The Destructive Effects Cu (II) on Various Organs of Wistar Rats

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Abstract. Heavy metal pollution in wastewater is always a serious environmental problem, because heavy metals cannot be degraded and can accumulate in living tissue. Cu (II) can cause poisoning and impairing various organs. This study aims to investigate the effect of induction of Cu (II) ions on the organs of rats. In this study the rats are injected by 1000 mg/L Cu (II). After 5 hours, these three rats' blood were taken in each organ, observes rats' organs. In the observation, the rats' organs were accumulated by Cu (II) include Lungs (332.5 x 10^{-4} mg/g), Heart (319.9 x 10^{-4} mg/g), and Kidneys (1103.8 x 10^{-4} mg/g). The distribution of Cu (II) accumulation looks unevenly where the lowest concentration is found in the Lungs and the highest concentration is found in the kidneys. The damage of organs are very dangerous which can lead to various health problem. Further studies are needed to investigate some disease which are related to the organs' damage due to accumulation of Cu (II).

Keywords: Destructive effect, Cu (II), Organ.

1. Introduction

Heavy metal pollution in wastewater is always a serious environmental problem, because heavy metals cannot be degraded and can accumulate from living tissue. Rapid industrial development contributes to the release of toxic heavy metals in water flow, so the problem of pollution or pollution of heavy metals is a major problem in developing countries. Cu (II) is a metal that is widely used in industry, and is an essential trace element for human health and plays an important role in carbohydrate and lipid metabolism. According to WHO the maximum concentration of Cu (II) that can be received in drinking water is 1.5 mg / L. The adult human body contains 100-150 mg Cu (II), the amount that exceeds the level above will cause poisoning [1].

In the case of copper poisoning it can inhibit the enzyme dihydrophihydratase involved in haemopoiesis and homeostasis. High copper content in the human heart can cause Wilson's disease, thalassemia, hemachromatosis, yellow atrophy in the liver, tuberculosis and carcinoma. Chemical physics methods such as chemical deposition, oxidation reduction processes, electrochemical
treatment, filtration, and membrane technology have been widely used in industrial and waste disposal. This process is less effective and expensive, especially when heavy metal ions in the solution contain 1-100 mg/L of severely decomposed heavy metal ions [2]. Several techniques have been applied to remove heavy metals from the air. They are such membrane filtration, ion exchangers, and chemical controllers. Chemical physics methods such as chemical deposition, oxidation reduction processes, electrochemical treatment, filtration, and membrane technology have been used extensively in industrial and waste treatment. This process is less effective and expensive, especially when heavy metal ions in the solution contain 1-100 mg/L of severely decomposed heavy metal ions. Another disadvantage of the above methods is that it is not effective when heavy metals are in low concentrations, and can even cause secondary cesspits which are more difficult to remove [1,2].

Biosorption is the ability of certain active biomass or microbes to bind heavy metals from solution. A biopsy or bioaccumulation is an attractive alternative in removing heavy metals in solution. Biomass can act as a chemical compound, as an ion exchanger, and can absorb more than 25% dry weight in attracting metal ions; Pb, Cd, U, Cu, Zn, Cr and others [2]. Recently, there are many studies about biosorption of heavy metal. One of these studies is research of Sirilamduan et al (2011) reported that Using a biomass of salak skin (Zalacca edulis) to adsorb modified Cu (II) ions with CaCl2. The results showed the treatment of biomass with CaCl2 accelerated the biosorption capacity of Cu (II) ions based on the Langmuir equation, absorption of Cu (II) ions by Zalacca edulis treated with CaCl2 was 27.03 mg/g at pH 5. In another study, Wahyuni et al. (2014), Using langsat fruit seeds (Lansium domesticum Corr) with a batch method for adsorption of Cd (II) and Cu (II) ions. The optimum pH for adsorption of Cu (II) is 4 and pH 6 for Cd (II). The optimum biosorbent temperature was 40°C and the maximum adsorption capacity for Cd (II) was 5.71 mg/g and 4.99 mg/g for Cu (II).

Babaknejad et al (2015) [3] which analyzed the parameters of serum Cu (II) toxicity associated with kidney function in male Wistar rats. The thirty male Wistar rats were grouped into 3 groups (N = 10) where the first group as a control was injected by 0.5 mL ordinary salt solution. Second and third Group was injected by 0.5 and 1.5 mg/kg Cu (II) respectively through intraperitoneal injection for 21 days. The research question is how the effect of giving induction of Cu (II) ions to the organs of rats. This study aims to investigate the effect of induction of Cu (II) ions on the organs of rats. The benefit is to find out the case of Cu (II) ion poisoning in the organs of rats. Copper sulfate is a crystal salt that is blue and can cause poisoning in the digestive tract and damage to the intestine. At a maximum dose of 0.5 gr it will cause nausea and if more doses of it will cause poisoning and irritation. Copper is a strong enzyme inhibitor [6].

Based on these facts. This study has purpose to investigate the impact of Cu (II) against various organs in the body using in vivo model (Mainly against lung, heart, and kidney).

2. Methods

In this study, there are six rats which use as samples. The six rats was grouped into 2 group. Three rats were group as a control group and the remain rats were group as Cu Group which were used to determine the spread of metals in each organs. The Cu Group was induced with 1000 mg/L Cu (II) at a dose of 1 mL x weight of rat/200 g rat body weight by injecting in the near part of the stomach. After 5 hours the 3 rats are taken by blood and each organ consists of the heart, lungs and kidneys. The solution of Cu (II) was obtained from CuSO4·5H2O crystals weighed 3,9302 g and dissolved into 1L volumetric by aqueadust gradually. Observation of rats organ damage after Cu (II) was observed. The damage of the organs was determine using the blood sample from each organs.

Determining level of the Cu (II) in the organs by putting the crushed’s organs into porcelain cup which had been heated in 100-105°C. After that, porcelain cup are oven until the water gone. Then put into furnace for 6 hours in 600°C. The sample in porcelain was put into fume hood, then added 3mL of 86% HNO3 and heated until the HNO3 remained a little in porcelain and added 1 mL of distilled water. Then dissolve to 10 mL in to measuring flask. Determination level of Cu (II) in
samples was using AAS. The measurement results are then calculated for the metal content of each in the organs of the rats in each group.

Figure 1. Model of Intervention in Group Samples

3. Results and Discussion

Table 1. The level Cu (II) in the Various Organs of Wistar Rats Group I and II

| No | Organs   | Control (x 10^{-4} mg/g) (Group I) | Cu (x 10^{-4} mg/g) (Group II) |
|----|----------|-----------------------------------|---------------------------------|
| 1  | Lungs    | 136.1                             | 332.5                           |
| 2  | Heart    | 160                               | 319.9                           |
| 3  | Kidney   | 324.6                             | 1103.8                          |

Based on the table, it can be seen that there is accumulation of Cu (II) in all organs of experimental rats which includes the heart, lungs, and kidneys. The distribution of Cu (II) accumulation looks unevenly where the smallest concentration is found in the Lungs and the highest concentration is found in the kidneys. In second group, which is a group of rats which were only treated with Cu (II), there was an increase in the levels of Cu (II) in all organs. The ranges of Cu (II) concentration from the lowest to the highest in second group are Heart, Lungs and Kidneys. This increment concentration is due to the presence of functional groups such as hydroxyl groups, acboxylics, sulfates, amines, amides and phosphates found in biosorbents [7].
Based on Figure 2 above, the level of Cu (II) in group control was the highest level in kidney (324.6 x 10^{-4} mg/g) and the lowest in lungs (136.1 x 10^{-4} mg/g). In the others hand, the highest level of Cu (II) in Cu Group is kidney (1103.8 x 10^{-4} mg/g) and followed by lungs (332.5 x 10^{-4} mg/g) and heart.

Copper can also accumulate in water and soil even at higher levels it can attach to clothes and skin. Circulation and metabolism of copper in the body requires good function of liver, bladder and adrenal glands. If one of these organs is impaired, the body is unable to excrete and utilize copper properly. Copper will accumulate in the liver, the subsequent effects can cause inability to excrete copper. Increasing copper concentrations will cause accumulation of the brain, joints and lungs, which will affect tissue structure and function [6]. "Vineyard's sprayer" lung disease was first reported in 1969, referring to lung disease that arose among vineyard workers in the Portuguese who used Bordeaux solution, a 1-2% copper sulfate solution neutralized with calcium hydroxide. They experienced lung fibrosis and histocytic granulomas containing copper. Most of these workers also experienced pulmonary adenocarcinoma, hepatic angiosarcoma and micronodular cirrhosis, increasing the likelihood of carcinogenic effects from chronic exposure to copper [8].

4. Conclusion
The distribution of accumulation of Cu (II) looks unevenly in each organ which founds highest in kidneys (1103.8 x 10^{-4} mg/g) and lowest concentration in heart (319.9 x 10^{-4} mg/g) Further research is recommended looking for prevention of Cu (II) increment.

References
[1] Ahmed, A.J., Begum, A.S., 2012. Adsorption Of Copper From Aqueous Solotion Using Low-Cost Adsorbent. *Archives of Applied Research*. 4(3) :1532-1539
[2] Khan, S., Farooqi, A., Danish, M.I., Zeb, A. 2013. Biosorption Of Copper(II) From Aqueous Solution Using *Citrus sinensis* Peel And Wood Sawdust: Utilization In Purification Of Drinking And Water. *IJRRAS*. 16(2);297-306.
[3] Sirilamduan, C., Umpuch, C., Kaewsarn, P. 2011. Removal Of Copper From Aqueous By Adsorption Using Modify Zalacca edulis peel modify. Songklanakarin Journal Of Science And Technology. 33(6):725-732.

[4] Wahyuni, D., Furqani, F., Astuti, A.W., Khoiriah, Indrawati, Zein, R., Munaf, E. 2014. Removal Of Cadmium (II) And Copper (II) From Aqueous Solution By Using Langsat Fruit (Lansium Domesticum Corr) Seed. Research Journal Of Pharmaceutical, Biological And Chemical Sciences. 5(5):1320-1328.

[5] Babaknejad, N., Moshtaghie, A.S., Shahanipour, K. 2015. The Toxicity Of Copper On Serum Parameters Related To Renal Functions In Male Wistar Rats. Zahedan Journal Of Research In Medical Sciences. 15: 29-31.

[6] Ashish, B., Neeti, K., Himanshu. 2013. Copper Toxicity: A Comprehensive Study. Research Journal Of Recent Sciences. 2: 58-67.

[7] Shresta, B. Homagai, PL. Pokhrel, MR. Gimire, KN. 2012. Exhausted Tea Leaves-a low cost bioadsorbent for the removal of Lead (II) and Zinc (II) from ther aqueous solution. J. Nepal. Chem. Soc. 30 : 123-130

[8] Vijayakumar, S. Sasikala, M. Dhanapal, R. 2012. Copper Poisoning-A Short Review. International Journal of Pharmacology & Toxicology. 2 (1) : 39-43.