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RESEARCH ARTICLE

URL of this article: <http://heanoti.com/index.php/hn/article/view/hn20121>

Mussel Shell Powder as Bio-adsorbent of Heavy Metals in Water

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ABSTRACT

Mussel shell contains chitin and chitosan that can be used as bio-adsorbent to reduce heavy metal level in contaminated water. The purpose of this study was to measure the Pb heavy metal level in well water in Keputih residential-formerly a dumping ground-before and after the application of mussel shell powder of 0, 1, 2, and 3 gram by stirring it for 10 and 30 minutes at 60 rpm. The research type was experimental, used One Group Pre-Post Test Design method. The object was well water which contaminated by leachate at Keputih residential ex dumping ground, Sukolilo Surabaya. The observation showed that the well water in the residential contain heavy metals of 1.049 mg/l. After being given 1, 2 and 3 gram shell powder, it decreases to 58%, 87% and 97%. Based on the statistical test, significant result was obtained at the addition of mussel shell powder of 1 and 3 grams, while addition of 2 grams was not. The conclusion is mussel shell powder can reduce the heavy Pb metal level in the well water in the Sukolilo residential and is advisable that the next researchers continue to check physical condition of the well water.

Keywords: Bio-adsorbent, Heavy metals, Water, Mussel shell powder

INTRODUCTION

With the development of oil and gas, agriculture, and other types of industries, the pollution level in water caused by industrial waste is increasing. Water is often contaminated by heavy metals inorganic components such as Hg, Pb, As, Mn, Cr, and Ni. Hg and Pb are the most common heavy metals contaminants.

Pb heavy metal in the form of lead (inorganic) has the toxicity range of 1000-100,000 ppm. It is slightly higher than copper (Cu) and mercury (Hg). Most heavy metals are toxic, carcinogenic and pose a serious threat to human, animal, and plant⁽¹⁾. The toxic nature of this heavy metal will take effect as it accumulates in considerable quantity in the living beings. One way to absorb heavy metals level in water is by using bio-adsorbent.

Research by Riswanda on Utilization of White Shrimp (*Litopenaeus vannamei*) Chitosan as Lead (Pb) Heavy Metal Bio-adsorbent on Clams Meat in Estuary of Gunung Anyar River showed that concentration and immersion duration of the chitosan significantly influence to the decreasing of Pb heavy metal level in Clams meat, at a concentration of 2.0 grams⁽²⁾. While research by Santoso and Isti'adah entitled "The Study of Utilization of Tellina sp Tellina sp Shell as Bio-adsorbent to Treat Wastewater Containing Copper Metals Ion (II)" found that the presence of chitin on the mussel shell is 2 g⁽³⁾.

Balongdowo Village, Candi District, Eastern Region of Sidoarjo, is the largest fishing village in East Java Province that produces mussel. It produces around 8,540,400 kg to 8,675,300 kg per year⁽⁴⁾. The production results in mussel shell waste pile, causing new environment problem. Some people use mussels shell waste as a mixture of animal feed and as additional material in concrete mix. It has never been used as a clean water processor in reducing the metal level in the water. Darjati & Marlik had conducted a study using mussels shell powder as a natural preservative of tuna, with the result that the tuna with a concentration of 3: 1 for 30 hours resulted in total plate of 5.0 x 10⁵ colonies/gr. The average organoleptic value of 7.00 meets the requirements of SNI no. 7288, 2009⁽⁵⁾.

Mussel shell contains chitin and chitosan that can be used as adsorbent; this has been done by Afranita et al. titled "Potency of Anadara granosa (*Anadara granosa*) Ash as Adsorbent"⁽⁶⁾. Chitosan is a biopolymer. It naturally has a cluster of Amine and hydroxyl (NH₂) capable of forming hydrogen bonds and molecules of ammonia. The addition of polyelectrolyte serves as a coagulant in the water treatment process where polymer synthesis is present. This polymer has a functional group whose ionic chains can be ionized. The ionic nature of

polyelectrolytes is one that determines performance as flocculant⁽⁷⁾. Mussel shell contains biopolymer that functions as coagulant and flogulan in water treatment.

Keputih dumping ground has now changed its function becoming a residential area⁽⁸⁾. In the preliminary study, It is found that the heavy metal level in the groundwater in the forms Fe is 3.30 mg/l and Mn is 2.2 mg/l. These exceed the threshold value set by the Regulation of Health Ministry No. 416 Year 1990 about: Terms and Supervision of Water Quality of 0.05 mg/l and 0.1 mg/l⁽⁹⁾.

Based on the preliminary study, the researcher wants to do research of mussel shell powder as Bio-absorbent to lower the heavy metal level in well water Keputih residential, with the topic: utilization of mussel shell powder as Pb heavy metal bio-adsorben in well water" in Keputih Residential (ex dumping ground area in Sukolilo Surabaya).

METHODS

The type of the reseach was experimental. The researcher gave treatment to the object to see the outcome. The research was using One Group Pre-Post Test Design with the addition of shell powder with concentration of 0 gr, 1 gr, 2 gr and 3 gr, repeated 6 (six) times. The object of the research was well water in Keputih Residential Ex Dumping Ground area, Sukolilo Surabaya. The method for measuring the Pb level in well water was *Atomic Absorption Spectrophotometer* (AAS). Stirring speed for the formation of flog is 60 rpm for 10 minutes and 30 minutes. Numerical data obtained from Laboratory examination results were analyzed by using mean score⁽¹⁰⁾, then analyzed by using paired samples t-test.

RESULTS

Table 1. Level of Pb in well water by stirring 10 minutes and 30 minutes with 0 gram, 1 gram, 2 gram and 3 gram concentration of mussel shell powder.

No	0 gram Control	10 minutes (mg / L)			30 minutes (mg / L)		
		1 gram	2 gram	3 gram	1 gram	2 gram	3 gram
1	1.03	0.49	0.16	0.02	0.36	0.12	0.02
2	1.05	0.56	0.11	0.02	0.38	0.11	0.01
3	1.02	0.50	0.09	0.03	0.36	0.11	0.01
4	1.07	0.50	0.10	0.05	0.35	0.10	0.02
5	1.05	0.44	0.08	0.02	0.37	0.09	0.01
6	1.05	0.47	0.13	0.04	0.39	0.11	0.01
Mean	1.05	0.49	0.11	0.03	0.37	0.11	0.01
min	1.02	0.44	0.08	0.02	0.35	0.09	0.01
max	1.07	0.56	0.11	0.05	0.39	0.12	0.02

Table 2. The result of pair t test test statistics

No	Handling	P Value
1	control - 1 gram 10 minutes	0.000
2	control - 2 grams 10 minutes	0.000
3	control - 3 grams 10 minutes	0.000
4	control - 1 gram 30 minutes	0.000
5	control - 2 grams 30 minutes	0.000
6	control - 3 grams 30 minutes	0.000
7	1 gram 10 minutes - 30 minutes	0.001
8	2 grams 10 minutes - 30 minutes	0.732
9	3 grams 10 minutes - 30 minutes	0.020

The table showed that the mean score of Pb level in well water with a concentration of 0 gram mussel shell powder was 1.05 mg/l. The mean score of Pb level in well water with 1 gram, 2 gram and 3 gram powder concentrations by 10 minute stirring is 0.49 mg/l, 0.11 mg/l, 0.03 mg/l and mean of Pb level in well water with a concentration of 1 gram, 2 gram and 3 gram mussel shell powder by 30 minutes stirring is 0.37 mg/l, 0.11 mg/L, and 0.01 mg/l. The mean score of Pb level in the well water in Keputih Resident ex dumping ground area Sukolilo exceeds the required threshold value of 0.05 mg/l⁽¹¹⁾, except in those with the addition of 3 grams of mussel shell powder by 30 minutes stirring. Although the goverment has no longer used the location as damping site, but local people still do.

DISCUSSION

The previous waste dumping activity in Sukolilo was the cause of well water pollution in the surrounding area. Soil sampling practicum conducted by Surabaya Environmental Health student on October 17, 2016 revealed

that the soil contained Pb, Cd and Ar heavy metals. Although the place was no longer waste disposal site, but the decomposing process continues and soil became porous that the leachate flowed in the underground water and polluted nearby water source.

Since well water in Keputih Residential contained high level of heavy metals exceeding the specified threshold value, processing was necessary by giving the mussel shell powder as bio-absorbent to reduce and possibly even remove the heavy metal. After the process, statistical data obtained showed a significant result; the decrease of Pb level compared to those without processing.

Previous research has shown that mussel shell powder could be used as bio-absorbent to reduce wastewater containing copper metal ions (II). It contained 26,82% gram chitin which is part of chitosan that functions as inhibitor of microorganism growth and reduces the level of heavy metals in water. Experiment of various addition levels (1,2, and 3 grams), it was found that 3 grams addition resulting 97% reduction (becoming 0,02 mg/l). It met the permissible quality standards set by Regulation Health Ministry of Indonesia (0.05 mg/l)⁽¹¹⁾.

CONCLUSION

Based on the research, it is found that the level of Pb in well water in Keputih Residential ex dumping ground Sukolilo Surabaya exceed the limits of Permenkes Regulation No. 32, 2017. By adding mussel shell powder, the Pb heavy metal decreased until meets the regulatins on the Quality Standard of Environmental Health and Water Health Requirements for sanitary hygiene, Swimming Pool, Solus Per Aqua, and public baths. So mussel shell powder can be used as absorbent material to reduce Pb heavy metal level well water in the Keputih Residential - ex dumping ground Sukolilo Surabaya.

Mussel shell powder can only be used to reduce the heavy metal level in the polluted well water, but it can not physically change the well water, such as removing the color, smell and taste. Therefore, further research is needed to change the physical condition of the water source to meet the physical requirements as a suitable clean water used by the local community.

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