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Original Article

Efficacy of Aloe Vera Powder In Bioremediation of Heavy Metals From Waste Water

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ABSTRACT

Water is important component of life but on earth, major part of water is wasted without human consumption. The resulting scarce water conditions along with continuous pollution of existing fresh water bodies are the serious challenges in current times. Addition of Heavy metals in water results in water toxicity and pollution. The presence of heavy metals in wastewater causes toxic effects on living organisms. The removal of metals from waste water can be removed by the process of bio sorption that results in the metals absorption on the biological surfaces. **Objective:** Keeping in consideration, present study was aimed for the removal of heavy metals from wastewater by using aloe vera leaf powder as adsorbent. **Methods:** Adsorption experiments of different metals in waste water were done using different percentages of Aloe Vera powder and results were recorded in terms of change in pH of solutions. **Results:** Alovera present at low percentages in mixture showed less adsorption. Similarly, adsorption was found to be higher with higher alovera percentage showing decrease in pH of the mixture. Atomic absorption spectrophotometric determination was done for metal Zn while analysis of Na was done using flame photometric technique for adsorption of metals in waste water. Results showed that 1.4 % alovera powder has used the metal absorbent efficiency was 9.495 %. However, with addition of 4 % alovera powder, percentage efficiency was increased to 10.237 % showing positive effect of alovera powder on metal extraction. **Conclusion:** By flame photometry of sodium result showed that extraction efficiency was 500 % using aloe vera powder. Aloe vera plant was proved to be an excellent biomaterial for accumulating metal ions from wastewater due to its outstanding uptake capacity.

INTRODUCTION

Heavy metals excessively released into the environment due to rapid industrialization sodium, zinc, copper, lead, mercury are detected in industries wastewater [1]. These heavy metals caused different environmental problems. A major problem is water pollution this occurs when we discharged waste water directly or indirectly heavy metals wastewaters industrial waste in to the environment [2]. Aloe vera plant. Aloe vera L. (Aloe barbadensis Miller) is one of the important remedial plant that belongs to kingdom plantae and family Liliaceae. Aloe vera is used in different purposes either for food and drinking purposes, or help to treat skin diseases. The digestive health is improved as well as they are also used in cosmetics such as cream, soaps and shampoos. Because they have cooling properties they are used to treat burns and many others diseases and internally they are used for drinking purposes to treat many diseases [3]. Adsorption is one of the reversible processes that removed the heavy metals [4]. Heavy metals concentrations are reduced by various treatments in wastewater and drinking water they reduce the heavy metals high concentrations to the acceptable concentration [5]. Zinc and sodium is one of the most hazardous metals and they caused toxic effects when we released into environment from different industries activities such as ores and wastewater treatments [6]. Atomic absorption spectroscopy is used for quantitative analysis of the sample. They are used for analysis of metals and trace elements in industrial and environmental origin [7]. Sodium is absorbed by aloe vera and detected that aloe vera absorb the sodium by flame photometry [8]. It is a simple, fast and economical method for sodium determination [9]. The objectives of this research are to

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study and find out the characteristics of aloe vera used as an adsorbent material for removal of heavy metals through adsorption from wastewater. The uptake capacity of Aloe vera can be therefore, used to remove metals in wastewater.

METHODS

The present study was conducted in Biology Department at Lahore Garrison University. All the chemicals used were of analytical grade. All glassware (pyrex) were washed with detergent and dried in hot air oven (Memmert, Germany) before use. Glassware like petriplates, flasks, test tubes cylinders were sterilized before use in moist heat under pressure of 120 lb/inch for 15 minutes in an autoclave (Hiryama HICLAVE HVE-50). All the chemicals were conducted inside the biology safety cabinet (Model no.SF-VD-650, AshramanSCO). Media and other reagents were stored in refrigerator (Haier). Stock Solution of 0.012 M Sodium Acetate Sodium acetate was used as the source of Na(II) and all the solution were made in de-ionised water 1g of sodium acetate dissolved in 1000ml of distilled water [10]. pH was adjusted to 5.0 by the addition of drops of 0.1M HNO3 and 0.1M NaOH solutions. Stock solution of Zinc acetate for 0.005 Molar. Zinc acetate was used as the source of Zn(II) and all the solution were made in de-ionised water 1g of Zinc acetate dissolved in 1000ml of distilled water. pH was adjusted to 5.0 by the addition of drops of 0.1M HNO3 and 0.1M NaOH solutions. Preparation of adsorbent: For the preparation of adsorbent Aloe vera leaves used as absorbent [10]. Used mature Aloe vera leaves, collected from a potted plant they were washed and clean with water to remove dust they were cut into small pieces. Aloe vera leaves, dry at room temperature in a shadow for two weeks. After this alovera leaves were kept in hot air oven at 50 to 60°C for 3 hours till the leaves were dried and crisp. Then these dried Aloe vera leaves, were grind in a mechanical grinder (Aloe vera leaf powder, AVLP) and percentage yield was obtained.Chemical Pretreatment on Aloe vera: Chemical Pretreatment on Aloe vera was done following the method of [11]. About 1g of Aloe Vera powder was added was in 1 M of H3PO4 solution and then mixed using magnetic stirrer at room temperature for 6 hrs. at 120 rpm. After this adsorbent was dried in Hot air oven at 80 to 90°C for 6 hours. Then the H3PO4-treated aloe vera was obtained. Effect of different physiological conditions on chemical pretreatment. Pretreatment experiments at varying pHs Adsorption Experiments of different metals was done in the presence of different percentages dosage of Aloe vera powder (0.5, 1, 1.4, 2, 3, 4 %). The change in pHs of waste water was recorded in terms of metal adsorption. Pretreatment experiments at varying time intervals. Adsorption Experiments of different metals was done in the presence of different percentage (0.5, 1, 1.4, 2, 3, 4 %) Aloe Vera powder was used. This experiment was done in the presence various adsorption times (25 minutes, 30 minutes, 40 minutes). The adsorption experiments were carried out under the following experimental conditions [11]. The adsorption of metals onto Aloe Vera was done using best dosages of Aloe Vera at optimum pH and constant temperature. Different concentration of metal solutions was placed in bottles such as (25,50 mg/L) were adjusted to best pH and different dosage of Aloe Vera, were added in each bottle. The samples in bottles were agitated in a shaking incubator at 120 rpm in a constant temperature was maintain at 37°C.After, this mixture were filtered with whatman filter paper. After the filtration, this filtrate was analyzed for unabsorbed metals which remain in the solution with atomic adsorption spectrometry using paid services of Institute of Chemistry, University of the Punjab, Lahore Pakistan. Characterization of Biosorbent: Effect of Contact Time. Effect of contact time on the adsorption of Aloe Vera, using various adsorption times such 25minutes, 30minutes, 40 minutes. The pH of metals solutions was adjusted and different dosage of Aloe Vera were added in each bottle. These bottles were agitated for different times in a shaking water bath 120rpm at 37°C and then filtered. This filtrate was analyzed in atomic absorption spectrometry. The best time was then obtained at maximum adsorption efficiency (maximum removal). Adsorption experiment at optimized physiological conditions: The adsorption experiment at optimized physiological conditions, in which adsorption time period [11] for adsorption of metals ions (zinc and sodium) onto Aloe Vera. They were performed using the solutions of different metals and added the different dosages Aloe Vera in these solutions. This experiment was performed under the optimized pH and time of each adsorbent and adsorption period. Structural and morphological characteristics: Flame photometry. Flame photometer is used to determine the sodium in biological fluids. When sodium is added in wastewater and aloe vera is added in this solution. Aloe vera absorbs the sodium fastly in the solution. This solution is filtered and seen under the flame photometry. Then analysis of the sodium in the solutions was done. Atomic absorption spectroscopy: This technique is used to measure the concentrations of elements use wavelengths of light absorbed by an element. They analyzed the metals in the drinking water, wastewater and other samples following the methods of Reena et al., 2015. The amount of metal adsorbed per unit mass of the adsorbent (q in mg/g) was computed by using the following expression:

$$q = C0 - Ct/M$$

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Where C0 and Ct are metal concentrations in mg/L before and after adsorption respectively for time t, and M (g) is the amount of AV taken for 1 L metal solution. The percent adsorption efficiency is found from the relation

Adsorption (%) = C0 – Ct ×100/C0

RESULTS

Preparation of adsorbent and Chemical Pretreatment: Mature healthy aloe vera leaves were used to obtain aloe vera powder of light brown color and average yield was 75 % obtained by this method. Chemical pretreatment of powder was done to increase its absorbance. Pretreatment resulted in visible change in color from light brown to colorless. Effect of different physiological conditions on chemical pretreatment. Pretreatment experiments at varying percentages of aloe vera. Adsorption experiments of different metals in waste water were done in the presence of different percentages of Aloe Vera powder and results were recorded in terms of change in pH of solutions. Results showed that alovera present at low percentages in mixture showed less adsorption and confirmed by increased pH of this mixture. Similarly, adsorption was found to be higher with increased alovera percentage showing decrease in pH of the mixture (Figure 1).

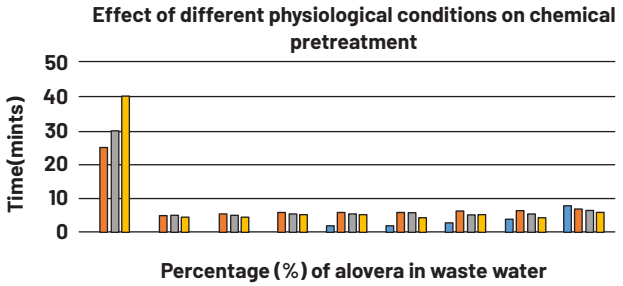

Figure 1: Effect of different times on absorotion capacity of aloe-vera powder

Comparative efficacy of different adsorption times (25 minutes, 30 minutes and 40 minutes) showed increased adsorption in first 25 minutes however, adsorption capacities of alovera were decreased afterwards. Maximum adsorption of alovera in mixture was found to be pH 6 (Table 1).

Time (min)	Varying percentages of aloe vera in waste water							
	0.04%	0.12%	0.2%	2%	2.07%	3%	4%	8%
25	5.1	5.6	6	6	6.1	6.5	6.6	7
30	5	4.4	5.6	5.8	6	5.3	5.5	6.5
40	4.6	4.6	5.5	5.2	4.5	5.5	4.6	6.1

Table 1: Effect of aloe vera on change in pH of waste water

Structural and morphological characteristics of Adsorption capacity of aloe vera with different metals in waste water was tested using Atomic absorption spectroscopy and Flame photometry. Structural and morphological characteristics: Atomic absorption spectroscopy of waste water containing metals. Results of Atomic absorbtion spectrosopy of waste water containing different metals (Na and Zn) was done using 25 ,12.5, 6.2, 3.1, 1.5 ppm concentrations of zinc acetate as standard samples and waste water contains metal either supplemented with or without the addition of aloe vera powder as adsorbent (Table 2).

Conc .ppm	Absorbance	Sample Used
1.56	0.3972	Metal solutions of zinc acetate
3.125	0.4591	
6.25	0.5963	
12.5	0.725	
25	0.9297	
-9.536363636	0.1987	50 ml of waste water containing 2.07g aloevera solution (zinc acetate) (4.14%)
7.072727273	0.5641	25 ml of wastewater containing 0.35g aloevera solution (zinc acetate) (1.4%)
-9.536363636	0.19	25 ml of Wastewater (Control)

Table 2: Atomic absorption spectroscopy of aloe vera for metal zinc adsorbtion from waste water

The metal absorbent spectroscopy analysis of zinc showed that when 1.4 % alovera has used the metal absorbent efficiency was 9.495%. However, with addition of 4 % aloe vera powder, percentage efficiency was increased to 10.237% showing positive effect of aloe vera powder on metal extract (Table 3).

Metal absorption efficiency	Metal(sodium)	Adsorption percentage %
	4%	10.24%

Table 3: Efficacy of zinc

Flame Photometry: Results of flame photometry of waste water containing different metals (Na and Zn) was done using 100, 80, 60, 40, 20, 10 ppm concentrations of sodium acetate as standard samples and waste water containing metal either supplemented with or without the addition of aloe vera powder as adsorbent (Table: 4).

Conc .ppm	Absorbance	Sample Used
100	99	Metal solutions of sodium acetate
80	60	
60	50	
40	39	
20	19.5	
10	9.5	
2355.656439	53	50 ml of wastewater containing 4.1 g aloevera solution (sodium acetate) 8.2 %)
3287.856964	70	50 ml of wastewater containing 4.1 g aloevera solution (sodium acetate) 8.2 %)
3287.856964	101.5	Waste water (Control) containing 100 ml waste water and no powder
2355.656439	48.6	Wastewater (Control) containing 50 ml waste water and no powder

Table 4: Flame photometry of aloe Vera for metal sodium adsorption from waste water

Similarly, when the metal analysis by flame photometry of sodium result showed that extraction efficiency was 500 % using aloe vera powder. This shows that maximum efficiency of aloe vera as metal extraction (Table 5).

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Metal(sodium)	Adsorption percentage %
8.2%	500%

Table 5: sodium efficacy

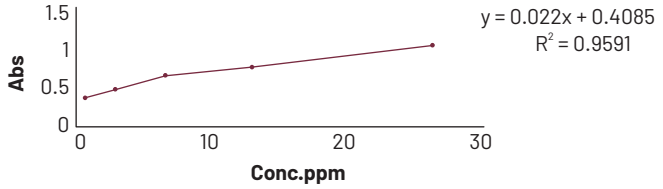

Figure 2: Atomic absorption of zinc in the presence of Aloe Vera

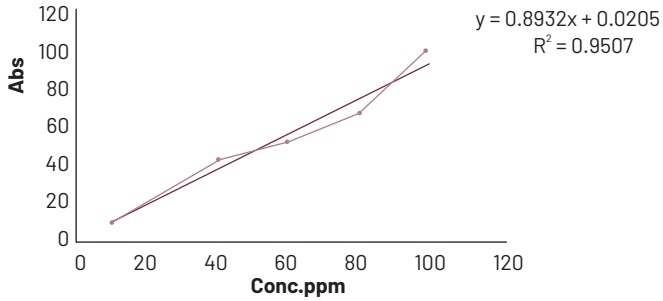

Figure 3: Flame photometry of waste water containing sodium

DISCUSSION

Water is life and all living organisms depend on water and necessary for all biological activities and help to maintain body functions. Now days, clean water is one major problem due to rapid industrialization and urbanization [12]. The growth of urbanized regions is occurring worldwide, and, as a result, research in the area of soil contamination by heavy metals has become increasingly important. Excessive amount of these elements can become harmful to organisms [13]. Heavy metals are naturally found in the soil, climate changing increase the concentration of trace elements in quantities dangerous for plants and animals. Some heavy metals such as Cu, Fe, Ni, Na and Zn are required in small quantities by organisms. However, extreme amounts of these elements can become harmful to organisms [13]. These heavy metals caused different environmental problems and major problems are water pollution [4]. Water pollution occurs when we discharged waste water directly or indirectly way in the environment was increasing [2]. The treatment of heavy metals in wastewater and drinking water is utilized to reduce the heavy metal levels to the acceptable concentration [5]. Heavy metals (zinc, sodium) into the environment from various industrial activities, when these heavy metals containing wastewater are used in soil as a source of water for plant they effects the plant growth. These heavy metals are also used in fertilizer when continuous fertilization of soils could increase the heavy metals concentration in soil and transfer these metals to human food chain [14]. Heavy metals are used as fungicides and pesticides to kill the pests when these heavy metals accumulate in living organisms at low level they caused many problems [15]. Heavy metals are not biodegradable and they affect biological functions of organisms. These heavy metals are excessively released in environment and caused water pollution. Zinc and sodium is excessively released as waste form and they caused adverse effect on human and animal health when we uptake regularly they caused diseases such as diarrhea, headache and blood pressure [16]. Mature healthy alovera leaves were used to obtain aloe vera they are clean and dried and grind these convert into fine powder. This powder is light brown color and average yield was 75 % obtained by this method [10]. Aloe vera is the plant they are used removed heavy metals in wastewater. Aloe vera leaf powder is one of effective and inexpensive method to remove heavy metals such as sodium and zinc in waste water [10]. Aloe vera also contains phytochemicals they are responsible for multifunctional activity of alovera this is beneficial for human [17]. This plant is used as a drinking and food purposes they are cure many diseases such as skin diseases and cancer [18]. Chemical preeatment of powder was done to increase its absorbance. Pretreatment resulted in visible change in color from light brown to colorless. They are many methods to remove heavy metals in the water adsorption as one of the method to remove heavy metals in the water [19]. Adsorption experiments of different metals in waste water were done in the presence of different percentages of Aloe Vera powder and results were recorded in terms of change in pH of solutions. Results showed that alovera present at low percentages in mixture showed less adsorption and confirmed by increased pH of this mixture. Similarly, adsorption was found to be higher with increased alovera percentage showing decrease in pH of the mixture [20]. Comparative efficacy of different adsorption times (25 minutes, 30 minutes and 40 minutes) showed increased adsorption in first 25 minutes however, adsorption capacities of aloe vera were decreased afterwards. Maximum adsorption of alovera in mixture was found to be pH 6 as reported by Malik et al., (2016). Adsorption capacity of alovera with different metals in waste water was tested using Atomic absorption spectroscopy and Flame photometer. Atomic absorption spectroscopy is used to measure the concentration of elements use wavelengths of light absorbed by an element. Waste water containing different metals (Na and Zn) was done using different ppm concentrations of zinc acetate and sodium acetate [21]. The metal absorption and spectroscopic analysis of zinc showed that when 1.4 % alovera has used the metal absorbent efficiency was 9.495 %. However, with addition of 4% alovera powder,

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percentage efficiency was increased to 10.237 % showing positive effect of aloe vera powder on metal extraction. Similarly, when the metal analysis by flame photometry of sodium result showed that extraction efficiency was 500% using alovera powder. When sodium is added in wastewater and aloe vera is added in this solution. Alovera absorb the sodium rapidly in the solution. This shows that maximum efficiency of aloe vera as metal extraction. Due to its outstanding uptake capacity, the aloe vera plant was proved to be an excellent biomaterial for accumulating metal ions from wastewater.

CONCLUSION

Adsorbent (aloe vera leaf powder) can be used efficiently to treat metal ions (sodium, zinc) in wastewater. Due to its adsorption of metals ions (sodium, zinc) uptake capacity, as visible by different tests, the aloe vera plant was proved to be an excellent biomaterial for accumulating heavy metals from wastewater in future.

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