ORIGINAL PAPER

REMOVAL OF TOXIC MERCURY AND OTHER HEAVY METALS IN CONTAMINATED WATER BY TUBANG BAKOD (*JATROPHA CURCAS* L.) LATEX

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Abstract. *There are several types of biomass that have been known to reduce metals concentrations from aqueous media. This study focused on the effect of Jatropha curcas L. latex as a potential biosorbent of heavy metals (Cadmium, Lead and Mercury) in contaminated water. The selection was based on the fact that these metals have known detrimental effect to health once the concentration exceeds the maximum allowable limit. The analysis of heavy metals concentrations were conducted using standard laboratory procedures using Atomic Absorption Spectrometer. Results of the study revealed that in the 24 hours post treatment, noticeable increase in pH, discoloration and precipitation were recorded slightly increased at electrical conductivity at 379 µS/cm. While there were no recorded decrease on the level Cadmium and Lead the concentration of Mercury has substantially decreased from 2.72 µg/mL to 0.07µg/mL. The overall findings clearly indicate the potential of Jatropha curcas L. latex to adsorb and precipitate the heavy metal Mercury from aqueous media. This may be due to the presence of phytochemical tannins. The metal adsorbent capacity of the plant extract was found at 600 µg/ml of dissolved Mercury.*

Keywords: *Jatropha curcas L., Heavy Metals, Mercury, Biosorbent, Tannins.*

1. INTRODUCTION

Cadmium, lead and mercury are heavy metals that lead to a number of undesired properties that affect humans and the environment [1]. Metals contamination have been widely recorded in various studies [2-11] due to anthropogenic activities. The World Water Assessment Programme of the United Nations Educational, Scientific and Cultural Organization (UNESCO) estimates that industrial activities is responsible for the annual accumulation of 300 to 500 million tons of sludge, heavy metals and toxic wastes and that 70% of untreated industrial waste in developing countries is dumped directly into the water systems [12].

In Turag River for example, the bioaccumulation of heavy metals (i.e. Cu, Cd, Cr, and Pb) in marine samples sediments and surface water (river) were recorded. It was shown that the bioaccumulation level of heavy metals in Turag River were higher than the Food and Agricultural Organization (FAO) approved standard level [13].

Another study have shown that Marilao, Meycauayan and Obando river systems revealed deteriorating quality of surface water that exceed environmental limits which has negative health implications not only to the local population but to those in Metro Manila where most of the fishes are sold. One of the major causes of pollution are effluents that

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contain heavy metals (Pb, Hg, Cr, As, and Cd) [14]. Studies on the Mirikpitik Creek found cadmium, copper and zinc levels that were many hundreds of times higher than typical background concentrations [15].

Industrial manufacturing processes, metal finishing, automotive, aerospace, semiconductor manufacturing, electroplated metal parts/washing, textile dyes and steel were known to produce wastewaters containing heavy metals like cadmium, chromium, lead and mercury. Wastewater discharge without proper treatment to water catchment would likely increased its concentrations in ground waters which are destined for potable drinking water [16].

To improve the quality of water, numerous studies have shown the potential of the plant materials as agent to remove heavy metals from surface water. Studies on *Jatropha curcas* L. revealed that it is a potential source of several secondary metabolites. The leaf, fruits, latex and bark contain glycosides, tannins, phytosterols, flavonoids and steroidal sapogenins. The leaf extract yield alkaloids, flavonoids, saponins, tannins, phenolic compounds, steroids and terpenoids which may serve as potential bioflocculant [17]. The Natural Flocculant from aloe vera for example, have known potential to improve the quality of water. It revealed 75% efficiency to removed turbidity, 91% of suspended solids and 15% for the obvious color [18].

The *Jatropha curcas* L. latex possess procoagulant and anticoagulant activities, at low concentrations, the ethyl acetate fraction exhibited a procoagulant activity, while the butanol fraction had the highest anticoagulant activity [19]. Flocculants are natural or synthetic substances that are used to separate solid and liquid through sedimentation by the process of flocculation in industrial plants. They bring together suspended solids greater than 0.1 mill microns comprised of repeating molecular units. The purpose of the flocculants is to neutralize the like charges in suspension by coagulating and flocculating them into larger size. The larger is the particle size, the faster is the settling rate, hence improved settling and cleaner the supernatant are achieved rapidly. Due to presence of negative surface charges on this particle, the electrostatic repulsion overwhelms the Van der Waals attractive forces, preventing aggregation, thus by adding positively charged flocculants the negatively charged particles are neutralized allowing the particles to form colloidal particles and aggregate [20]. Recently, a variety of flocculants comprising of inorganic compounds (polyaluminium chloride, aluminum sulfate); organic compounds (polyacrylamide, polyethylene amine) and natural bioflocculants (gelatin, chitosan, guargum and microbial flocculants) have found widespread applications in several industries such as pharmaceutical, fermentation, food industries and wastewater treatment processes [21]. The release of effluents contaminated with heavy metals without proper treatment poses a serious threat to public health. This is due to the persistence, biomagnifications and accumulation in the food chain. Consequently, water purification methods were being for removal of contaminants in water. It is for these reasons that the researcher conducted this study in order to find out the effect of Tubang-bakod (*Jatropha curcas* L.) latex on the concentrations of heavy metals from contaminated water and improve its physical quality.

2. MATERIALS AND METHODS

This study used the posttest experimental method to determine the coagulation and flocculation effect of *Jatropha curcas* L latex against cadmium, lead and mercury. The quantitative analysis of the supernatant liquid (24 hours post treatment) for heavy metals concentration was conducted at the University of Immaculate Conception Science Resource

Center, Fr Selga St, Davao City. *Jatropha curcas* L.. Latex was collected by cutting the leaf from the stem of the matured branches and as the whitish latex oozed out, about 1.0 mL of it was collected.

Figure 1. *Jatropha curcas* linn planted and propagated at Poblacion 2 (Midsayap ,Cotabato).

Figure 2. Collection of *Jatropha curcas* linn latex.

The batch coagulation experiment was carried out on another three 300 mL placed on a 500 mL of Erlenmeyer flask marked as Contaminated water with latex A (Trial 1), Contaminated water B with latex (Trial 2) and Contaminated water C with latex (Trial 3). The pH of the heavy metal contaminated water was adjusted by the addition of 0.1 M NaOH then, about 1.0 mL of the *Jatropha curcas* L. latex was added to each to serve as treatment. The contaminated water contained equal concentration of Cd, Pb and Hg which is about 10 mg/L.

Dependent t-test was utilized to infer the effect of *Jatropha curcas* L. latex in reducing the concentrations of heavy metal from contaminated water 24H post treatment. Likewise, the amount of metal bound by the bioflocculants was calculated as follows:

$$Q = v(C_i - C_f)/m$$

where Q is the metal uptake (mg metal per g bioflocculant), v the liquid sample volume (L), C_i the initial concentration of the metal in the solution (mg/L), C_f the final (equilibrium) concentration of the metal in the solution (mg/L) and m the amount of the added bioflocculant in grams (g).

3. RESULTS AND DISCUSSION

Results showed that the contaminated water has an electrical conductivity mean value of 386 ± 23.090 µS/cm indicating the presence of dissolved minerals or metals. The samples were clear and transparent as shown with the test for color and turbidity at 5 PCU and <5 NTU, respectively. The heavy metals (Cd, Pb and Hg) were found relatively high (before treatment) at 5.87, 11.00 and 2.72 µg/mL, respectively (Table 1).

Table 1. Physical and heavy metals characteristics of the contaminated water before and 24 hours posttreatment with *Jatropha curcas* L. latex.

Test Parameters	N	Before Treatment		24 hours Postreatment	
		Mean	S.D.	Mean	S.D.
Color [PCU]	3	5	0.000	379	15.133
Electrical Conductivity [µS/cm]	3	386	23.090	300	0.000
pH	3	3.3	0.100	4.63	0.306
Turbidity [NTU]	3	<5	0.000	29	11.358
Cadmium [µg/mL]	3	12.00	1.360	12.20	0.843
Lead [µg/mL]	3	11.00	1.251	11.41	1.004
Mercury [µg/mL]	3	2.72	1.827	0.07	0.000

Results of the test clearly indicated that *Jatropha curcas* L. latex was not able to precipitate Cd and Pb in the 24 h posttreatment with a concentration of 12.00 ± 0.843 and 11.41 ± 1.004, respectively. On the other hand, the researcher had recorded substantial decrease of Hg concentration to 0.07 µg/mL compared with the untreated contaminated water. The results demonstrated the potential bioflocculant property of *Jatropha curcas* L. latex against mercury. Overall, was demonstrated the capacity of 1 mL of *Jatropha curcas* L. latex to reduced Hg at 0.07 µg/mL from initial concentration of 2.72 µg/mL.

The results was suggestive of the potential *of Jatropha curcas* L. latex to adsorb and precipitate the heavy metal (Hg) in a highly contaminated mixture wherein a 1 mL of Jatropha curcas L. Latex may precipitate 600 µg of dissolved Hg. Statistical analysis showed that *Jatropha curcas* L. latex significantly ($p<0.05$) reduced the level of Hg from contaminated waters (Table 2).

Table 2. Amount of metal uptake by *Jatropha curcas* L. latex in the contaminated water 24 h after treatment.

Test Parameter	N	Volume tested [mL]	Added *Jatropha curcas* L latex [mL]	Q value [ug/mL]	Description
Cadmium	3	300.0	1.0	0	Negative**
Lead	3	300.0	1.0	0	Negative**
Mercury	3	300.0	1.0	600*	Positive***

**Significant at 0.05*
***No uptake of Pb and Cd by Jatropha curcas L. latex occurred*
**** uptake of Hg by Jatropha curcas L. latex occurred*

This paper confirmed that flocculants are natural or synthetic substances that are used to separate solid and liquid through sedimentation by the process of flocculation in industrial plants. They bring together suspended solids greater than 0.1 mill microns comprised of repeating molecular units. The purpose of the flocculants is to neutralize the like charges in suspension by coagulating and flocculating them into larger size.

4. CONCLUSION

Based on the study results, the researchers inferred the potential of *Jatropha curcas* L. latex as good bioflocculating agent for Mercury from surface water since it substantially reduced its concentration. The findings can be attributed to the 10% tannin found in the *Jatropha curcas* L. latex as the potential bioflocculating agent against Mercury at 600 µg/mL metal uptake capacity.

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