Original Research Article

Effectiveness of Water Hyacinth (Eichhornia Crassipes) And Water Spinach (Ipomoea Aquatica) to Reduce Nitrate and Phosphate Concentrations in Cimulu River Water, Tasikmalaya City, Indonesia

ABSTRACT

Water hyacinth and water spinach can be used as phytoremediation agents in the Cimulu River because these two plants can grow and adapt in the Cimulu River. This study compared the effectiveness of the two plants in reducing nitrate and phosphate in Cimulu river water. The research was conducted from September to October 2021. The research was conducted ex-situ and in-situ. Media retrieval from the Cimulu River was carried out in situ in the middle of the Cimulu River, Tawang District, Tasikmalaya City, Indonesia. aquatic plants, analysis of pH, temperature, and sampling were carried out ex-situ in the backyard of the house at the LIK Complex, Tasikmalaya City, Indonesia. Analysis of water samples such as DO, BOD, nitrate, and phosphate was carried out ex-situ at the Water Resources Management Laboratory of FPIK Padjadjaran University. The method used is an experimental method, with three treatments consisting of control treatment, treatment A (water hyacinth), and treatment B (water spinach). Each aquarium in treatments A and B contained aquatic plants weighing 200 g each. The results of the research conducted for 28 days showed that water hyacinth weighing 200 g was more effective in reducing nitrate and phosphate than water spinach with the same weight. Furthermore, water hyacinth can reduce nitrate by 61.72% and phosphate by 78.27% with the absorption rate of nitrate in one day reaching 0.006 g/m2 and phosphate 0.038 g/m2. The growth rates of water hyacinth in weeks I, II, III, and IV were 5.03±0.971%, 6.31±0.971%, 6.80±0.321%, and 7.18±0.277%. Meanwhile, other water parameters that can be reduced are BOD from 37.3 mg/L to 8.10 mg/L.

Keywords: Eichhornia crassipes, Ipomoea aquatica, Phytoremediation, The rate of decrease in nitrates and phosphates, Effectiveness

1. INTRODUCTION

The Cimulu River is a tributary of the Citanduy River in Tasikmalaya City, Indonesia. The area of the Cimulu River is 1546.2 hectares and passes through three sub-districts, namely Tawang, Cibeureum, and Purbaratu [1]. Various uses of the Cimulu river include residential activities in the form of household activities, economic activities of traders on the banks of the river and capture fisheries activities, there is even a hospital industry [2]. This activity resulted in the Cimulu River being in a moderately polluted status [3].

Polluted waters can be overcome by treating water in an alternative that is natural, inexpensive and easy to use with aquatic plants. The processing is known as phytoremediation, which is a system that uses plants with the help of microorganisms to convert and destroy contaminants into harmless [4]. Phytoremediation has been carried out with various types of plants, such as water hyacinth and water spinach. Water hyacinth has a structure of tissues and organs that support the process of absorption of organic materials and other substances, such as having large stomata holes compared to most other plants and the distance between stomata is eight times the size of the holes [5] . Water spinach has a fairly high adaptability to the environment. Water spinach is a plant that is selective for certain nutrients, so it can absorb organic matter and other substances in water bodies [6].

2. METHODOLOGY

2.1 Research Sites

The study was conducted in September–October 2021. The time required for phytoremediation observations was 28 days. Analysis of water samples and weighing of aquatic plants were carried out once a week.

The place for taking phytoremediation water media comes from the Cimulu River, Tasikmalaya City, Indonesia. The research was carried out ex situ in the backyard of the house having the address at Komplek LIK Kota Tasikmalaya, Indonesia. Where the research was made like a green house covered by fiber glass with an area of 2m×1.2m. This is done so that water hyacinth and water spinach can be exposed to optimal sunlight and avoid rain. Analysis of pH, temperature and observations of aquatic plants were carried out directly at the research site, while for nitrate, phosphate, DO and BOD were carried out at the Water Resources Management Laboratory of FPIK Unpad.

2.2 Materials and Methods

The materials used in the study were water from the middle Cimulu river with the highest concentration, namely nitrate 0.128 mg/L, phosphate 0.635 mg/L and BOD 37.3 mg/L, water hyacinth 200 g with a size of 15-20 cm, water spinach 200 g with a size of 20-30 cm, distilled water, manganese sulfate solution, oxygen reagent solution, sulfuric acid solution, starch indicator, sodium thiosulfate, $SnCl_2$ solution, NH_4 molybdate solution, Phenol disulfonic acid solution, 10% NH_4OH solution. While the tools used in the study were jerry cans, dippers, 36 x 22 x 26 cm aquarium, sample bottles, litmus paper, thermometer, coolbox, digital scales, ruler, camera, spectrophotometer.

2.3 Methods and Data Analysis

The research method used is the experimental method. The experiment was carried out with three treatments and four replications. The treatments consisted of control, treatment A for water hyacinth and treatment B for water spinach. The data were analyzed using quantitative descriptive methods and a comparison of the effectiveness between treatments was carried out [7].

2.3.1 Growth Rate and Plant Productivity

Biomass, growth rate, and biomass productivity can be obtained by collecting primary data results. The formula for finding the biomass growth rate is as follows [8]:

$$\mu = \left(\sqrt[t]{\frac{Bt}{Bo}} - 1 \right) x\ 100\%$$

μ = growth rate of biomass (%)
Bt = Final wet weight (g)
Bo = Initial wet weight (g)
t = Experimental Time (days)

Biomass productivity can be determined using the following formula [8]:

$$P = \frac{Bt - Bo}{A.t}$$

P = Productivity of Biomass (g/m2/day)
Bt = Final wet weight (g)

Bo = Initial wet weight (g)
A = Area of the Media Container (m2)
T = Length of Experiment (days)

2.3.2 Nitrate and Phosphate Reducing Rate

The rate of decrease in the concentration of phosphate and nitrate can be used by the formula, as follows [8]:

$$\mu = \left(\sqrt[t]{\frac{Ct}{Co}} - 1\right) x\ 100\%$$

μ = phosphate/nitrate decrease rate (%)
Ct = Final concentration
Co = Initial concentration
T = Experiment Time

Determine the rate of absorption of the concentration of phosphate and nitrate can be used the formula [8] :

$$P = \frac{Ct - Co}{A.t}$$

P = Absorption Rate (g/m2/day)
Ct = Final Concentration (g)
Co = Initial Concentration (g)
A = Media Container Area (m2)
T = Length of Experiment (days)

2.3.3 Effectiveness of Reducing Nitrate and Phosphate

Effectiveness of nitrate and phosphate reduction on water hyacinth and water spinach [9]:

$$E_f = \frac{Ci - Ce}{Ci} \times 100\%$$

Ef = Efficiency/effectiveness (%)
Ci = Initial concentration (mg/L)
Ce = Final concentration (mhg/L)

3. RESULTS AND DISCUSSION

3.1 BIOMASS, GROWTH RATE AND PRODUCTIVITY

<u>3.1.1 BIOMASS</u>

Biomass is organic material resulting from the photosynthesis process which is expressed in units of weight [10].

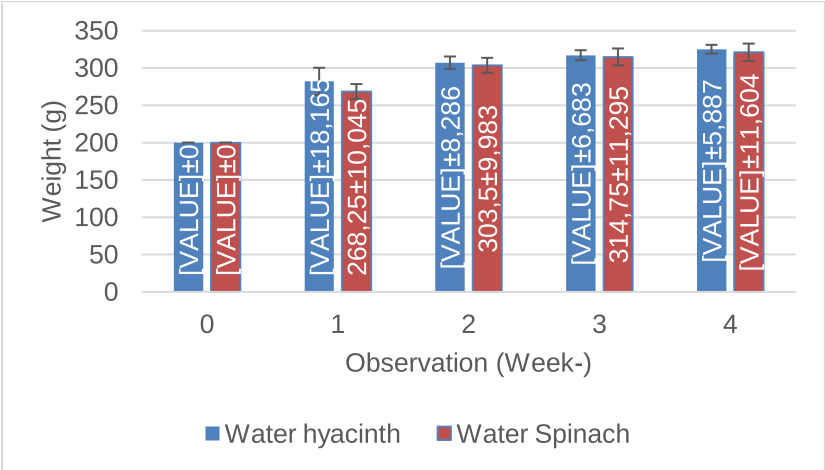

Figure 1. The weight of water hyacinth and water spinach during the research

Based on figure 1. the yield of water hyacinth and water spinach biomass growth week 0 weighed 200 g. Both treatments experienced an increase in weight from week 0 to week 4. Water hyacinth has a higher weight gain than water spinach, with the final weight of water hyacinth reaching 325 ± 5.887 g and water kangkung 321 ± 11.604 g. The growth ability of each plant is different, depending on several important factors such as light, growth regulators and nutrients [11].

Morphologically, water hyacinth has a network structure that supports the growth of water hyacinth faster than water spinach. One water hyacinth stem in 52 days can grow up to 1 m2 [12]. Even water hyacinth root can help increase biomass. The results showed that water hyacinth had thicker and denser fibrous roots than water spinach which had tap roots.

The results showed that water hyacinth has thicker and denser fibrous roots, compared to water spinach which has tap roots. This is evidenced in Figure2. and Figure 3.

Figure 2. Water hyacinth root

Figure 3. Water spinach root

The dense shape of the water hyacinth roots indicates that many rhizosphere microbes can degrade organic compounds for metabolic processes so that they can produce new cells and increase plant biomass [13].

3.1.2 Growth Rate

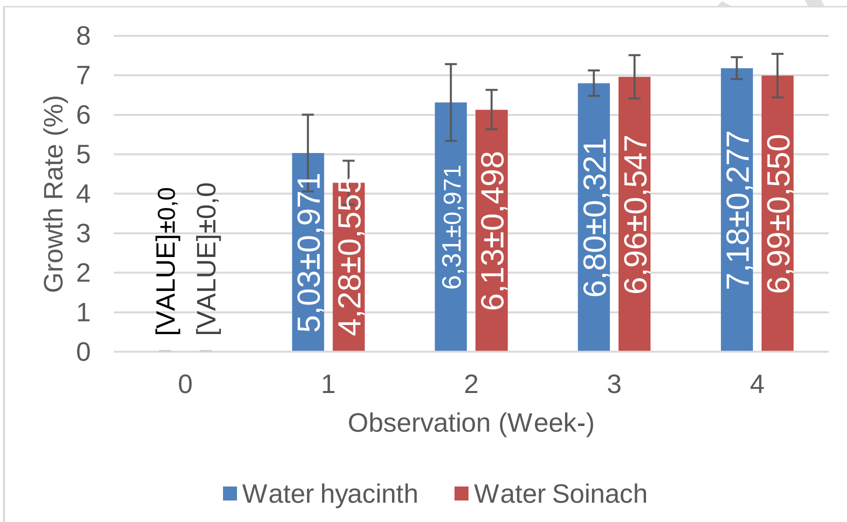

Figure 4. Growth rate of water hyacinth and water spinach during research

based on figure 4. Water hyacinth has a higher growth rate than water spinach. This is indicated by the growth rate of water hyacinth in the first week of 5.03±0.971% and the last week reaching 7.18± 0.277%, while water spinach was 4.28±0.55% and the last week it was 6.99±0.550%.

The performance of the growth rate of the two plants in the third and fourth weeks of the increase was not too high, this was because some of the leaves and stems of the plants began to change color and wither due to a decrease in the nutrient content in the planting medium. Plant wilting is caused by a decrease in the ability to absorb organic matter because at the beginning of the study the absorption of organic matter was very high [5].

3.1.3 Productivity

Plant growth rate is related to biomass productivity because the calculation of biomass productivity can determine the growth of plant weight in the media every day. The productivity of water hyacinth and water spinach biomass is presented in Table 1.

Table 1. The productivity of water hyacinth and water spinach

	Productivity (g/m^2/day)
Water hyacinth	9,70
Water spinach	9,39

In table 1. the biomass productivity of the two plants shows that water hyacinth has a higher productivity than water spinach. The productivity of water hyacinth is 9.70 g/m2/day while water spinach is 9.39 g/m2/day. This is because the weight of water hyacinth increases faster than water spinach. The increase in wet weight of water hyacinth occurs because the water used in this research contains nutrients needed for the growth of water hyacinth, such as N and P [5].

3.2 Nitrate and Phosphate Degradation Rate

3.2.1 Nitrate (NO_3)

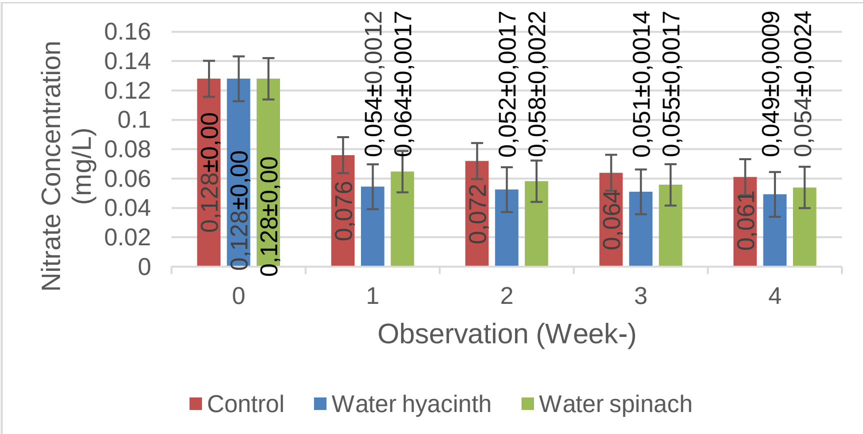

Figure 5. Nitrate concentration during research

Based on Figure 5 in the preliminary test week 0 to 4 in both plants there was a decrease, namely 0.128±0.00 mg/L NO3 to 0.049±0.0009 mg/L NO_3 in water hyacinth treatment, while water spinach 0.054±0.0024 mg/L NO_3. This is because water hyacinth is able to properly absorb organic materials containing N nutrient compounds and store them in water hyacinth vascular tissue for metabolic processes that are used to multiply cells [14].

Plant age can affect the ability to reduce nitrate compounds. When the plant is still young, the ability to reduce nitrite, nitrate, ammonia and phosphate is higher. However, after reaching a certain size, its ability decreases [15].

Table 2. Rate of Nitrate Reduction and Absorption in one day during research

	Rate of nitrate reduction in 1 day (%)	Rate of nitrate absorption ($g/m^2/day$)
Control	2,61	0,005
Water hyacinth	3,37	0,006
Water spinach	3,03	0,005

Based on the results of calculations, in table 2 water hyacinth has a superior absorption percentage of 3.37% with an elimination rate of 0.005 mg/L NO_3 in 1 day, while water spinach is 3.03% at a rate of 0.005 mg/L NO_3 in 1 day.

Tissue structure in water hyacinth is very influential in the absorption process, because it has larger and wider leaves, so it can store a lot of nutrients and has large stomata holes, when compared to most other plants and the distance between stomata is eight times as large as the holes [5].

3.2.2 Phosphate (PO_4)

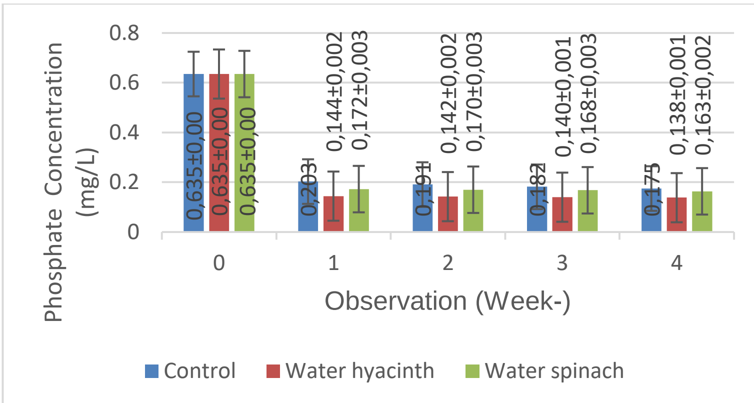

Figure 6. Rate of phosphate Reduction and Absorption in one day during research

Based on Figure 8. the preliminary test or week 0 is 0.635±0.00 mg/L PO4. After doing the research from the first week to the fourth week, the three treatments decreased. Water hyacinth treatment succeeded in reducing the highest phosphate from 0.635±0.00 mg/L decreased to 0.138±0.001 mg/L. Phosphate is the main inorganic nutrient needed for the growth of water hyacinth. Other nutrients, both organic and inorganic, have no effect such as nitrate and phosphate [12]. Therefore, during the study, the two treatment plants decreased, although the decrease in phosphate concentrations in the two plants was not much different.

Table 3 Phosphate Depletion and Absorption Rate in one day during research

	Phosphate Reducing Rate/day (%)	Phosphate Absorption Rate ($g/m^2/day$)
Control	4,49	0,035
Water hyacinth	5,30	0,038
Water	4,74	0,036

The results of the calculation of the rate of decline and absorption in 1 day is that water hyacinth is able to absorb 5.30% in 1 day with an elimination rate of 0.038 mg/L PO4 in 1 day, while in kale it is 4.74% with an elimination rate of 0.036 mg/L PO4 in 1 day. 1 day. The highest rate of decrease and absorption was found in the water hyacinth treatment because the large leaf width indicates a high chlorophyll content, relatively more phosphate is needed to store and transfer energy in the form of ATP and ADP [15].

3.3 Effectiveness of Reducing Nitrate and Phosphate

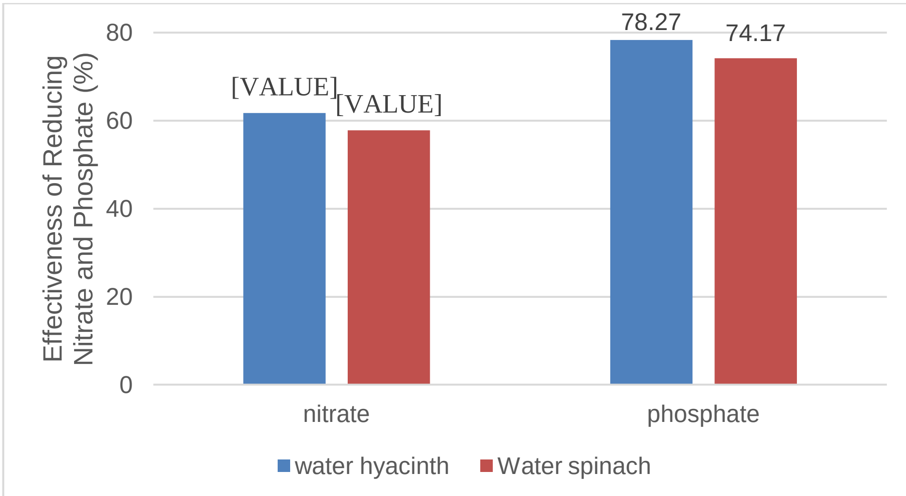

Figure 7 Effectiveness of Reducing Nitrate and Phosphate

The results of the observations in Figure 7 water hyacinth and water spinach were able to reduce the concentration of nitrate and phosphate. The results of the calculation of the effectiveness of nitrate and phosphate reduction showed that water hyacinth was more effective in reducing nitrate and phosphate, namely the concentration of nitrate could be decreased by 61.72% and phosphate by 78.27%. this is in accordance with previous research, in water hyacinth WWTP industrial wastewater efficiently reduces nitrate by 98.41% and phosphate by 86.14% [16]. Water hyacinth can reduce the concentration of phosphate in hospital industrial wastewater by 28.33% or 5.829 mg/L [17].

Water spinach with a weight of 200 g, effectively reduced the concentration of nitrate by 57.81% and phosphate by 74.17%. This is in accordance with several previous studies, in water spinach laundry wastewater weighing 200 g in 10 days can reduce phosphate by 41.61% [18]. The concentration of nitrate in aquaponic system waste can be reduced by 58.57 mg/L water spinach [19].

3.4 Water Quality

3.4.1 Temperature

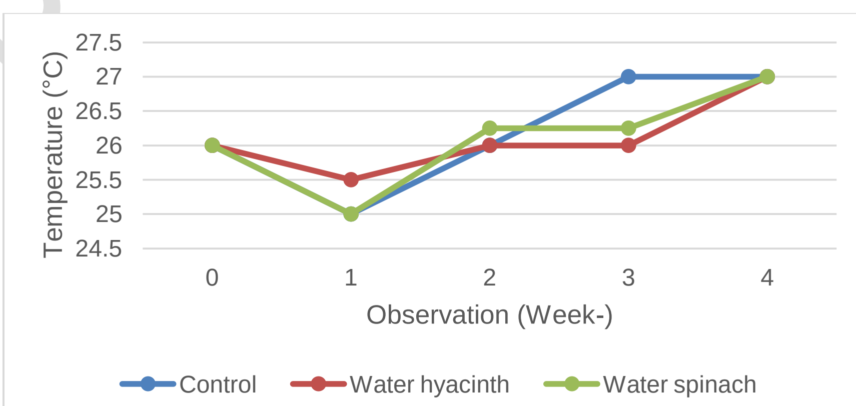

Figure 8 Temperature during the research

based on Figure 8 the temperature in the three treatments fluctuated. At the beginning of the research, the temperature was at 26°C and at the end of the fourth week of research the temperature was 27°C. The highest temperature was found in water spinach treatment. This was caused by leaf cover which was more tenuous, compared to water hyacinth leaf cover. It can be seen in Figure 9 and Figure 10.

Figure 9 The density of water hyacinth leaves

Figure 10 The density of water spinach leaves

Water hyacinth and water spinach can tolerate water hyacinth with a temperature of around 21–25.5°C, but water hyacinth grows optimally at a temperature of 27°C – 30°C [5]. and water spinach grows optimally. at a temperature of 25–30°C [5].

3.4.2 Power of Hidrogen

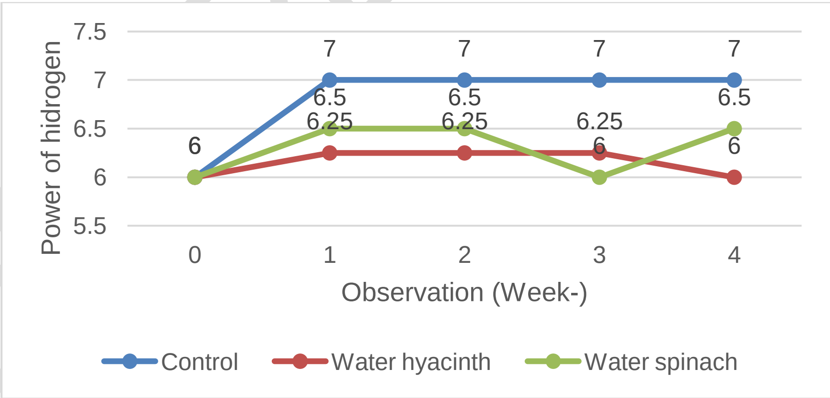

Figure 11 pH value during the research

Based on Figure 11 the pH value of week 0 is 6 in all treatments, the first week to the fourth week for the control treatment has a stable value of 7. The water hyacinth treatment has a stable pH value from the first to the third week with a value of 6.25 and decreases in the fourth week. with a pH value of 6, while in water spinach treatment the pH value fluctuated, in the first to second week, the pH was stable with a value of 6.5 and decreased in the third week to 6, but increased again in the fourth week with a value of 6.5. Plants can grow well at a pH of 5.5-7, because the process of absorption of nutrients from the waters can take place well [20].

3.4.3 Dissolve oksigen (DO)

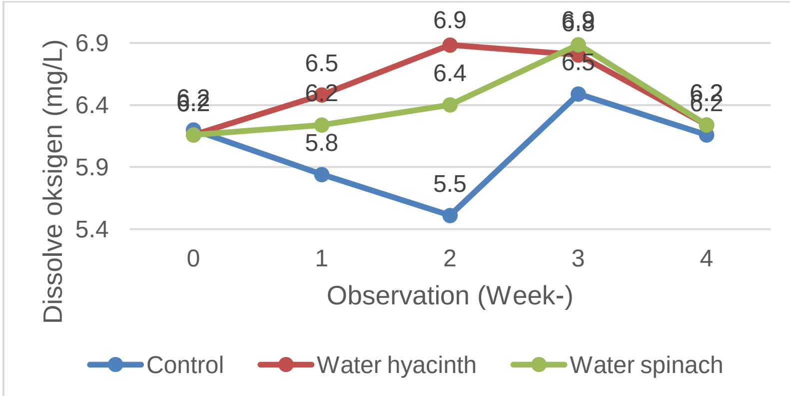

Figure 12 Concentration of Dissolved Oxygen during the research

based on figure 12 Dissolved oxygen concentration week 0 is 6.2 mg/L. Dissolved oxygen concentration control treatment 0 to 4 weeks fluctuated. Water hyacinth experienced an increase in dissolved oxygen concentration in the 0 to the third week from 6.2 mg/L to 6.9 mg/L and decreased in the fourth week. Dissolved oxygen concentration in the 0 to 1 week water spinach treatment was stable and increased in the second to third weeks from 6.2 mg/L to 6.9 mg/L, but decreased in the fourth week. This happened because during the research there were several stalks of both dead and rotting plants. The decomposition of organic matter from decaying dead stalks can produce foul-smelling gases and cause a drastic drop in dissolved oxygen concentrations that are harmful to organisms.

3.4.4 ***Biologycal Oxygen Demand*** (BOD)

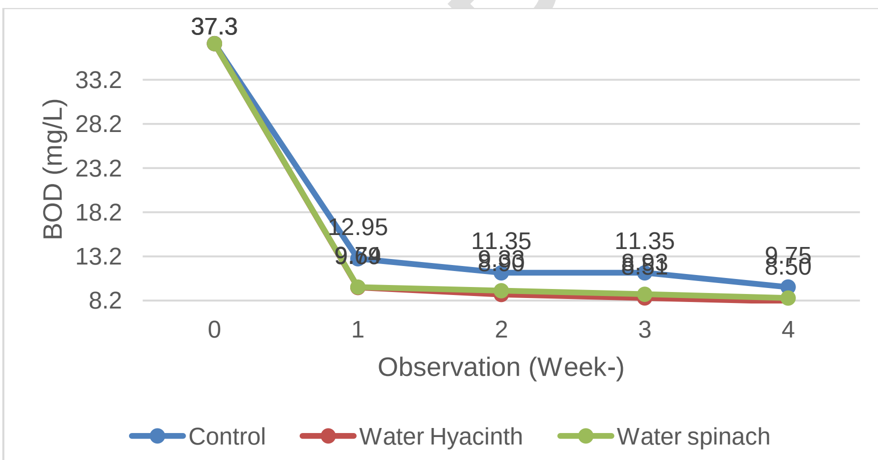

Figure 13 BOD values during the research

The results of the calculation of the BOD value in Figure 13, week 0 reached 37.3 mg/L. All treatments experienced a decrease in BOD values from week 0 to week four, except for the control treatment from week two to three, where the BOD value was stable at 11.35 mg/L. The BOD value decreased the most, namely in the treatment with water hyacinth in the fourth week reaching 8.10 mg/L.

The decrease in the BOD value in water hyacinth occurs due to the rhizofiltration process, namely the deposition of pollutants by the roots, then the absorbed nutrients will enter the stem through transport vessels and spread to all parts of the plant. Nutrients in stems that have undergone biological reactions and accumulate will be passed on to the leaves [21].

4. CONCLUSION

Based on the results of research that has been carried out for 28 days, water hyacinth weighing 200 g is more effective in reducing nitrate and phosphate than water spinach with the same weight. Water hyacinth can reduce nitrate by 61.72% and phosphate by 78.27% with the rate of absorption of nitrate in one day reaching 0.006 g/m2 and phosphate of 0.038

g/m2. The growth rate of water hyacinth at weeks I, II, III and IV were 5.03±0.971%, 6.31±0.971%, 6.80±0.321% and 7.18±0.277%. Meanwhile, other water parameters that can be reduced are BOD from 37.3 mg/L to 8.10 mg/L.

REFERENCES

[1] SUP Citanduy Hulu, *Profil Sub Unit Pelayanan (SUP) Citanduy Hulu*. Tasikmalaya, 2017.

[2] S. Fadjarajani, E. B. Singkawijaya, and T. Indriane, "Peran Serta Masyarakat Dalam Menjaga Kelestarian Sungai Cimulu Di Kota Tasikmalaya," *Pros. Semin. Nas. Geogr. UMS IX 2018. Restor. Sungai Tantangan dan Solusi Pembang. Berkelanjutan*, pp. 248–254, 2018.

[3] Dinas Lingkungan Hidup Kota Tasikmalaya, *Laporan Pemantauan Kualitas Lingkungan Tahun 2017*. Tasikmalaya, 2017.

[4] A. Artiyani, "Penurunan Kadar N-Total Dan P-Total Pada Limbah Cair Tahu Dengan Metode Fitoremediasi Aliran Batch Dan Kontinyu Menggunakan Tanaman Hydrilla Verticillata," *Spectra*, vol. IX, no. 18, pp. 9–14, 2011.

[5] L. S. Indah, B. Hendrarto, and P. Soedarsono, "KEMAMPUAN ECENG GONDOK (Eichhornia sp.), KANGKUNG AIR (Ipomea sp.), DAN KAYU APU (Pistia sp.) DALAM MENURUNKAN BAHAN ORGANIK LIMBAH INDUSTRI TAHU (SKALA LABORATORIUM)," *DIPONEGORO J. MAQUARES*, vol. 3, no. 1, pp. 1–6, 2014.

[6] J. E. Hapsari, C. Amri, and A. Suyanto, "EFEKTIVITAS KANGKUNG AIR (Ipomoea aquatica) SEBAGAI FITOREMEDIASI DALAM MENURUNKAN KADAR TIMBAL (Pb) AIR LIMBAH BATIK," *Anal. Anal. Environ. Chem.*, vol. 3, no. 1, pp. 30–37, 2018.

[7] P. D. Sugiyono, *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Bandung, 2019. [Online]. Available: https://media.neliti.com/media/publications/112355-ID-pengaruh-struktur-aktiva-ukuran-perusaha.pdf%0Acholar.google.es/scholar?hl=es&as_sdt=0%2C5&q=Funcionalidad+Familiar+en+Alumnos+de+1°+y+2°+grado+de+secundaria+de+la+institución+educativa+parroquial+"Peq

[8] T. Chrismadha and Y. Mardayati, "Uji Tumbuh Lemna (Lemna perpusilla Torr.) dan Penyerapan Unsur Hara dalam Media Air Waduk Saguling," *J. Oseanologi dan Limnol. di Indones.*, vol. 38, no. 33, pp. 369–376, 2012.

[9] Muljadi, "Efisiensi Instalasi Pengolahan Limbah Cair Industri Batik Cetak dengan Metode FisikaKimia dan Biologi terhadap Penurunan Parameter Pencemar (BOD, COD, dan Logam Berat Krom (Cr)," *Ekuilibrium*, vol. 8, no. 1, pp. 7–16, 2009.

[10] S. A. Rohman, J. Purbopuspito, and J. J. Rondonuwu, "Produksi, sekuestrasi dan sebaran karbon kangkung air (Ipomoea aquatica, Forsk. L.) pada kebun telaga di desa Kalasey Satu," *J. Cocos*, vol. 1, no. 2, pp. 1–11, 2017.

[11] T. S. B. Utami, Z. Hasan, M. L. Syamsuddin, and H. Hamdani, "FITOREMEDIASI LIMBAH BUDIDAYA IKAN KOI (Cyprinus carpio) DENGAN BEBERAPA TANAMAN SAYURAN DALAM SISTEM RESIRKULASI AKUAPONIK," *J. Perikan. dan Kelaut.*, vol. X, no. 2, pp. 81–88, 2019.

[12] P. Soedarsono, B. Sulardiono, and R. Bakhtiar, "Hubungan Kandungan Nitrat (No3) & Fosfat (Po4) Terhadap Pertumbuhan Biomassa Basah Eceng Gondok (Eichhornia Crassipes) Yang Berbeda Lokasi Di Perairan Rawa Pening Ambarawa, Kabupaten Semarang," *J. Manag. Aquat. Resour.*, vol. 2, no. 2, pp. 66–72, 2013, [Online]. Available: http://ejournal-s1.undip.ac.id/index.php/maquares

[13] R. Nurkemalasari, M. Sutisna, and E. Wardhani, "Fitoremediasi Limbah Cair Tapioka dengan menggunakan Tumbuhan Kangkung Air (Ipomoea aquatica)," *J. Inst. Teknol. Nas.*, vol. 1, no. 2, pp. 81–92, 2013.

[14] D. Vidyawati and H. Fitrihidajati, "Pengaruh Fitoremediasi Eceng Gondok (Eichornia Crassipes) Melalui Pengenceran Terhadap Kualitas Limbah Cair Industri Tahu," *LenteraBio*, vol. 8, no. 2, pp. 113–119, 2019.

[15] H. Effendi, *Telaah Kualitas Air Bagi Pengelolaan Sumber Daya dan Lingkungan Perairan*. Yogyakarta: Kanisius, 2003.

[16] I. Imron, D. Dermiyati, N. Sriyani, S. B. Yuwono, and E. Suroso, "Perbaikan Kualitas Air Limbah Domestik Dengan Fitoremediasi Menggunakan Kombinasi Beberapa Gulma Air: Studi Kasus Kolam Retensi Talang Aman Kota Palembang," *J. Ilmu Lingkung.*, vol. 17, no. 1, p. 51, 2019, doi: 10.14710/jil.17.1.51-60.

[17] R. Purwasari, M. M. Fauzie, and Haryono, "Pengaruh Fitoremediasi Eichornia crassipes Terhadap Kadar Fosfat dan Amonia di Instalasi Pengolahan Limbah Cair RSUP Dr Sardjito Yogyakarta," *J. Kesehat. Lingkung.*, vol. 3, no. 4, pp. 160–166, 2012.

[18] F. Dewi and M. Faisal, "EFISIENSI PENYERAPAN PHOSPAT LIMBAH LAUNDRY MENGGUNAKAN KANGKUNG AIR (Ipomoea aquatic forsk) DAN JERINGAU (Acorus calamus)," *J. Tek. Kim. USU*, vol. 4, no. 1, pp. 7–10, 2015.

[19] A. G. Kushayadi, S. Waspodo, and N. Diniarti, "PENGARUH MEDIA TANAM AKUAPONIK YANG BERBEDA TERHADAP PENURUNAN NITRAT DAN POSPAT PADA PEMELIHARAAN IKAN MAS (Cyprinus carpio)," *J. Perikan. Unram*, vol. 8, no. 1, pp. 8–13, 2018, doi: 10.29303/jp.v8i1.70.

[20] H. Effendi, B. Amalrullah Utomo, G. Maruto Darmawangsa, and R. Elfida Karo-Karo, "FITOREMEDIASI LIMBAH BUDIDAYA IKAN LELE (Clarias sp.) DENGAN KANGKUNG (Ipomoea aquatica) DAN PAKCOY (Brassica rapa chinensis) DALAM SISTEM RESIRKULASI," *J. Ecolab*, vol. 9, no. 2, pp. 80–92, 2015, doi: 10.20886/jklh.2015.9.2.80-92.

[21] H. Ahmad and R. Adiningsih, “Efektivitas Metode Fitoremediasi Menggunakan Tanaman Eceng Gondok dan Kangkung Air dalam Menurunkan Kadar BOD dan TSS pada Limbah Cair Industri Tahu,” *J. Farmasetis*, vol. 8, no. 2, pp. 31–38, 2019, doi: 10.32583/farmasetis.v8i2.599.