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Toxicity Test of Waste Oil Before and After Treatment Using Phytoremediation on Bioindicators

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ABSTRACT: Silugonggo River is a river that crosses Juwana District, Pati Regency, Central Java, which empties into the Java Sea. Industrial activities and workshops around the Silugonggo River cause river water to become polluted with used oil.. Even though many people around the river use the Silugonggo River for daily activities, one example is as a place to find fish for side dishes and traded.. The purpose of this study was to determine the concentration of lead in river water contaminated with used oil waste and the LC50 value of 0-96 hours against bioindicators, namely tilapia (Oreochromis niloticus), before and after being processed using phytoremediation. This research phase includes: 1) toxicity tests before treatment consisting of: preliminary tests with waste concentrations of 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100%, and actual tests with waste concentrations of 15, 16, 17, 18, 19, 20, 21, 22, 23, and 24%; 2) The process of treating waste oil with phytoemidiation using water hyacinth and kale plants is tested for plant weight variations. Plant weight variations are 200 grams, 300 grams, 400 grams, and 500 grams, and the process of processing waste oil is carried out continuously; 3) Post-treatment toxicity test consisting of: preliminary test with waste concentrations of 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100%, and actual tests with waste concentrations of 42, 43, 44, 45, 46, 47, 48, 49, 50, and 51%. The results showed that the effective weight in reducing lead in water hyacinth plants and kale plants was 500 grams with lead weight being <0.0058 mg / L (under Quality Standards according to the Decree of the Government Regulation of the Republic of Indonesia Number 82 of 2001 concerning Water Quality Management and Water Pollution Control). The LC50 value of 96 hours of waste oil before processing is 19.66%. The LC50 value 96 hours after processing is 46.69%.

KEYWORDS: phytoremediation, waste used oil, toxicity test

1. INTRODUCTION

The Silugonggo river is a river that crosses Juwana District, Pati Regency, Central Java. Indonesia. Industrial and workshop activities around the Silugonggo river cause the river water to become polluted with used oil. Used oil contains a number of substances that can pollute river bodies. In accordance with the statement (Kasman, et al., 2016) that waste or used oil residue contains combustion residue which is acidic, corrosive, deposits, and contain heavy metals such as lead (Pb). According to Naria (2005), the presence of lead (Pb) in environmental components, namely water, soil and air, allows the transmission of pollution to develop more widely in various living creatures, including humans, causing health problems, such as disruption of red blood synthesis, anemia and decreased intelligence in children.

Considering the significant impact of used oil on human health and the environment, waste containing used oil must be treated before being discharged into water bodies. One method for processing used oil waste uses phytoremediation. Phytoremediation is a waste processing method using plants as pollutant absorbers. The advantage of the phytoremediation method is easier and cheaper compared with chemical waste processing methods. Plants that are commonly used to process liquid waste are plants with high pollutant absorptivity and having survival ability in polluted water. According to Rondonuwu (2014), water spinach can absorb 83.84% of pollutants, while water hyacinth plants (Novitriani and Kusmiati, 2013) can reduce lead (Pb) by 61%. Based on the background description above, the following problem formulation is obtained. In the present work, a polluted water of Silugonggo river is treated using phytoremediation method. The aims of the work are to figure out Pb content of the water before and after treatment and to figure out whether the result qualifies the Government Regulation No. 82 of 2001 concerning Water Quality Management and Water Pollution Control. The work also purposes to examine the LC50 value of 0-96 hours in contaminated river water

2. MATERIAL AND METHOD

The equipment used for this research included 11 aquariums with a capacity of 10 L each, acclimatization tank, aerator, 150 L jerry can, pH meter, scoop, fishing net, label paper, log book, phytoremediation tank (60 cm long x 40 cm wide cm x height 30 cm). Meanwhile, the materials used are Tilapia fish, well water, used oil waste. The research is performed in 3 steps, i.e. acclimatization; before phytoremediation test, and after phytoremediation test

The acclimatization stage for bioindicators, namely fish test animals, is the stage of adjusting the test animals to laboratory conditions by placing them in an acclimatization tank containing well water for 7 days at a temperature of 25o-30o and continuously supplied with oxygen using an aerator. Preliminary tests were carried out to determine the concentration limit that causes 50% death of test animals. The concentrations of river water contaminated with used oil waste used in preliminary tests before and after processing using the phytoremediation method were 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100%. Each aquarium was filled with 10 tilapia fish and filled with a mixture of waste water and clean water according to the waste concentration of 10 liters. Then observations were made at 0, 24, 48, 72 and 96 hours. At each observation, the number of deaths of test animals in each aquarium was recorded. The actual test is a continuation of the preliminary toxicity test. The actual test is used to determine the LC50 value 0–96 hours by referring to the concentration of preliminary test results. The waste concentration used for the actual test was obtained from probit calculations from the preliminary test, namely using probit analysis and linear regression with SPSS or Statistical Package for the Social Sciences (Santoso, 2020). Probit analysis is an analysis that uses a statistical transformation procedure from the percentage of test animal death data (in this study tilapia or Oreochromis niloticus was used) into a variation called probit, which is then combined with pollutant concentration data (in this study used waste oil in the Silugonggo River) is used to determine the LC50 0–96 hours based on the linear regression equation.

Treatment of waste oil with phytoremediation begins with acclimatization of water hyacinth and kangkong plants, namely by placing the plants in the provided containers which have been filled with well water for 7 days. Variations in plant weight are 200 grams, 300 grams, 400 grams and 500 grams. Next, each plant was placed in a phytoremediation tank with a weight according to the results of the 48 hour residence time effectiveness test, with the aim of determining the level of effectiveness in reducing Pb levels. Processing is carried out using a continuous method, namely water flows from the storage tank to phytoremediation tank 1, followed by phytoremediation tank 2. Water from phytoremediation tank 2 is used for toxicity tests after processing which includes preliminary tests and actual tests.

3. RESULT AND DISCUSSION

The width of the Silugonggo River is around 20 m, the depth is 2.51 m and the discharge is 5.30 m3/second and the weather conditions during sampling were cloudy with a water pH of around 7 and a water temperature of 28˚C. Based on the Republic of Indonesia government's regulatory decision Number 82 year 2001 concerning water quality management and water pollution control, the concentration of Lead (Pb) for controlling water pollution is 0.03 mg/L, the concentration of Lead (Pb) in river water contaminated with used oil waste before processing was 0.0117 mg/L.

Table 1. Lead (Pb) concentration of used oil after processing using water hyacinth plants

No.	Weight (gram)	Pb concentration	
		Before (mg/L)	After (mg/L)
1	200	0,0117	<0,0058
2	300	0,0117	<0,0058
3	400	0,0117	<0,0058
4	500	0,0117	<0,0058
Standard Pb concentration: 0,03 mg/L			

From table 1 it can be seen that the results of processing river water contaminated with used oil waste, the smallest lead concentration is the same for both water hyacinth and water spinach plants, namely at a plant weight of 200 -500 grams, namely <0.0058 mg/L. Referring to research that has been conducted (Subaris *et al,*, 2007) that the effective weight of plants is 500 grams, both water hyacinth and water spinach plants can reduce lead by 50.4% because both plants contain special tissue called aerenchima which functions as a means of transporting oxygen so that elements from soil or water are absorbed more quickly by plants. Based on the Republic of Indonesia government's regulatory decision Number 82 of 2001 concerning water quality management and water pollution control, the concentration of Lead (Pb) for controlling water pollution is 0.03 mg/L so that the lead level after processing is below the quality standard.

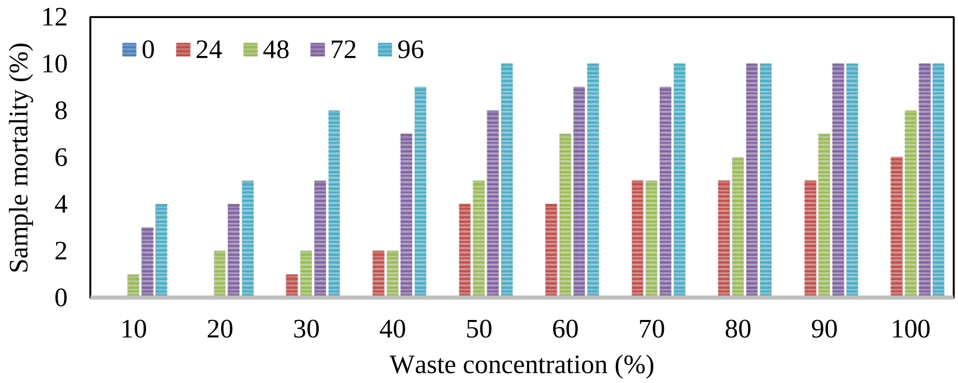

Figure 1. Sample mortality before phytoremediation test

Based on Figure 1, it can be seen that the higher the concentration of river water contaminated with used oil waste, the higher the mortality of tilapia test animals (directly proportional). This means that the higher the concentration of contaminated river water, the higher the level of toxic lead. As a result, the mortality value of test animals is higher. According to (Yuniar, 2009), this shows that the longer the contact time of liquid waste with bioindicators, the average number of deaths will increase due to the decreasing durability of bioindicators. Furthermore, after the data in Figure 1 was analyzed using probit regression using SPSS, the LC50 value at 96 hours of observation was 18.99%. This means that the concentration range used for actual testing on river water contaminated with used oil waste before processing using phytoremediation is a liquid waste concentration of 15 - 24%.

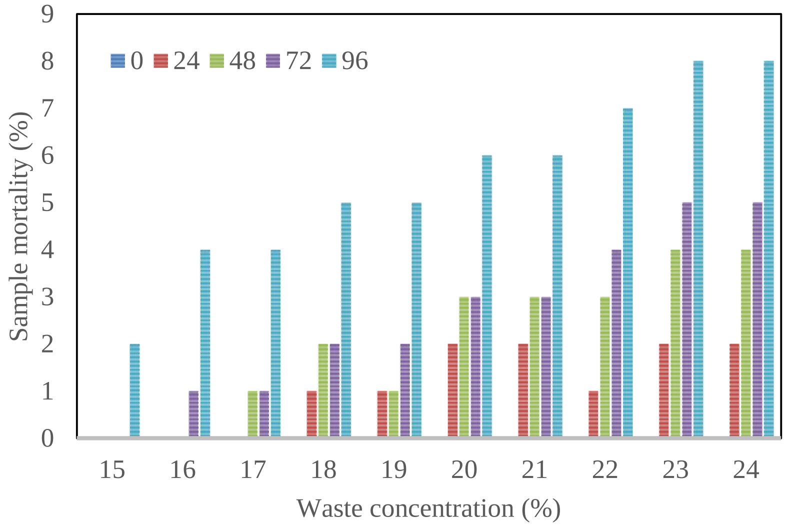

Figure 2. Mortality of tilapia test animals from used oil waste in the actual test before phytoremediation

Based on Figure 2, it can be seen that the higher the concentration of river water contaminated with used oil waste, the higher the mortality of the test animals and the longer the observation time, the higher the mortality of the test animals. According to (Yuniar, 2009), the relationship between the level of lead toxicity and fish mortality is directly proportional. The higher the level of toxicant given, the greater the mortality of the test fish. This is caused by the higher the level of toxicant, the higher the accumulation will occur so that the mortality of tilapia will be greater.

The concentration variations used in the preliminary test after processing using phytoremediation were 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100%. The results of preliminary tests on river water contaminated with used oil waste after processing can be presented in Figure 3.

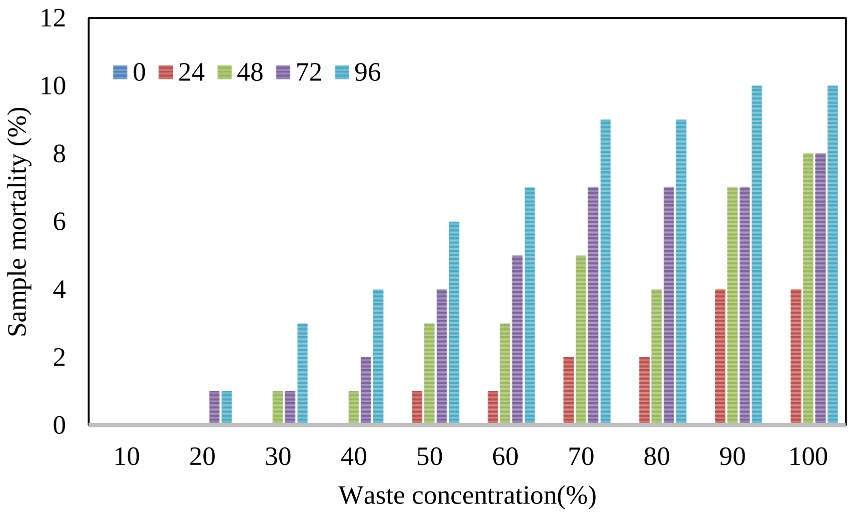

Figure 3. Mortality of tilapia from used oil waste in preliminary tests after phytoremediation

Figure 3 shows that tilapia fish mortality decreased after processing using phytoremediation. This is caused by decreasing lead levels. The death of test animals is not always caused by a single factor but is also caused by a synergistic phenomenon, namely a combination of two or more substances that strengthen the poison's power. The lethal effect of a pollutant on living things is a response that occurs when xenobiotic substances disrupt cell or sub-cell processes in living things to an extent that causes direct death (Prayogo *et al.*, 2016). Then, after being analyzed using probit regression using SPSS, the LC50 value at 96 hours of observation was 46.18%. This means that the concentration range used for the actual test on river water contaminated with used oil waste after processing using phytoremediation is a liquid waste concentration of 42 - 51%, with concentration details: 42%, 43%, 44%, 45%, 46%, 47%, 48%, 49%, 50%, and 51%. The actual test results on river water contaminated with used oil waste after processing can be presented in Figure 4.

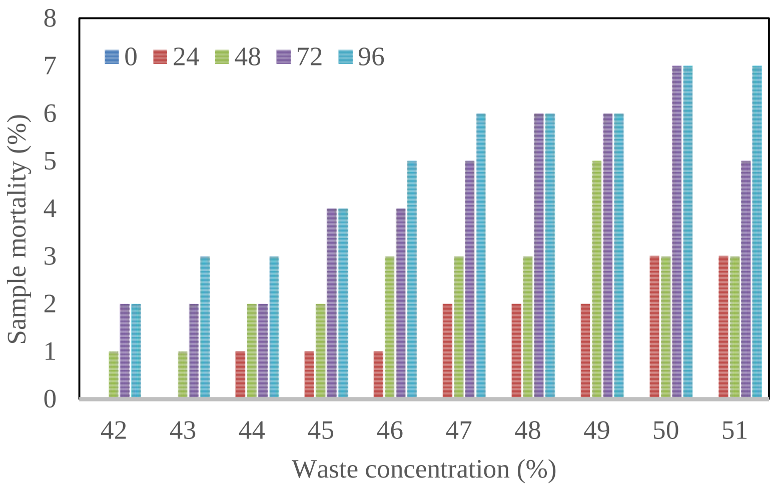

Figure 4. Mortality of tilapia test animals from used oil waste in actual tests after phytoremediation

Based on Figure 4, it can be seen that the higher the concentration of river water contaminated with used oil waste, the higher the mortality of test animals and the longer the observation time, the higher the mortality of test animals. It can be seen that the LC50 value of 96 hour observations is at 46.69%.

Table 2. Improvement of LC50 0–96 hours of used oil waste in actual tests phytoremediation

No	LC50 0 – 96 h Before	LC50 0 – 96 h After	Toxicity Improvement LC50 0 – 96 h
1	LC50 – 0 h = -	LC50 – 0 h = -	-
2	LC50 – 24 h = 28,16%	LC50 – 24 h = 53,30%	47,16 %
3	LC50 – 48 h = 23,32 %	LC50 – 48 h = 53,32%	56,26%
4	LC50 – 72 h = 23,33 %	LC50 – 72 h = 47,84%	51,22 %
5	LC50 – 96 h = 19,66 %	LC50 – 96 h = 46,69 %	57,89 %

Based on Table 2, the longer the time the used oil waste is in contact with the test fish, the average number of fish deaths will increase at lower concentrations of used oil waste water. It is suspected that the resistance of the test fish as a bioindicator will decrease over time, so that even at low waste concentrations it can kill the fish. Used oil wastewater is likely to accumulate in the gills, skin and other parts of the fish so that it can disrupt the respiratory and digestive processes which ultimately results in the death of the test fish, because used oil wastewater according to (Rolling, *et al.*, 2002) is categorized as B3 waste because it has toxic characteristics and is flammable. Used oil can pollute land and water if it is thrown into the environment. So used oil must be managed as B3 waste.

The toxicity of used oil wastewater to test fish based on LC50 0-96 hours is relatively higher in used oil wastewater before phytoremediation, compared to used oil wastewater after phytoremediation. This means that the mortality of test fish based on LC50 0-96 hours of used oil waste water before phytoremediation was carried out occurred at a lower concentration (15 - 24 %) when compared to used oil waste water after phytoremediation (42 - 51 %). Based on table 2, the reduction in toxicity in used oil wastewater before phytoremediation was carried out on test fish based on LC50 0-96 hours was 47.16 – 57.89%. Used oil wastewater before phytoremediation has a safe limit for fish life at a concentration of 2.332% (10% x LC50-48), while used oil wastewater after phytoremediation has a concentration of 5.332%. So based on the 0-96 hour LC50 data and the safe concentration of used oil wastewater, it turns out that it can be proven that phytoremediation can actually reduce the toxicity of used oil wastewater originating from industrial and workshop activities that pollute the Silugonggo River which crosses Juwana District, Pati Java Regency. Central, which empties into the Java Sea.

4. CONCLUSSION

Improvement of toxicity of river water contaminated with used oil waste based on LC50 0-96 hours, namely, LC50 0 hours = -%, LC50 24 hours = 47.16 %, LC50 48 hours = 56.26 %, LC50 72 hours = 51.22 % and LC50 96 hours = 57.89 %. The most effective reduction in lead in plants weighing 500 grams was a reduction of 50.4%. Based on the Republic of Indonesia government's regulation, the Lead (Pb) concentration for controlling water pollution is 0.03 mg/L, meaning that the lead concentration from the research results is <0.0058 mg/L which is still below quality standards. Further research is needed to analyse other parameters besides Pb contained in Silugonggo River water. Apart from that, it is also necessary to carry out research using other plants in phytoremediation test

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