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EFFECTIVENESS OF LAUNDRY WASTE TREATMENT WITH *CHRYSOPOGON ZIZANIOIDES* L

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ABSTRACT

The increase in the laundry industry has an impact on the environment if the laundry liquid waste is not managed properly. Laundry waste generally contains high concentrations of sodium, boron, ammonia, nitrogen, surfactants and phosphates. Therefore, it is necessary to consider the right method in reducing the dangers posed by the waste from the laundry. Plants are agents that can reduce harmful pollutants in nature, one of which is *Chrysopogon zizanioides* L grass. The aim of the study was to determine the effectiveness of phosphate absorption using *C. zizanioides* grass with four different concentration treatments. The results of this study indicate that the use of *C. zizanioides* grass has an effect on the efficiency of reducing phosphate levels in laundry waste. Besides, the concentration of laundry waste also affects the growth of *C. zizanioides* grass, where the higher the concentration given, the smaller the growth of root and leaf length. The rate of removal of phosphate levels in waste is the largest or best in the K 100 treatment.

KEY WORDS : *Chrysopogon zizanioides* L, Laundry waste, Phosphate concentration, Phytoremediation.

INTRODUCTION

The existence of laundry services actually brings considerable benefits, especially for people who have a high level of activity. However, this activity will have an impact on the environment if the wastewater is not managed properly. Laundry waste contains phosphate which can pollute the environment due to the contribution of phosphate loading of 25-30%, which can cause eutrophication. In addition, Rochman (2009) stated that the domestic liquid waste with the highest volume was detergent. This is in line with the world's detergent production which reached 2.7 million tons/year, with an annual production increase of 5%. Detergent at a concentration of 0.5 mg/l has been able to form foam so that it inhibits the diffusion of oxygen from the air to the surface of the water body. Furthermore, Rifai (2013) stated that, domestic waste is the largest polluter in Indonesia, which is 85%.

Utilization of plants in reducing natural pollutants is the most efficient, easy and does not require large costs in its application. For this reason, the selection of the right plant species needs to be carried out as a phytoremediator agent. *Chrysopogon zizanioides* L grass is a metal hyper accumulator plant that has high absorption or accumulation properties of heavy metals in plant tissues. This plant is very tolerant of drought and flooding, frost, heat, extreme soil pH, toxicity of Al and Mn, and very tolerant to various metals such as As, Cd, Cu, Cr, and Ni (Truong *et al*., 2008).

This study tries to develop an alternative method of treating laundry wastewater through the use of grass *C. zizanioides*, L as a phytoremediation agent in waste control. The mechanism of pollutant absorption through roots which are then translocated to parts of the plant body to help plant metabolism (Rosnah, 2012). Where plants are expected to remediate pollutants with various concentrations of laundry waste given.

MATERIALS AND METHODS

This research was conducted at the Laboratory of the Faculty of Fisheries and Marine Sciences,

University of Papua. Where the material used is detergent waste taken from Laundry "X", Manokwari. Chemicals for phosphate analysis are: Sulfuric Acid (H2SO4) 5N, Potassium Phosphate (KH2PO4), Potassium antimonyltartarate K(sbO) C4H4O, Ammonium molybdate (NH4)6 Mo7O24.4H2O) and Ascorbic acid (C6H8O6) 0.1 M and tested using Atomic Absorption Spectrophotometer (AAS). The test plant material used was C. zizanioides L grass, where the plant was prepared using the "Splitting Mature Plants" method which was 2 months old. Then the plants were transferred to a 1 liter container using a mixture of soil and compost in a ratio of 1:1 and maintained for 1 month. The plant acclimatization stage was carried out through a preliminary test by immersing the test plants in wastewater concentrations with different concentrations every day (5%, 15% and 25%) for 3 days and then ready to carry out phytoremediation tests for 15 days.

The planting tank used is 45 x 35 x 26 cm (40 liter volume) as many as 12 pieces using the floating method. In the phytoremediation test, each bioreactor contained 12 clumps with a spacing of 10 cm so that a total of 144 clumps were required for 12 bioreactors. Several measurements were taken to support the phytoremediation test, namely water quality measurements of pH, DO and temperature which were carried out every day, measurements of plant biomass which were carried out at the beginning and end of the study. Measurements taken were root and leaf length growth and reduction of phosphate levels in wastewater. Determination of plant biomass is done by calculating the difference between the final weight minus the initial weight divided by the final weight using a formula that refers to the SNI 13-6793-202 method.

The experiment was conducted using a non-factorial completely randomized design with 4 different concentration treatments, namely 100%, 50%, 75% and 0% (as control) and 3 replications. Research variables include the independent variable (waste concentration and residence time) and the dependent variable, namely: the concentration of P in water.

To determine the effect of treatment, it was tested using analysis of variance (ANOVA) followed by Duncan's Multiple Range Test (DMRT) with a level of 5% using the SPSS version 16 program (Heryanto, 1996).

RESULTS AND DISCUSSION

Characteristics of Laundry Waste

The characteristics of the initial "X" laundry waste that was taken had a sharp smell and a cloudy white foam with a phosphate content of 2.6 mg/l, DO 7.4 mg/l, temperature 27.6 ^{0}C and pH 9.18. The average results of reducing phosphate levels in wastewater using *C. zizanioides* L. grass for 15 days can be seen in Figure 1.

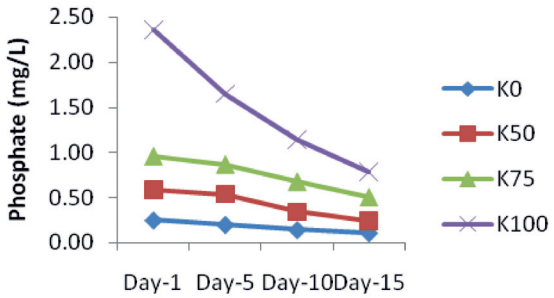

Fig. 1. Graph of the effect of phytoremediation treatment for 15 days

Based on the graph above, it shows that the phytoremediation test on laundry waste that is suitable for disposal to the environment is the K0 and K50 bioreactors, with a phosphate content of 0.25 mg/l, this is possible because at the plant propagation stage, manure is given. In addition, at the acclimatization stage, the plants were also treated with laundry water immersion with different concentrations every day. In the K50 bioreactor containing laundry water with a concentration of 50%, the initial phosphate content was 0.58 mg/L which decreased to 0.24 mg/l. This indicates that the grass root vetiver (*C. zizanioides* L) is able to absorb phosphate well.

The results of laboratory tests and data analysis showed a significant decrease in the value of phosphate (PO4-3) in each test for 15 days. This happens because microorganisms in the root zone begin to develop, and help break down the material, as shown in Figure 2.

C. zizanioides L is classified as an emergent aquatic plant that plays a very good role as a stabilizer in absorbing certain nutrients beyond their needs. Widjaja (2004) states that emergent aquatic plants with basic roots play a very important role as a stabilizer for the bottom of the water. Aquatic plants can also function as traps for organic matter in eutrophic waters, even certain aquatic plants that

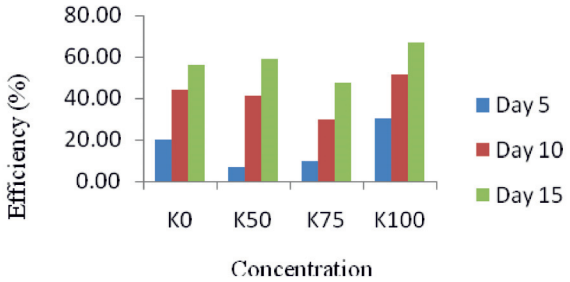

Fig. 2. Phosphate Reduction Efficiency for 15 days

have luxury uptake properties, which are active or able to absorb certain substances or nutrients beyond their needs.

From the statistical test it was found that the difference in the concentration of waste had a significant effect on the observed response, especially the difference in concentration in reducing phosphate levels. Widmer and Frick (2007), stated that detergents can be decomposed within a few weeks to several months while the ecolabel requirements provide a period of time for the decomposition of detergent waste in the environment only two days. From the research results, the coefficient of R2 = 0.967, this value indicates that the experiment with the given concentration difference model has been able to explain that the total diversity of phosphate removal in wastewater is about 96.7%, while the rest or 1 – R2 = 0.033 or 3 3% is due to trial error. In other words, the factor of differences in concentration and the length of time of exposure of the test plant for the grass root Vetiver (*C. zizanioides* L) in wastewater has been able to explain the total diversity as a response to the removal of phosphate levels in wastewater around 96.7%, while the remaining 3.3%. caused by other unknown factors. With a coefficient value of R2 = 96.7%, it is sufficient to indicate that the level of strength of the relationship between the difference in concentration given and the length of exposure time is very strong for the removal or reduction of phosphate levels in wastewater

Relationship between plant growth and water quality

The results of measuring water quality from day 1 to day 15, obtained an average pH value ranging from 7.57 to 8.36, which is in accordance with environmental quality standards, with a maximum pH limit of 9. Fardiaz, (1992) stated that the pH conditions that could be applied to plants ranged from 6.0 to 8.0. The decrease in the pH value of the detergent waste is thought to be due to the release of the sulfonate group from the detergent which is then oxidized to sulfate (Hermawati *et al.*, 2005) as shown in Table 1.

The temperature range for 15 days of the study ranged from 28.02 °C - 30.35 °C, still within the normal range for waste temperatures, as well as for the growth and life of aquatic plants, where the permissible temperature emission limit is 30 °C. The temperature range between 28.02 °C -30.35 °C isconsidered the optimal temperature to support the activity of microorganisms in decomposing pollutants (toxic substances) in laundry waste into nutrients to support the growth of the test plants. This is in accordance with Rahadian (2017) statement that a temperature of 15 °C–35 °C is the optimal temperature for microorganisms to treat pollutants contained in laundry waste.

The more dissolved oxygen (DO) levels in the

Table 1. Average improvement of laundry waste quality for 15 days

Concentration (%)	Parameter	Average Water Quality		
		Day-5	Day-10	Day-15
K0	pH	7.57	7.81	7.91
	Temperature	28.02	29.33	30.20
	Dissolved oxygen (DO)	7.07	9.57	9.15
K50	pH	8.09	7.89	7.83
	Temperature	28.35	29.53	30.02
	Dissolved oxygen (DO)	6.82	4.97	4.93
K75	pH	8.22	7.97	8.09
	Temperature	28.27	29.38	30.35
	Dissolved oxygen (DO)	6.00	4.75	4.48
K100	pH	8.36	8.05	7.92
	Temperature	28.42	29.27	30.13
	Dissolved oxygen (DO)	6.63	4.93	4.48

knockout bioreactor both on the average measurement for day 5, day 10 to day 15, followed by an increase in temperature. This data is said to deviate in theory, because according to Ahsan (2005), an increase in water temperature will cause several consequences including the amount of dissolved oxygen in the water decreases, the speed of chemical reactions increases, the life of fish and other aquatic animals is disrupted, if the lethal temperature limit is exceeded, fish and other aquatic animals will die. Dissolved oxygen can increase if the number of decomposers decreases because the organic matter in the wastewater has been completely decomposed.

Plant growth, both the addition of root length and leaves of the test plant grass Vetiver (*C. zizanioides* L) was the response of the test plant to the availability of water and nutrients. Roots are the main organs of plants in absorbing water, minerals and materials that are important for plant growth and development.

Optimal growth of root and leaf length growth occurred in K0 bioreactor, where this media was a growing medium as a control containing pure tap water without dilution, so that the test plants thrived in response to the photosynthetic process that went well. In contrast to the K100, K75 and K50 bioreactors that grow in media with high concentrations of detergent waste, stress test plants as a result of the disruption of the photosynthetic process thereby inhibiting the growth of root and leaf length, this is in accordance with the opinion of Siburian *et al.* (2020), which states that the growth of plant roots and leaves is strongly influenced by the nutrient content that is absorbed and the environmental conditions in which it grows. Environmental factors that affect plants include the availability of water, nutrients, climate and the presence of pests and diseases.

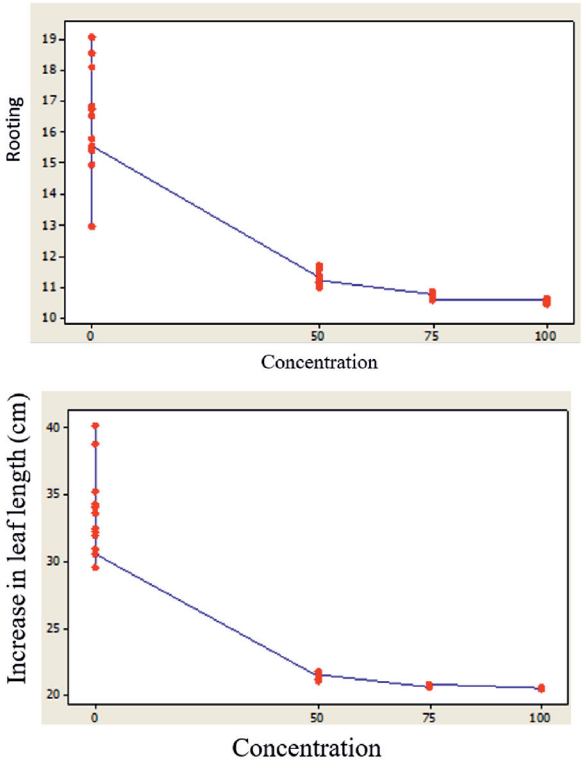

Fig. 3. Effect of Waste Concentration on Root and Leaf Length Growth

Based on the observations, it can be seen that the K0 bioreactor has the maximum growth. The high levels of phosphate in wastewater and low DO and pH levels in the K100 bioreactor caused the growth of roots and leaves to be disrupted or hampered as a result, the metabolism and respiration of the test plants were disrupted (the photosynthesis process did not run optimally) so that the growth of root length and leaf length was hampered. This is in accordance with Hermawati *et al.*, 2005, if phosphorus is present in excessive amounts then root growth will exceed the canopy. The accumulation of phosphate in the body will result in impaired binding of heavy metal ions. Plant roots play a very good role in absorbing phosphorus contained in wastewater. Excess phosphate in the vacuole is stored as polyphosphate deposits and in the form of inositol hexaphosphate (Raharjo, 2015).

Correlation test showed that the correlation value of the root growth of the Grassroots grass test (*C. zizanioides* L) was -0.549980, and the result of the plant leaf correlation test was -0.51889298. This illustrates that the relationship between root and leaf stem growth with the application of different phosphate concentrations is negative, meaning that the higher the concentration of waste, the smaller the root growth and leaf stem length.

Plant Biomass

Wet weight weighing aims to determine the

Table 2. Average Biomass Calculation Results (%) after the phytoremediation process

Concentration (%)	Average (gr)		Biomass(%)
	Day-0	Day-15	
K0	17.33	113	112,83
K50	22.33	80.33	80,05
K75	26.00	80.00	79,66
K100	29.00	75.67	75,25

absorption of water and nutrients contained in plants. The wet weight of the plant shows the amount of water content in plant tissues or organs other than organic matter (Hermawati, 2005).

The increase in plant biomass of the grass test *C. zizanioides* L showed that there was growth as a result of interactions involving environmental parameters such as light, temperature, water and other factors such as nutrients or in this case phosphate in the wastewater of the test media. Bioreactor K0 showed the largest total biomass production of 112.83%. Siburian *et al.* (2020) stated that plant growth is strongly influenced by internal and external factors of plant growth. The measurement results showed that the high laundry contaminants had an impact on the inhibition of the growth of the test plants which resulted in the lower plant biomass. Hermawati, *et al.* (2005) stated that plants whose photosynthesis is inhibited, the assimilation process will be disrupted so that it affects plant biomass. The results of the correlation test carried out on the concentration of laundry waste was -0.47850046, meaning that the higher the concentration of waste, the smaller the total plant biomass.

CONCLUSION

Utilization of *C. zizanioides*, L was able to reduce phosphate levels in laundry waste. Even if it will have a negative impact on plant growth if the concentration level of laundry waste is higher.

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