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Toxicity of Single and Mixed Compounds to Water Hyacinth

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ABSTRACT

The purpose of this study was to determine the level of substance toxicity in individual tests and mixed tests through a comparison of EC_{50} values by looking at the effect of growth inhibition, namely not the emergence of new shoots. For plants carried out by batch reactor system with observation time for 4 days. This research consists of several stages, namely leach characterization as the initial data for making toxicants, single toxicity test and mixed exposure test. The results showed the biggest removal efficiency in the mixture is formaldehyde.
KEYWORDS: water hyacinth, glucose, ammonium, formaldehyde

INTRODUCTION

The use of aquatic and wetland plants, such as water hyacinth, to uptake pollutants in wastewater treatment is considered by researchers [1]. Some pollutants such as organic matter be toxic for water hyacinth. Ammonium, glucose, and formaldehyde were chosen to represent exposure levels in the environment. Ammonium is widely used as a drug, an agent in the treatment of metabolic alkalosis, in food as an additive for cakes and drinks. Glucose is a source of energy found everywhere in biology. Glucose is widely used especially in the food industry [2]. Formaldehyde is one of the important compounds in the chemical industry, daily household products such as home cleaning materials, paper, shampoo, deodorants, toothpaste, lipstick, nail coloring, pesticides, and has a very large role in the manufacture of hard thermoset resins [3].

Water hyacinth effectively helps clear the river because it is phytoremediation which can absorb organic, inorganic and other heavy metals which are pollutants [4]. The presence of water hyacinth as an aquatic biota can be used as an indicator of certain pollution in water bodies and the adverse effects on the surrounding ecosystem. On many occasions, biota are exposed not only to one type of substance, but to exposure to toxic substances that contain many substances. Negative effects are toxic for living things based on the interaction of many substances in the environment [5].

Based on the description above, it is necessary to do biological testing of toxic mixtures in laboratory-scale research. Toxicity such as ammonium, glucose and formaldehyde are subjected to toxicity tests using test organisms. With this toxicity test, it can be seen all the effects of ammonium, glucose and formaldehyde on aquatic biota which can be in the form of effects on growth which cause effects of ecosystem changes. This can illustrate the level of certain pollution in the environment and the adverse effects on the surrounding ecosystem.

METHODS

Initial Data Collection

The initial data needed in the study was the characterization of leachate in TPA Benowo. This data is used as the basis for making ammonium and organic matter concentrations (BOD and COD). Data were obtained by sampling and analyzing leachate quality of TPA Benowo, Surabaya with the following parameters. The results of the analysis of ammonium, BOD and COD concentrations will be used as the basis for making toxics for toxicity tests namely ammonium, BOD (glucose) and the difference in COD and BOD values for the value of non-biodegradable organic matter (formaldehyde).

Preparation of Test Biota

All plants used in toxicity tests must be propagated in advance to obtain test plant saplings. After the propagules reveal the new leaf buds are used for test biota [6]. The water hyacinth plant (*Eichornia crassipes*) used from the propagation stage is the second generation which has specifications with criteria, namely: leaves that are still fresh and not yellowing, plant age is around 20 days, plant height is 18.3 cm and plant weight is around 27-30 grams. During this process the plants must get enough sunlight for photosynthesis, the space to grow is large, the water is calm, the temperature is between 20-30ºC. The reactor is placed in the Plant House and the pH for the growth of water hyacinth ranges from 4.5 to 7.5.

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Single Toxicity Test

In each container used, plants with wet weight 1 plant water hyacinth weighing 27-30 grams were placed which had almost the same height. The number of test plants is 4 pieces for the RFT test. Variations in toxic concentrations are distinguished in the percentage of toxicity, which is equal to 0% (control); 20%; 40%; 60%; 80% and 100% [7]. For control, it only contains water hyacinth and diluent water without toxicity.

Mixed Exposure Test

The Acute Toxicity Test aims to determine the toxic concentration that can cause a 50% effect of the test biota in a relatively short time. For each different concentration, repeated 3 times. In each reactor in the plant test 10 water hyacinths were given in 10 liters of water. Toksikan like ammonium, glucose and formaldehyde mixed and put into the reactor according to the concentration obtained from the RFT results. Negative effect data that occurs in plants obtained at 96 hours was used to determine the EC_{50} value. Variations in toxic concentration were determined in the narrowed range finding test. For control, it only contains water hyacinth and diluent water without toxicity.

RESULTS AND DISCUSSION

Characteristics of Leachate

Leachate used came from the Benowo landfill collection pool. Samples were analyzed to determine the initial characteristics of leachate. The parameters used were BOD, COD, pH, temperature, turbidity and NH_4. They were used as the basis for making artificial waste concentrations.

Single Toxicity Test

Variations in ammonium concentration given are 0%, 20%, 40%, 60%, 80% and 100% or equivalent to the control solution; 147 mg/L; 294 mg/L; 441 mg/L; 588 mg/L and 735 mg/L. The reactor body used is in the form of a plastic tub with a volume of 4 L of water, the number of test plants is 4 [8] and this stage is carried out for 4 days. The result of the range finding test that will be chosen is the concentration of ammonium which does not have a negative effect on plants, namely the concentration that makes the water hyacinth shows new shoots and remains fresh. In this case NH_4^+ inhibits the growth of shoots, but not on the leaves and stems so that they remain green. In the first stage, namely with NH_4 until the fourth day, so the concentration of NH_4^+ used is at 40%, namely the concentration of NH_4^+ 294 mg/L in plants E. crassipes, because at concentrations of 60%, 80% and 100% do not show new shoots. The EC_{50} ammonium value of E. crassipes obtained was 322 mg/L.

In glucose, all concentrations produce shoots in all plants. Plants themselves produce glucose through photosynthesis which is stored by plants and used as their nutrition. Because at a concentration of 1.017 mg/L, the plants still germinate, the glucose concentration is increased to get a concentration where glucose has a negative effect on the single toxicity test. Based on the above line equation, the EC_{50} glucose value obtained on the single toxicity test was 1,193 mg/L. Glucose can have a negative effect on plants that is not the growth of new shoots when the concentration is excessive in plants. When the density of water in the growing media is lower than the density in plant roots, osmosis can occur well. Addition of glucose in high concentrations can increase osmotic pressure. When high concentration of glucose is added, the osmotic gradient decreases and causes absorption of water to the plant roots to decrease. Plants will lack fluids and growth will be hampered [9].

In formaldehyde, all water hyacinths are able to show new shoots at a concentration of 0.07 mg/L within 3 days. Formaldehyde includes non-biodegradable organic substances which are toxic. Formaldehyde is a toxic organic matter, with the increasing level of toxicity of a substance, the higher the toxicity of a substance can cause biota to die [10]. Formaldehyde is very difficult to decompose in nature and requires a long time to decompose. This can also be seen from the results of the RFT, where almost all concentrations of formaldehyde have an effect on E. crassipes. The concentration of effect that causes 50% biota to not sprout is 0.085 mg/L.

Mixed Exposure Test

After getting the concentration range in each test solution, namely the concentration where the water hyacinth is able to live 100% or which shows new shoots, then the three test solutions, namely NH_4, glucose and formaldehyde will be mixed to find out the effects that occur when the substances interact. The increase of glucose EC_{50} value during individual toxicity test with mixed toxicity test was 1193 mg/L to 1307 mg/L (8.74% decrease in toxic properties). Ammonium EC_{50} value is 322 mg/L to 361 mg/L (10.88% decrease in toxic properties), EC_{50} value of formaldehyde is 0.085 mg/L to 0.4 mg/L (97.6% reduction in toxicity) . Based on the results of the study, there were differences in the effect of concentration between individual toxicity tests on each substance and toxicity test when all three substances were mixed. The difference is greater with the decreasing level of formaldehyde toxicity, which indicates that the substance is antagonistic, when the value of $EC_{50\text{-mix}} > EC_{50\text{-individual}}$.

CONCLUSION

Formaldehyde was the most toxic compound for *Eicchornia crassipes*. In addition, the compound possessed the biggest removal efficiency in the mixture of compunds containing glucose and ammonium. It suggested for further research.

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