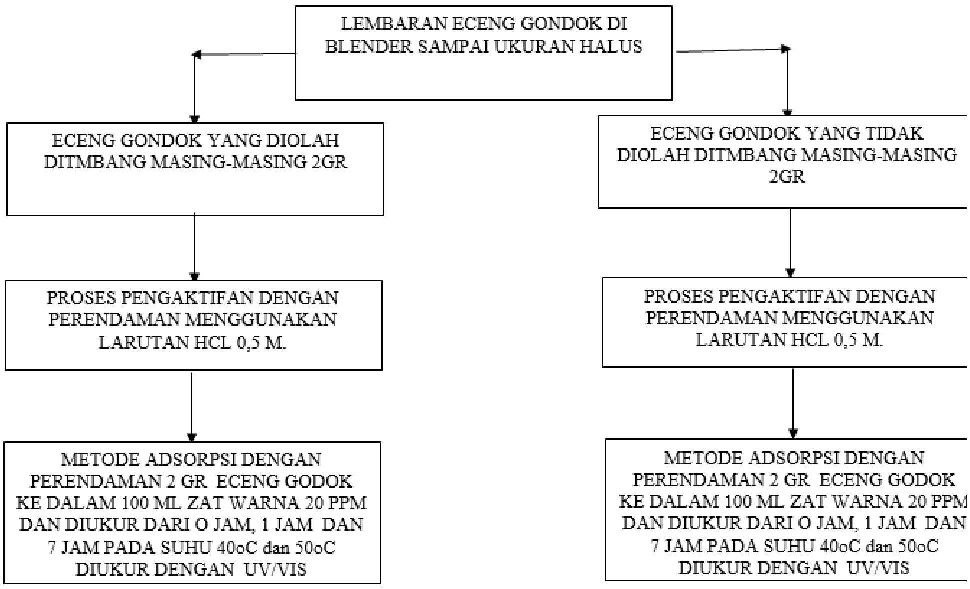



Gambar 2. Diagram Alir Proses Penyerapan Dengan Variasi Masa




Gambar 3. Diagram Alir Proses Penyerapan Dengan Variasi Suhu

# RESULTS AND DISCUSSION

## Results

Panjang Gelombang : 420 mm

| Sampel | ABS | k.ABS |
|---|---|---|
| Larutan Standar | 0,262 | 0,2617 |

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**I. Processed water hyacinth**

**a. Room Temperature**

| Sampel | | ABS | k.ABS |
|---|---|---|---|
| **Massa (gram)** | **Waktu (Jam)** | | |
| 2 | 0 | 0,198 | 0,1982 |
| | 1 | 0,133 | 0,1326 |
| | 7 | 0,116 | 0,1157 |
| 3 | 0 | 0,203 | 0,2025 |
| | 1 | 0,153 | 0,1530 |
| | 7 | 0,137 | 0,1373 |
| 4 | 0 | 0,261 | 0,2612 |
| | 1 | 0,190 | 0,1903 |
| | 7 | 0,161 | 0,1615 |

**Temperature $40^0$C and $50^0$C**

| Sampel | | ABS | k.ABS |
|---|---|---|---|
| **Massa (2 gram)** | **Waktu (Jam)** | | |
| 40 | 0 | 0,187 | 0,1874 |
| | 1 | 0,195 | 0,1954 |
| | 7 | 0,213 | 0,2128 |
| 50 | 0 | 0,190 | 0,1904 |
| | 1 | 0,169 | 0,1694 |
| | 7 | 0,207 | 0,2067 |

**Unprocessed water hyacinth**

**b. Room Temperature**

| Sampel | | ABS | k.ABS |
|---|---|---|---|
| **Massa (gram)** | **Waktu (Jam)** | | |
| 2 | 0 | 0,449 | 0,4490 |
| | 1 | 0,375 | 0,3754 |
| | 7 | 0,231 | 0,2313 |
| 3 | 0 | 0,499 | 0,4990 |
| | 1 | 0,324 | 0,3243 |
| | 7 | 0,214 | 0,2145 |
| 4 | 0 | 0,688 | 0,6880 |
| | 1 | 0,255 | 0,2554 |
| | 7 | 0,267 | 0,2675 |

**Temperature $40^0$C and $50^0$C**

| Sampel | | ABS | k.ABS |
|---|---|---|---|
| **Massa ( 2 gram)** | **Waktu (Jam)** | | |
| 40 | 0 | 0,296 | 0,2957 |
| | 1 | 0,198 | 0,1979 |
| | 7 | 0,172 | 0,1720 |
| 50 | 0 | 0,356 | 0,3557 |
| | 1 | 0,208 | 0,2078 |
| | 7 | 0,186 | 0,1862 |

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# CALCULATION

The Beer–Lambert law is linear ($A \propto C$), so a decrease in absorbance ≈ a decrease in concentration.

General formula

(Hukum Beer–Lambert)

% penyerapan = $\left(\frac{Ao-At}{Ao}\right)$x 100%

Tentukan $\mathbf{A_0}$ = absorbansi awal (t = 0).

Tentukan $\mathbf{A_t}$ = absorbansi pada waktu .

Hitung **% penyerapan**:

% penyerapan = $\left(\frac{Co-Ct}{Co}\right)$x 100%

- Water hyacinth processed with various masses

Massa : 2 gr

= $\left(\frac{0.198-0.13}{0.198}\right)$x 100%

= 58,3 %  artinya turun 41%

Massa : 3 gr

= $\left(\frac{0.203-0.137}{0.203}\right)$x 100%

= 47,1 % artinya turun 53%

Massa 4 gr

= $\left(\frac{0.261-0.161}{0.261}\right)$x 100%

= 35,5% artinya turun 64,5%

- Water hyacinth processed with varying temperatures

Suhu :40 °C

= $\left(\frac{0.187-0.213}{0.187}\right)$x 100%

= 95,2% artinya turun 0,5%

Suhu : 50 °C

= $\left(\frac{0.190-0.207}{0.190}\right)$x 100%

= 90% artinya turun 10%

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- Unprocessed water hyacinth with mass variations

Massa : 2 gr

$= (\frac{0.449-0.231}{0.449})$x 100%

= 94,3 % artinya turun 5,5%

Massa : 3 gr

$= (\frac{0.499-0.214}{0.499})$x 100%

= 57,1 % artinya turun 43%

Massa 4 gr

$= (\frac{0.688-0.267}{0.688})$x 100%

= 61,1% artinya turun 38,9%

- Untreated water hyacinth with temperature variations

Suhu : 40 °C

$= (\frac{0.296-0.172}{0.296})$x 100%

= 41,8% artinya turun 58,2%

Suhu :50 °C

$= (\frac{0.356-0.186}{0.356})$x 100%

= 47,7% artinya turun 52,3%

**KURVA**

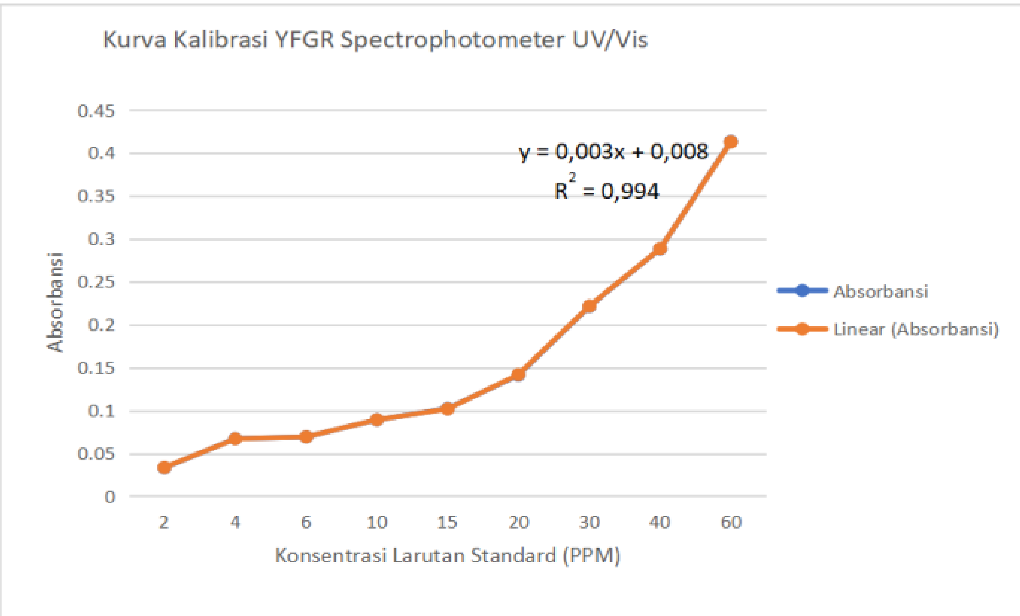


Figure 3. Calibration Curve

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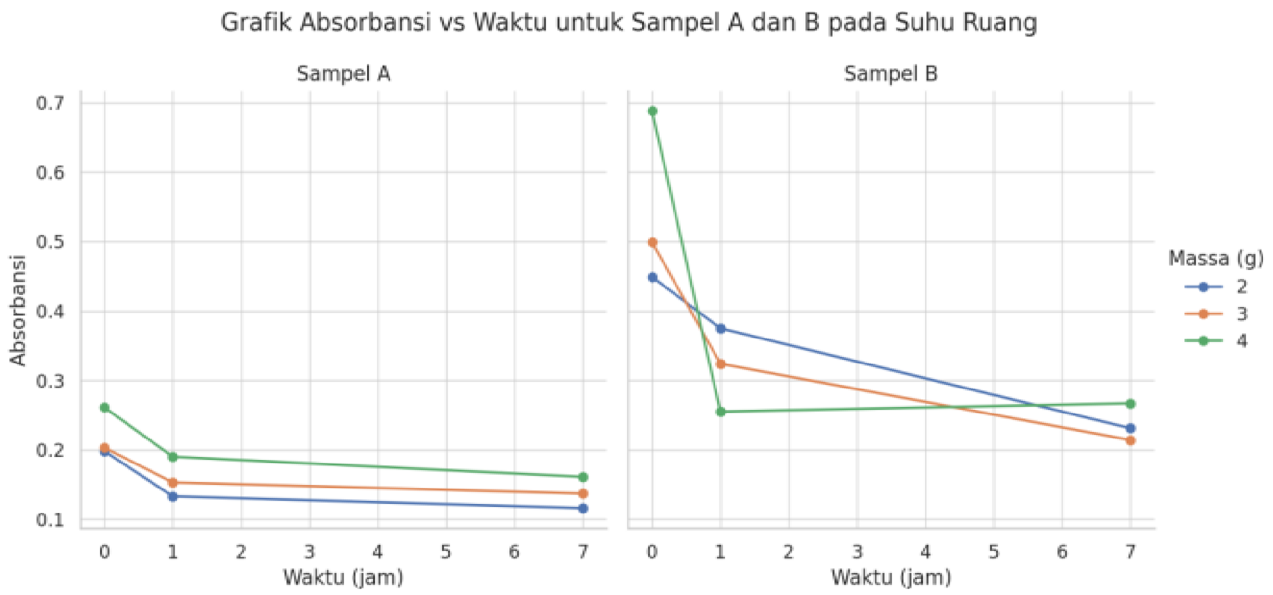


Figure 4. Graph of absorbance vs time by treated (sample A) and untreated (sample B) water hyacinth with variations in mass

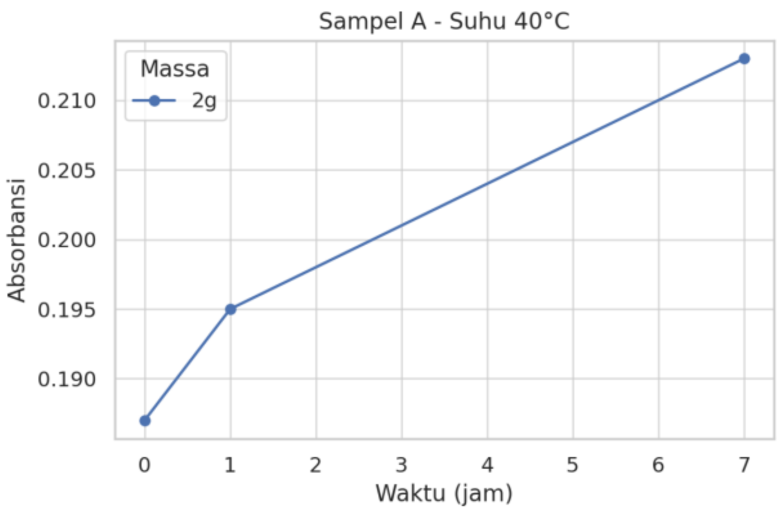


Figure 5. Graph of absorbance vs time of water hyacinth processed at 40ºC

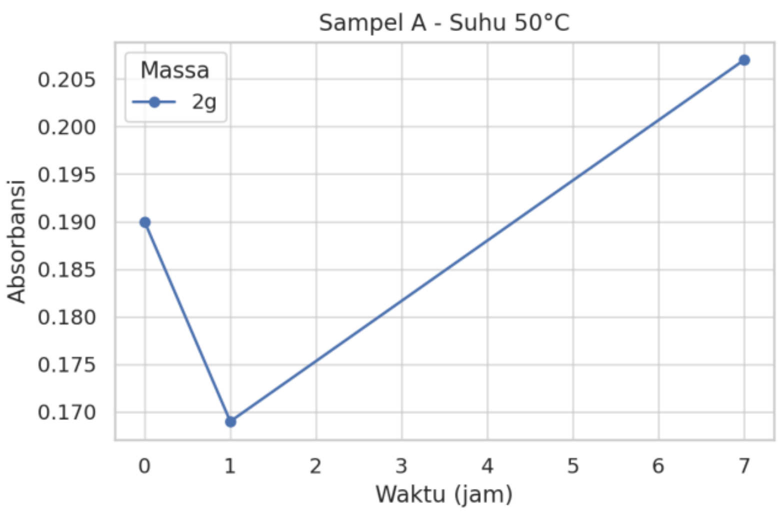


Figure 6. Graph of absorbance vs time of water hyacinth processed at 50ºC

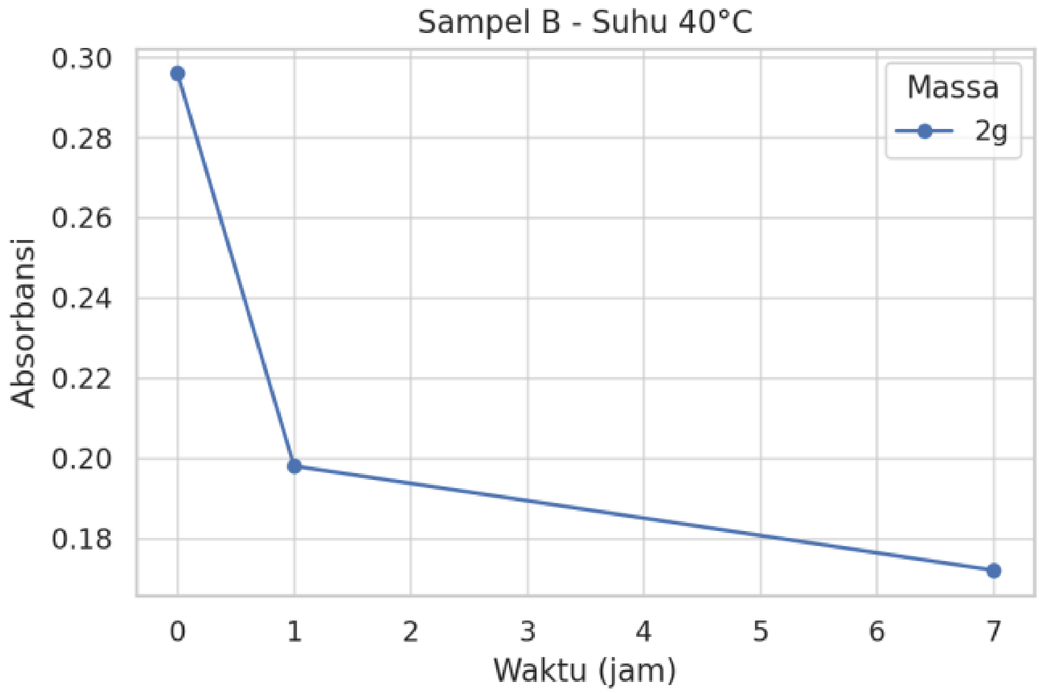


Figure 7. Graph of absorbance vs time of untreated water hyacinth at 40°C

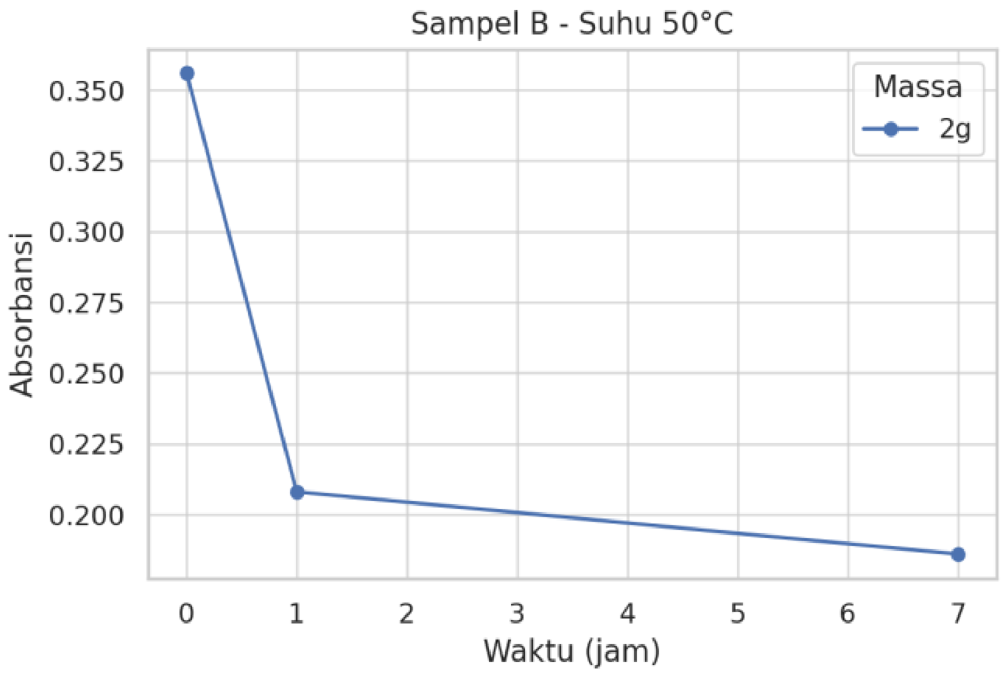


Figure 8. Graph of absorbance vs time of untreated water hyacinth at 50°C

## DISCUSSION

Adsorption Quality and Consistency. The results and analysis showed that the initial absorbance value for treated water hyacinth was lower, indicating that the solution had begun to degrade more rapidly. The decrease was more consistent and stable across all weights (2 grams, 3 grams, and 4 grams). There was no fluctuation until the final 7 hours, indicating a regular and robust adsorption mechanism. The results and analysis of untreated water hyacinth showed a very high initial value, indicating that the adsorbent was not yet active. A decrease occurred, but at certain weights (e.g., 4 grams), the absorbance actually increased from 1 hour to 7 hours (0.255–0.267), indicating possible re-adsorption or adsorption instability.

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NaOH serves as a treatment, removing excess lignin, fat, and cellulose compounds. It also opens more active pores, increasing the surface area of the adsorbent, and enhancing interactions with the substance molecules. Untreated water hyacinth's structure is still rough and closed, resulting in lower and less stable adsorption capacity.

## CONCLUSION

Based on the research results and analysis of the effectiveness of dye absorption using water hyacinth as an adsorbent, it can be concluded that:

Treated water hyacinth (treated with NaOH) had higher adsorption effectiveness than untreated water hyacinth, as indicated by a more significant and consistent decrease in absorbance values over time.

Treated water hyacinth showed better absorption quality and consistency, with no fluctuations in absorbance values for up to 7 hours of contact time at all masses (2g, 3g, and 4g), indicating a stable and efficient adsorption process.

On the other hand, unprocessed water hyacinth showed a high initial absorbance value and an unstable decrease, even experiencing an increase again at a certain time, which indicates the possibility of re-desorption or irregularity in the adsorption process at room temperature, but at a certain temperature (50 °C.) there was a decrease which means that at a certain appropriate temperature the absorption process becomes more effective.

NaOH treatment was proven effective in increasing the adsorption capacity and stability of water hyacinth by removing excess lignin, fat, and cellulose, opening active pores, and adding active functional groups that enhance interaction with dyes.

## SUGGESTION

It is recommended to always pretreat water hyacinth with NaOH before using it as an adsorbent to increase the effectiveness and stability of the adsorption process.

Further research can be conducted to test the effectiveness of water hyacinth adsorption on other types of dyes or other industrial wastes to expand its application.

## REFERENCES

1. Djufri R, dkk., 1996. " Teknologi Pengelantangan, Pencelupan dan Pencapan " . Bandung : Institut Teknologi Tekstil
2. Isminingsih.L. dan Djufri R. 1999." Pengantar Kimia Zat Warna " .Bandung : Institut Teknologi Tekstil.
3. Peters R.H., 1975 " Textile Chemistry " Vol. III. The Physical Chemistry of Dying. Elsevier Scientific Publishing Company : New York.
4. Saepudin Suwarsa. 1998. " Studi Pendahuluan Penggunaan Serbuk Gergaji untuk menghilangkan Zat Warna Tekstil dalam Air Buangan ". Bandung : ITB
5. Tangendjaya dan Budi 1998." Pemanfaatan Limbah Padi Untuk Industri ", Bogor : Pusat Penelitian dan Pengembangan Tanaman Pangan.
6. Joedodibroto, R. 1983. " Prospek Pemanfaatan Eceng Gondok dalam Industri Pulp dan Kertas. Berita Selulosa, Edisi Maret 1983. Volume XIX No. 1 Balai Penelitian Pulp Balai Besar Selulusa. Bandung.
7. Fessenden R.J and Fessenden J.S. 1989." Kimia Organik " Jilid 2, Edisi 3, Erlangga,Jakarta.
8. Delaroza, R., 2008. Adsorpsi Logam Berat menggunakan Adsorben Alami Pada Air Limbah Industri. Jakarta: Universitas Trisakti.
9. Effendi, H., 2003. Telaah Kualitas Air; Bagi Pengelolaan Sumber Daya dan Lingkungan Perairan.. Yogyakarta: Kanisius.
10. Kusnaedi, 2004. Mengolah Air dan Air Kotor Untuk Air Minum. Jakarta: Swadaya.
11. Nurhasni, Firdiyono, F. & Sya'ban, Q., 2012. Penyerapan Ion Aluminium dan Besi dalam Larutan Sodium Silikat Menggunakan Karbon Aktif. 2(4), pp. 516-525.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VIII August 2025

12. Yassir,.2011. Variasi Waktu dan Konsentrasi HCL dan H2SO4 Pada Pemanfatan Eceng Gondok Sebagai Adsorben Zatwana tekstil Y 76 R.“Universitas Muhammadiyah Palembang”.
13. Ahdiyati, W. N., 2020. Modifikasi Eceng Gondok Menggunakan Asam Sitrat Sebagai Adsorben Limbah Logam Cr dan Cd Pada Limbah Cair Laboratorium Kimia, Malang:Universitas Islam Negeri Maulana Malik Ibrahim.