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Communications:

Role of Water Hyacinth (*Eichhornia crassipes*) to Decrease Heavy Metal Pollution Levels of Lead (Pb) in the Waters of Sengguruh Reservoir Village Kepanjen District Malang Regency

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Abstract: Sengguruh reservoir located in Sengguruh Village Kepanjen District Malang is one of the existing dams in the southern city of Malang. Sengguruh reservoir serves as a reservoir for Hydroelectric Power Plant (hydro) as well as the filter input load Sutami Dam and Lahor Reservoir. Many industrial and household wastes that enters and flow into the body of Lesti Kali Brantas River Basin causes each location of sengguruh waters polluted by Lead (Pb) which is a heavy metal. Increase in the population of water hyacinth can reduce the concentration of heavy metals in water, so it is necessary to study pollution levels of Pb in the waters of Sengguruh Reservoir. The purpose of this study is to determine the differences in concentration of Pb in water hyacinth and water pollution, as well as to determine the level of Pb at different stations of Sengguruh Reservoir. The experiment was conducted in June 2012. This research includes exploratory study with a purposive sampling method. Manual sampling was carried out at each of the stations to collect water samples. Water and plant samples were analysed in the laboratory of Chemistry Department of Teacher Training and Education Faculty of Muhammadiyah University of Malang. Survey results revealed the existence of different levels of Pb content in water and water hyacinth plants in all locations. At the location of water stationI average heavy metal content is 2.785 ppm, station II the average heavy metal content is 0.904 ppm, the average station III heavy metal content is 0.13 ppm. In the water hyacinth plant organ content of Pb at station I reached an average of 3.669 ppm for roots, 5.499 ppm for stems and 1.791 ppm for leaves. At station II the average heavy metal content of was 4.438 ppm for root, 5.322 ppm for stem and 1.633 ppm for leaves. At station III the average heavy metal content was 1.299 ppm for root, 0.957 ppm for stem, 0.629 ppm for leaves. Based on this research it has also been shown that the organ which has the potential to absorb Pb in the organs of roots and stems that reach an average content of Pb 2.35 ppm for roots and 2.95 ppm for stems at all locations.

Keywords: *Heavy Metal, Lead (Pb), Sengguruh Reservoir, Water hyacinth (Eichhornia crassipes)*

1. Introduction

Water is an important component of human life and the entire ecosystem that exists in nature. Increased human needs for water has caused various negative impacts such as pollution and environmental damage. Some chemicals have polluted the environment indicating pollution by heavy metals. Damage to water due to human activities such as that of Sengguruh's reservoir high heavy metal pollution will have a negative impact on human health in particular.

Heavy metals impacts on human health negatively and as such its mischievous disposal is detrimental, especially when the Al-Qur'an has very clearly prohibited mischief as Allah says in the letter Ar-Rum verse 41, which reads:

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ظَهَرَ ٱلْفَسَادُ فِى ٱلْبَرِّ وَٱلْبَحْرِ بِمَا كَسَبَتْ أَيْدِى ٱلنَّاسِ لِيُذِيقَهُم بَعْضَ ٱلَّذِى عَمِلُوا۟

لَعَلَّهُمْ يَرْجِعُونَ ۝

Meaning: I have seen the damage on land and sea because of actions by human hands, that God may feel to them some of the (result of) their deeds, that they come back (to the right)

Sengguruh reservoirs located in Sengguruh Village Kepanjen District Malang is a meeting place and Kali Brantas River downstream Lesti. The flow of the two rivers is dumping point of industrial wastes such as paper mill and plastic waste as well as being the disposal point of household waste that is around the vicinity. Industrial waste disposal plant and household waste flow to the body Kali Brantas and Lesti will cause heavy metal pollution in the waters of the Sengguruh Reservoir. Waste from the household can contain heavy metals from inorganic waste, mostly in the form of plastic. Waste produced by paper mills and plastics factories also potentially contain Pb used in the production of Pb as a coloring agent. Lead metal is used as a coloring agent in the plastics industry (Palar 1994). Pb in the paper mill industry is used as a fuel additive and lead in paint pigments. According to Frank in Cahyono (2007), chemicals that are likely present in the waste of paper mills are hazardous metals such as mercury, lead, cadmium, chromium and so on.

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Water hyacinth plants in aquatic reservoirs are allegedly able to accumulate heavy metals present in waters. The series of studies on the ability of water hyacinth in reducing heavy metal concentrations of lead Pb in water has been made. Based on the results Syaiful (2008), the ability of water hyacinth to absorb pollutants is by ability to accumulate Pb in root tissues, and stalks. Achieved the highest accumulation for the treatment of 3000 ppm Pb in the growing medium, respectively accumulated in the roots and stems in the amount of 3, 453,34 and 2,185,70 microgram / g dry weight for 10 days. Waterhyacinth could reduce levels of Pb in the planting medium averaged 80% over a period of 10 days for all treatments through a mechanism rizofiltrasi (rhizofiltration) and fitoekstraksi (phytoextraction). Waterhyacinth plants can act as an agent for Pb phytoremediation of polluted water, but less tolerant of Pb concentration is too high. Liao Chang (2004) and Syaiful (2008) suggested water hyacinth has the ability to accumulate Pb.

Research conducted in the waters of Erh-Chung showed that water hyacinth is capable of accumulating Pb at 542mg/m^2 with a capacity of 5.4 kg / ha. Measurement of Pb metal was conducted on plant tissue water and sediment media.

2. Materials & Methods

This research is exploratory, to determine the level of heavy metal pollution by Pb at each location in the Sengguruh reservoir of Kepanjen Subdistrict, Malang regency. The research was conducted in May 2012 at the Sengguruh Reservoir Kepanjen District Malang. Analysis of water hyacinth and water reservoirs carried out at the Laboratory of Department of Chemistry Faculty of Teacher Training and Education University of Muhammadiyah Malang.

2.1. Field Observation

Preliminary survey to identify areas of research more deeply, studied the conditions of Sengguruh reservoir briefly but thoroughly, and streams that drain the reservoir Sengguruh. The material used in this study is a sample of water reservoirs and water hyacinth.

2.2. Reservoir Water Sampling

Water samples taken from three different stations using a simple method that is directly taking water samples and put in 600 ml plastic bottles. Samples of water and plants are first obtained from the central reservoir which is a meeting place Sengguruh Brantas River and Lesti River.

The second sample was taken in the middle of the reservoir area and the last sample taken at the expanse of water reservoirs. Image sampling locations are presented in Fig. 1.

2.3. Water and Water Hyacinth Plant Sampling

Plant sampling was conducted by a preliminary study to determine the places that will be selected as sampling stations. Determining the location of the sample by using purposive sampling method to determine the location of the incident based on several considerations were then divided into 3 stations. Water sampling points with the point sampling plant hyacinth (*E. crassipes*) was performed on 3 stations that have been determined, including the roots, stems and leaves. Each research station is divided into three substations observations represent the entire Sengguruh reservoir. Substation located between 1-5 meters from the edge of the reservoir it is based on the presence of water hyacinth that grew ± 5 meters from the edge. Stations I Regional meetings Kali Brantas and Lesti, II : Dam reservoir are, III : Outlet Regional Water Sengguruh Reservoir

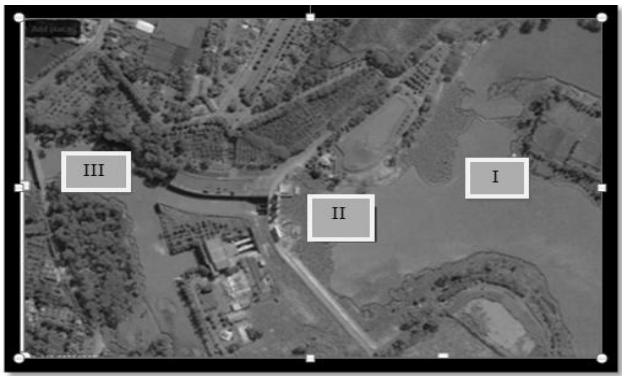

Fig. 1. Sampling Location of Water and Plant Water Hyacinth.

2.4. Samples Analysis

Samples taken from water hyacinth at Sengguruh Reservoir washed, then the oven at a temperature of 80^o C for 48 hours. After drying the samples crushed to a powder, the sample was pulverized using a blender. Powder samples were then weighed as much as 4-6 grams and then put into the furnace at a temperature of 450^o C for 12 hours until a white ash. Ash samples were then chemically descructed. Sample solution was then poured into a plastic bottle and is ready for its Pb content analyzed with a spectrophotometer.

2.5. Data Analysis

The results obtained by the analysis of metal content processed by statistical means. Data measurements Pb content in the roots, stems and leaves of water hyacinth plants (*E. crassipes*) were analyzed by analysis of variants (ANOVA) if found real differences (significant) then followed by BNJ at level 5%.

3. Results & Discussion

3.1. Heavy Metal Content of Lead (Pb) In Sengguruh Reservoir

Based on the results of the study Pb content in the waters of the Sengguruh reservoir's data obtained as follows in Table 1.

Table 1. Data content of Pb ppm in Sengguruh reservoir.

Water sample	Replicate			Total	Pb (ppm)
	I	II	III		
Station 1	3.231	3.112	2.012	8.355	2.785
Station 2	1.239	1.244	0.229	2.712	0.904
Station 3	0.128	0.139	0.125	0.392	0.130
Total				11.49	

From the above data it is known that the stations I, II and III Pb content were well above water quality standards. According to Government Regulation No. 82 Year 2001 Pb levels allowed to be in water is 0.03 ppm. Average Pb, the highest found in the water reservoir at the base station I Sengguruh reaching 2.785 ppm. Station I was meeting of Kali Brantas River and downstream Lesti. The second river is also used as a waste dump of industries located along the river such as the disposal of waste paper mill and factory plastic and a household waste disposal, which are mostly inorganic waste. Both plants use the Pb in the production process, as a dye. Thus, Pb is still in a concentrated state in proximity to its sources of pollution. The low content of Pb in station II water when compared to the train station I caused due to the dilution of Pb as it moves towards the region of station II.

Concentrations of Pb decline because waste materials are carried by the flow of the river has been partially sedimented allegedly on the way leading to the dam area. According to Juliana (2008) factors greatly affect river flow dilution process, where waste carried by river currents will disperse into the water, so the concentration of heavy metals in the water will decrease.

At the third station location, heavy metal was lower than the station I and station II. The lowest Pb content was recorded at station III water, presumably because the reservoir in sediment deposition had on station location II, while sampling the surface of the water. Heavy metals particles bonded with mud from the river with a molecular weight that is heavier than water will sink. This is according to French (1997) who said that Pb is very easily absorbed by the fine particles such as mud depending on the molecular absorption and particle size of the metal. Though the Pb at station III tended to decrease abortion, but was still beyond the quality standards as established by Government Regulation No. 82 Year 2001 of Pb levels allowed to be in water that is 0.03 ppm.

3.2. The role of water hyacinth (*E. crassipes*) Heavy Metals Pollution Lowers Level of Pb in the waters of the Sengguruh Reservoir

Water hyacinth has the ability to accumulate heavy metals in the polluted waters in a reservoir such as Sengguruh. High concentration the heavy metals in the water results in the higher concentrations of the heavy Pb in plants. Presence of water hyacinth in the water can help reduce the concentration of heavy metals in contaminated water, because the water hyacinth plant is a plant that can accumulate heavy metals in its various organs. Relationship between Pb levels in the water hyacinth of Sengguruh reservoir is represented in Fig. 1.

Water at the station I had higher Pb contents than stations II and III. Shorter distance will have greater levels of Pb due to its high concentration before dilution. The presence of water hyacinth plants can help reduce the heavy metals. Water hyacinth plants in the base station I had a faster direct contact with Pb, and can accumulate heavy metals. Load input is not worth the waste of water hyacinth population, as water station I was still in a state polluted by lead (Pb) content in plants and water hyacinth are also quite high.

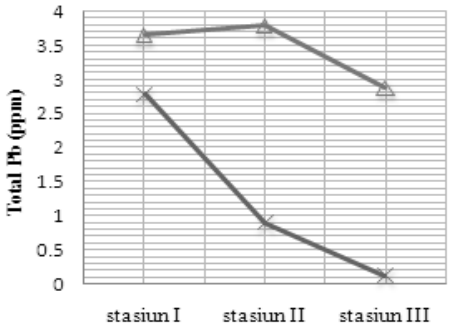

Fig. 1. Relationship of Pb levels in the water hyacinth in the waters of the Sengguruh reservoir (Δ=waterhyacinth, X =water)

Heavy metal content in plants at station II showed the highest concentration. Station II is a central Sengguruh reservoir within ± 300 meters from the station I have heavy metal content is lowers than the station I. The distance from the source of pollution also affects the heavy metals in the low waters at station II. This is in accordance with the opinion of Ruyitno (1991) in the horse's bit heavy waters will experience further dilution was concentrated by means of the physics that is by deposition of heavy metals and eventually it will settle in the bottom waters.

The low concentrations of heavy metals in the base station II is also aided by the presence of water hyacinth plants that have a greater amount of density than station I. The high content of Pb in the body of water hyacinth in this location due in part to water hyacinth plants derived from base station I brought that stream toward the dam area.

Heavy metals in plants at station III shows Pb content is low when compared to the train station I and II on the waters. This is due in addition to the station III is the water discharge locations where metals Pb reservoirs undergo dilution and absorption by aquatic organisms at the base station I and station II. Distance of station III's location with sources of pollution also affects the amount of Pb levels in the river. At closer distances Pb levels are greater than at longer distances. Waste containing heavy metals carried by river currents causes Pb concentrations to decrease. Waste materials carried by the flow of the river have been partially sedimented on arrival at the dam area.

According to Bryan (1987), heavy metals in water will experience three processes; dilution, deposition, and absorption by aquatic organisms, so that the heavy metals which are in the area spending a lot less water. This is in accordance with the opinion Hutagalung (2002) further away from the source of the pollutant material waste streams have been partially brought sedimented on the way to the sea.

Figures are accompanied by the same letter are not significantly different according to HSD test 5%.BNJ 5%. Figure average heavy metal lead (Pb) in the water hyacinth plant organs (*E. crassipes*) at all locations are presented in Fig. 2.

Table 2. Average heavy metal lead (Pb) in the water hyacinth plant organs (*E. crassipes*) at all locations.

Plant Organ	**Pb (ppm)**	Water Standards Regulation No. 82/2001
Root	2.35 b	0.03 ppm
Petiole	2.95 b	
Leaf	1.01 a	

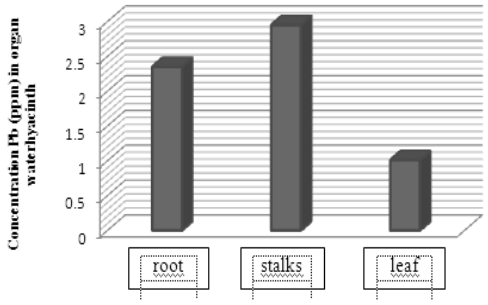

Fig. 2. Average heavy metal lead (Pb) (ppm) in the water hyacinth plant organs (*Eichhornia crassipes)* at all locations.

Fig. 2 shows the high heavy metal lead (Pb) on organ water hyacinth roots and stalks, the roots of water hyacinth which are microbial rhizosfera accumulate heavy metals. According Surawiria (1993) that microbial rhizosfera is a form of symbiosis between bacteria with fungi, which are able to perform the decomposition of the organic and inorganic material contained in water and use it as a source of nutrients. After the metal was brought into the root cells, the metal will then be transported through the network carrier, the xylem and phloem to other plant parts to improve the efficiency of transport, bound by metal chelate molecules produced by plants. To prevent the poisoning of the water hyacinth plant cell has a mechanism to localize the heavy metals in the organs of roots and stems. In plant organs are elongated, like a stalk enlargement occurs mainly to the one-dimensional, cell enlargement is largely the event of water absorption into the expanding vacuole vacuole where the shaft size larger than the organ leaves and roots. Solute concentration in the vacuoles is high and there are hundreds of materials including Pb dissolved. The water pressure causes growth by pushing the wall and membrane to inflate (Salisbury & Ross, 1995).

Table 3. The average total heavy metal lead (Pb) ppm were found in water hyacinth plants on each station

Location	**Pb (ppm)**	**Standart Water PP No 82 year 2001**
Station I	3.653 c	0.05pm
Station II	3.797 c	
Station III	2.885 b	

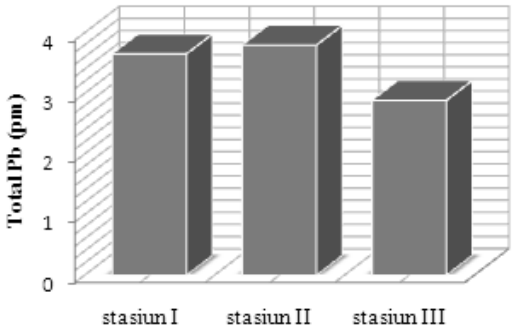

Fig. 3. The average total heavy metal lead (Pb) ppm were found in water hyacinth plants on each station.

Figures are accompanied by the same letter are not significantly different according to HSD test 5%.BNJ 5%. The low content of Pb in water hyacinth plants at the site III station is allegedly because of the Pb in sediment deposition experience base station I and station II. This assumption is supported by the opinion Fitriyah (2003) in which the heavy metal content of Pb in sediments is higher than the body of water. Heavy metals have simple binding properties of organic matter and sediment in the bottom water unites with it. The role of water hyacinth in reducing Pb content in the Sengguruh reservoir is determined by the number density of water hyacinth. Water hyacinth has the ability to absorb heavy metals, in addition to the process of dilution and deposition in sediments.

4. Conclusion

There are different levels of heavy metal pollution by Pb at any location in the Sengguruh water reservoir. There are differences in Pb concentration between Sengguruh Reservoir water and water hyacinth plants. Accumulation of heavy metals takes place in the organs of plants roots and stalks of water hyacinth.

5. Acknowledgements

We thank Jasa Tirta which allowed the study in Senguruh reservoir, we also express deep thanks to the Laboratory staff of Department of Chemistry Faculty of Teacher Training and Education University of Muhammadiyah Malang.

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