Toxicity of Cadmium (Cd) on *Artemia salina*

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Abstract

Cd is a non-essential metal and a widespread micropollutant that has physiological effects on aquatic organisms. Cd heavy metal poisoning can be acutely caused by contamination at high doses, while chronic poisoning is generally caused by low levels of contamination and long exposure time. This research was conducted in June 2022 at the Marine Chemistry Laboratory Faculty of Fisheries and Marine, Universitas Riau, which aims to determine the value of LC_{50} (*Lethal Concentration*) for 24 hours after being given a toxicant in the form of Cd and to determine the level of Cd toxicity in *A. salina*. The method used in this research is the experimental method with the experimental unit *A. salina*. The LC_{50} of Cd on *A. salina* revealed 11.7109 mg/L. This concentration is capable of causing the death of 50% of the test animals. Furthermore, the water quality in the acute toxicity test, P0 (control), was classified as good to support the life of *A. salina*, while at P1 (3.13 mg/L) - P5 (50 mg/L), it was classified as polluted.

1. Introduction

Water pollution can occur because industrial and domestic waste is discharged into waters without being treated first. However, the pollutant levels are still above the established Quality Standards. Some industries produce waste that contains hazardous chemicals such as heavy metals, thus changing the physical and chemical appearance of polluted water such as cadmium (Cd). Metals found in the aquatic environment are generally in the form of ions. The ions are free, organic ion pairs, complex ions and other forms of ions (Palar, 2008).

Cadmium (Cd) is a non-essential metal and a micro-pollutant that is widespread and has physiological effects on aquatic organisms. Cadmium (Cd) is often used as the main or additional material in the industry (Setiawati, 2009), including the nickel-cadmium battery industry (50-55% of world consumption), pigments (18-20%), coating materials (8-12%), stabilizers in the plastic industry and other synthetic goods (6-10%). By the end of the 20th century, 45% of the total global pollution was cadmium metal. Cadmium heavy metal poisoning can be acutely caused by contamination at high doses, while chronic poisoning is generally caused by contamination at low levels and long exposure times.

Connel & Miller (1995) stated that acute toxicity tests are beneficial for assessing the harmfulness of chemicals to life in water. Toxicity testing is administering a compound to test animals to determine toxic effects. This test can show the target organs that may be damaged and their specific toxic effects and provide clues about the doses that should be used in more extended tests. Methods used in toxicity testing consist of LC (*Lethal Concentration*), ED (*Effective Dose*) and ET (*Effective Time)* (Schmitz, 2008).

Artemia salina is one of the test animals that can be used for toxicity testing. Artemia is one of the mainstay commodities in the fisheries subsector and is quite sensitive to heavy metal pollution. Therefore, information is needed on the toxicity value of several heavy metals to the life of Artemia as a reference material in setting or reviewing the quality standards of liquid waste for industrial

activities so that the aquatic environment is in good condition for the use and rational management of coastal areas can be realized.

2. Methodology

2.1. Time, Place, and Materials

This research was conducted in June 2022 at the Marine Chemistry Laboratory, Faculty of Fisheries and Marine Sciences, Riau University.

2.2. Method

The method used was experimental. *A. salina* eggs were hatched in a 0.5 g egg incubator filled with 1000 mL seawater and supplied with oxygen using an aerator. Eggs will hatch after 18-24 hours and are ready to be tested after 48 hours.

2.3. Procedure

Before conducting definitive tests, preliminary tests were conducted to determine the range of cadmium (Cd) concentrations to be tested. This test was conducted because no information or literature on cadmium toxicity to A. salina has been found. This test was conducted to obtain the final concentration range of cadmium heavy metal that will be used for the definitive test. The concentration of heavy metal $CdCl_2$ in the preliminary test refers to the concentration suggested by Rand & Petrocelli (1985), namely = 0.00; 0.1; 1.0; 10.0; 100.0; 1000.0 mg/L. At the same time, the test water quality was measured.

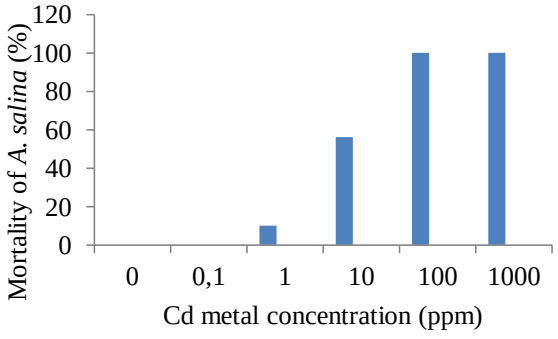

Figure 1. Results of the preliminary test for Cd metal against *A.salina*

Furthermore, the definitive test is the final stage and is carried out to determine whether or not a material is toxic to an organism. The concentration is based on the LC value$_{50}$ obtained from the preliminary test results. After obtaining the number of deaths in the preliminary test, it is recommended that the dilution factor used be 0.5 of the upper limit concentration (US EPA, 2000). This test was conducted for 24 hours with three replicates for each concentration. The test solution that has been made is put into a 250 ml Erlenmeyer as much as 100 ml. Preparation of the test solution starts from control: 3.13, 6.25, 12.5, 25 and 50 ppm.

2.4. Data Analysis

Analysis The probit analysis used is based on the linear regression equation, calculated by knowing the mortality of *A. salina* larvae and then calculating using the line equation.

3. Result and Discussion

Before conducting toxicity tests, preliminary tests need to be carried out to determine the concentration range to be tested. This test was carried out because no information or literature on the toxicity of Cd to *A. salina* has been found. The test was conducted 24 hours using a concentration sequence (ppm) of 0, 0.1, 1, 10, 100, and 1000, with three replicates for each concentration (Figure 1).

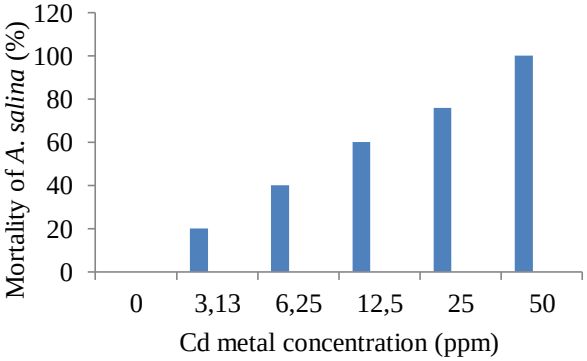

Figure 2. Results of the test for Cd metal against *A.salina*

Figure 1, it can be seen that in the control and concentration of 0.1 ppm, no test animals died. In comparison, at a concentration of 1 ppm, Artemia had begun to die as much as one tail, and the highest mortality was found at a concentration of 100 ppm and 1000 ppm, which was as much as ten tails.

After obtaining the number of deaths in the preliminary test, it is recommended that the dilution factor used be 0.5 of the upper limit concentration (US EPA, 2000). Therefore, the

highest concentration to be used is 0.5 of the upper limits of 100 ppm, which is 50 ppm and then 0.5 of 50 ppm and so on. Then, the results of the new concentrations used for the primary test are 3.13, 6.25, 12.5, 25 and 50 ppm.

Figure 2, it can be seen that in control, no test animals died, while at a concentration of 3.13 ppm, *A. salina* had begun to die, namely as many as two tails and the highest mortality was found at a concentration of 50 ppm as many as ten tails. After 24 hours of exposure (Figure 2), the number of surviving Artemia decreased as the concentration of cadmium heavy metal increased. The observation of the toxicity test on *A. salina* in the first 15-20 minutes showed a decrease in the movement of the test animals. Some Artemia began to lose the ability to swim in the water sample. After that, within 5-6 hours at each different concentration, the death of the test animals was already shown. All the animals died after 24 hours at Cd metal concentrations above 50 ppm.

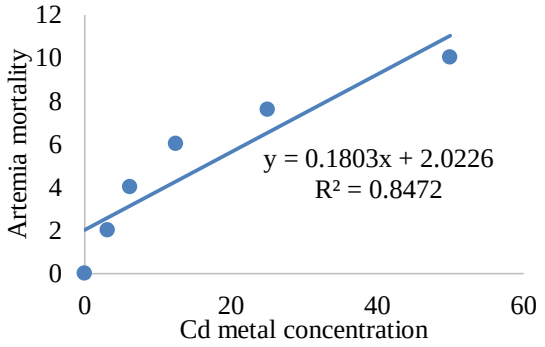

Figure 3. Probit Regression Analysis of *A.salina*

Based on the regression graph of *A. salina* (Figure 3), the trend line shows the values of a and b for heavy metal Cd are 0.1803 and 2.0226, respectively. The lethal concentration to be calculated is 50% mortality, and the y value is 5. So that the probit logarithm is converted into antilog with x10, the LC value50 for *A. salina* at Cd metal concentration is 11.7109 ppm.

The results show that the concentration exceeded the established quality standards. So, if water is found with Cd metal content, as shown in the results of this study, further water treatment is needed to remove the heavy metal content. The addition of Cd metal to the water used as a sample in animal tests and the deaths obtained at each concentration and repetition show that Cd metal harms the environment and living things (Musyarofah, 2017).

Mortality calculations also align with observations of test animals after administering heavy metal Cd as a pollutant, where the more significant the concentration added, the greater the mortality of test animal deaths. It cannot be denied that Cd metal is a heavy metal that has high toxicity because it can cause the death of test animals during the experiment (Reis et al., 2017).

In addition, test animals that have been exposed to Cd or other heavy metals can be seen through hyperactive movements, paralysis and then death. According to (Christin et al., 2015), test animals that have been contaminated will show symptoms of stress as a process to reduce biochemical reactions that occur between toxic substances in the body, thus slowing down the toxic effects received.

4. Conclusion

Based on the results of this study, it can be concluded that the higher the concentration given, the mortality of *A.salina* is also higher, starting from a concentration of 3.13 ppm *A. salina* has begun to die as many as two tails to the highest concentration of 50 ppm *A. salina* experienced death as many as ten tails. Cd metal tested against *A. salina* provides a toxic effect with an LC_{50} value of 11.7109 ppm, which can cause the death of 50% of the test animals.

During the final test, the concentration should be lower than 50 mg/L Cd to obtain the LC_{50} value in a more extended exposure period of 96 hours (LC_{50} -96 hours).

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