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Protection of Human Health by Low Cost Treatment in Rural Area

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Abstract Arsenic is most abundant element on the Earth and found in groundwater in both + (III) and + (V) oxidation states. If taken in sufficient quantities, arsenic can pose a threat to human health. In the rural area without awareness or high treatment cost it can consumed directly by local people. To reduce the effect on arsenic on drinking water medicated natural occurring plant seed is used for removal of toxic substance. In this study Moringa oleifera is used as coagulant material to reduce the toxicity of drinking water. Moringa oleifera is that seed which proved and optimized this problem in rural area. It can be reduced 91% of arsenic and 93% of hardness from drinking water.

Keywords: *coagulation, dissolved, filtration, suspended, toxicity*

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1. Introduction

Arsenic is widely distributed throughout the earth crust. Arsenic are introduced into the water through the dissolution mineral, ores, concentration in ground water by erosion and industrial effluent. Natural oxidation or reduction and suitable temperature and pH support to increase the arsenic concentration in ground water. General trivalent arsenite (As [III]) or prevalent arsenate (As [V]) inorganic arsenic are occur in environment. Concentration of arsenic was found less than 10 microgram in water but its concentration was high in natural mineral deposition water. The international drinking water standard allows 0.2 mg/L by WHO in 1958 which further revaluated 0.01 mg/L in 1963. Arsenic contamination of drinking water is a world-wide problem which has hit the West Bengal region of India particularly hard [1]. About 40 million people are suffered from different disease in eastern part of India. Long term exposure to arsenic via drinking water leads to a wide range of health problems including: skin cancer, gangrene of the limbs, vascular diseases, conjunctivitis, central nervous system damage and hyperkeratosis [2]. The harmful effect of arsenic is shown in Figure 1.

Figure 1. The harmful effect of arsenic (a) skin disease (b) Sensitive section (c) Foots (d) Hand

Unfortunately there is no known cure for arsenic poisoning and therefore providing arsenic free drinking water is only way to minimized the adverse health effect [3]. Methods such as oxidation, filtration, ion exchange and reverse osmosis have been shown to be effective for the removal of arsenic from water [4]. However, these methods require considerable infrastructure and are expensive to operate, thus making them impractical for small community scale water treatment systems. As a large number of people in West Bengal obtain their water from small wells, as opposed to from large municipal water plants, it is necessary to develop technology that can be implemented on a small scale to remove arsenic from drinking water as it is extracted from the well. Several investigators have reported adsorption methods for the removal of arsenic from drinking water; however there is still a need to develop effective field deployable adsorbents and delivery systems [5]. On the other hand, naturally occurring coagulants are usually presumed safe for human health's as well as inexpensive are recommendation for arsenic remediation. Some studies on natural coagulants have been carried out and various natural coagulants have been produced or extracted from microorganisms, animals, or plants [6].

Recently, considerable attention has been paid to eco-friendly and bio-friendly plants, which can prevent and cure different human diseases [7]. According to the World Health Organization reports, the use of traditional medicine in the first world countries is on the rise due to failure of conventional medicine that can cure chronic diseases, emergence of multi-drug resistant pathogens and parasites, adverse effects of chemical drugs, increasing cost and information of herbal medicine. Antimicrobial potentiality of different medicinal plants is extensively studied all over the world [8,9,10]. However, only a few studies have been carried out in a systematic manner. Moringa oleifera is medicinal species, belonging to monogeneric family Moringaceae (order Brassicales). It has 33 species of trees and shrubs distributed in sub-Himalayan ranges of India, Sri Lanka, North Eastern and South Western Africa, Madagascar and Arabia [11]. Today, it has become naturalized in many locations of the tropics and is widely cultivated in Africa, Ceylon, Thailand, Burma, Singapore, West Indies, Srilanka, India, Mexico, Malabar, Malaysia and the Philippines [12]. Almost all the parts of this plant: root, bark, gum, leaf, pods, flowers, seeds and seeds oil have been used for the various ailments in the indigenous medicine [14]. Moringa oleifera (family Moringaceae) is a tropical plant known to contain coagulating/flocculating compounds in the seeds. Many researchers have used M. oleifera seed as a primary coagulant, for water treatment [15]. Many studies have been carried out on the performance of M. oleifera seeds as a primary coagulant, coagulant aid and as conjunctive with alum. M. oleifera showed a high coagulation activity for the high turbidity water [16]. The coagulation activity was low for low turbidity water. Results of only three pilot scale studies using M. oleifera seeds extract as a primary coagulant in turbid surface water treatment worldwide have been documented. So the aim of present study is to test the M. oleifera seed for reduction of arsenic and hardness of drinking water. The parameters are compared with mixing time, dosing and retention time as well as effect on pathogen.

2. Material and Method

2.1. Material

The synethic ground water sample prepared in the lab the parameters are shown in Table 1. The chemical used were analytical reagent grade. The arsenate solution prepared from sodium arsenate ($Na_2HAsO_4.7H_2O$) produced from (Loba Chem. P. Ltd. Mumbai). The stock solution was prepared by dissolving 0.416 g of sodium arsenate in 100 ml distilled water. The intermediate arsenic solutions were freshly prepared before experiment and appropriate amount of tap water. The pH of the synthetic groundwater was adjusted using dilute HCl or NaOH solution.

Dry M. oleifera seeds used in the study were obtained from local market. The seed wings and coat were removed and the seed kernel dried in the oven at 50°C for 24 hours. The seeds were ground using a domestic food blender. Oil was extracted from the ground seed using a Soxhlet apparatus and hexane as the solvent. Only 25% w/w oil was extracted from the seed kernel because in a previous related study, it was observed that extraction of 25% w/w oil from M. oleifera seed powder gave the best performance when applied to coagulation. Five grams of oil extracted seeds (remaining cake) powder was blended at high speed for two minutes in a variable speed domestic food processor (National MJ-C85N) with 200 ml of distilled water added. The resulting suspension was filtered through a clean muslin cloth in a beaker and the filtrate made up to a final volume of 500 ml to yield a stock solution of approximately 10000 mg/l.

Table 1. Parameters of synthetic waste water

S. No	Parameters	Quantity (Mg/l)
1	pH	7.1
2	Arsenic	416
3	Hardness	500
4	TS (Total Solid)	100
5	TDS (Total Dissolve Solid)	70
6	SS (Suspended Solid)	30
7	Cl (Chloride)	6
8	S (Sulphur)	5

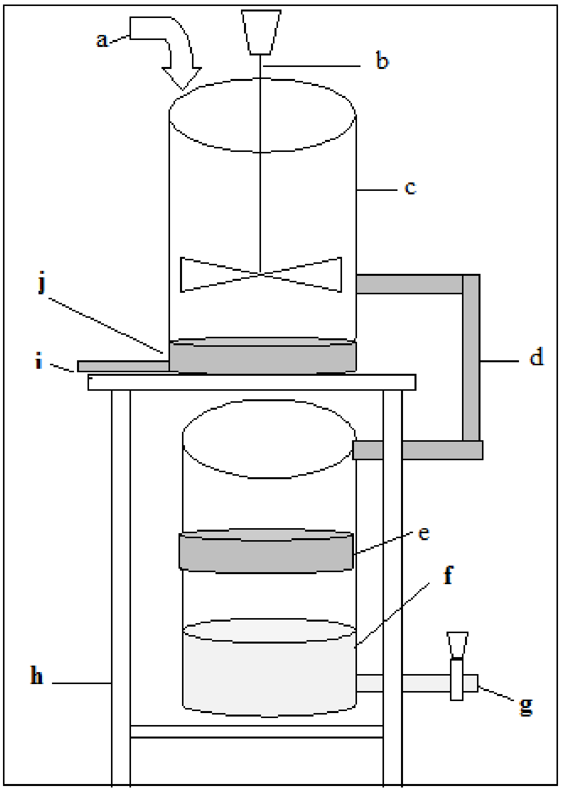

Figure 2. Experimental setup

2.2. Experiment Setup

The experiment setup is shown in Figure 2. Two tanks are arranged up and down with the help of wooden platform. A (a) measure quantity of ground water is feed either manually or by water pump, (b) is impeller it can be operated by motor or manually (c) is the feed tank in which water is proper mixed with coagulant with help of impeller, (d) is connecting pipe which connect feed tank and storage tank (f), (e) is the filter medium either it can filled with carbon black or washed sand, from (g) water sample was taken, (h) is plate form stand to hold up both the tank, From (i) sediment (j) are removed by opening the valve.

2.3. Analytical Method

To determine total arsenic [As (Tot) ¼ As (III) þ As (V)], samples were treated with L-cysteine in 2 M HCl and kept for 15 min at room temperature to reduce As (V) eAs (III). To determine As (III) in the presence of As (V), the carrier HCl solution was replaced by 2 M citric acid/citrate buffer at pH 5.0. The As (V) was then calculated from the difference of As (Tot) and As (III) [17]. The residual hardness of the product water was then measured using standard methods [18] after one hour settling time. The synthetic water sample was kept at constant pH of 7.2 for all experimental runs. For the surface and groundwater samples, water quality parameters measured before and after dosing were hardness, alkalinity, turbidity and pH.

3. Result and Discussion

3.1. Effect of Mixing Time

Mixing time is one of the factors which decided how percentage the substance is dissolved in another substance/matter. To determine the effect of M. Oleifera on reduction of arsenic and harness in drinking water initially shown in Figure. It was observed that it increase with increase in mixing time means when mixing time is 10, 20, 30, 40, 50, and 60 min, the percentage reduction of arsenic 25, 34, 48, 60, 72 and 90% and hardness 28, 39, 54, 66, 78 and 95% respectively. Basically two type of condition occur first either rapid mixing with short time or second slow mixing for long time. When rapid mixing for short time, charge neutralization occurs very rapidly. After a short time, the ions form hydroxide gels. The gels then can trap particles or bridge between particles creating a floc that may settle or at least be large enough to be removed by filtration. For slow mixing for long time encourage collision of particles and the gel to form a larger mass that will be settled or filtered from sample.

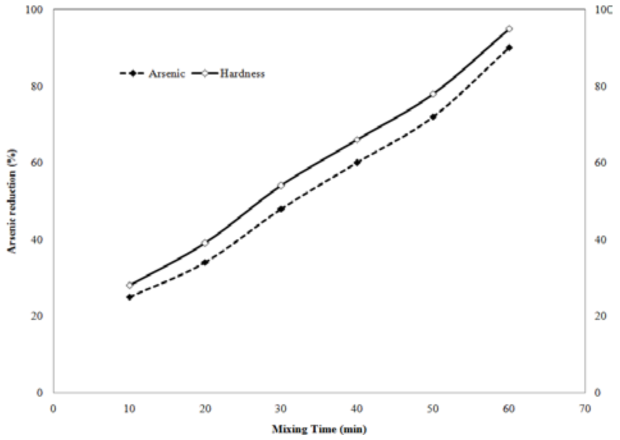

Figure 3. Effect of mixing time on arsenic and harness removal at mixing speed = 90 rpm, dosing = 30 mg/l, retention time 75 min

3.2. Effect of Speed of Mixing

Mixing with proper speed also affect the contamination removal and depend upon the types of pollutant. To determine the effect of mixing speed in percentage reduction of arsenic and harness of drinking water shown in Figure. It was found that it increase with increase with speed up to some specific after that decrease the performance of treatment. When the mixing speed 30, 60, 90, 120, 150 and 180 rpm, the percentage reduction of arsenic 20, 32, 48, 56, 72, and 64% and hardness 24, 35, 54, 59, 75 and 68% respectively. This apparent conflict can be explained by considering the two possible types of coagulation: charge neutralization and sweep floc. For sweep coagulation, slow mixing speeds are not required since most of the colloids are captured by becoming enmeshed in the growing precipitate. Charge neutralization or just charge neutralization, depending on the pH and the dose of the sample.

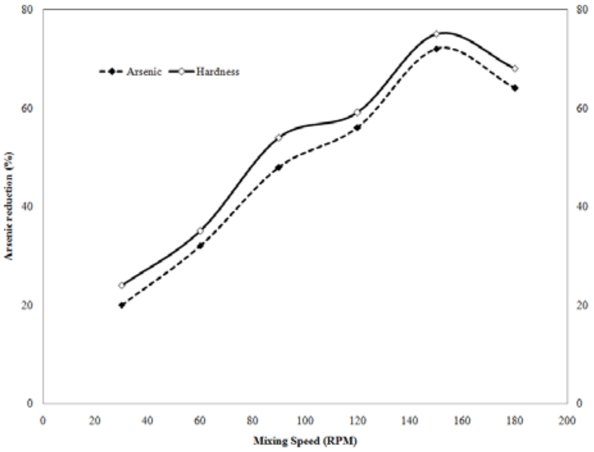

Figure 4. Effect mixing speed on arsenic and harness removal mixing time = 30 min, dosing = 30 mg/l, retention time 75 min

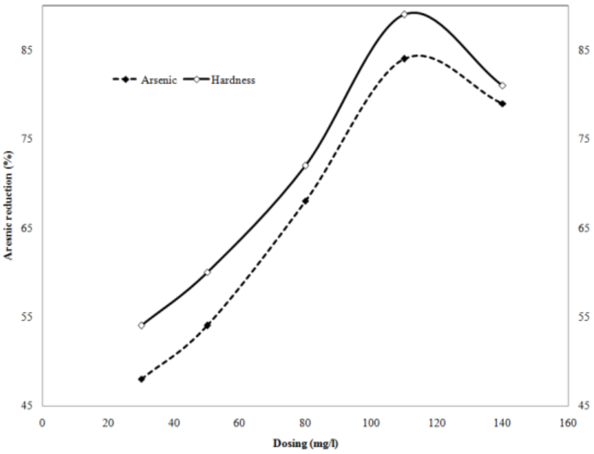

Figure 5. Effect dosing on arsenic and harness removal mixing time = 30 min, mixing speed = 90 rpm, retention time 75 min

3.3. Effect of Dosing

Arsenic and hardness removal efficiency as a function of coagulant dose at different initial pH is given in Figure. The curves of arsenic and hardness reduction show a common tendency: removal efficiency first rises with increasing coagulant dose, reaching the maximal value, and then decreases with further coagulant addition. The optimum coagulant dose (OCD) in this study is defined as the lowest coagulant dosage at which maximum arsenic and harness reduction efficiency is achieved. As seen from Figure at 110 mg/l the maximum arsenic 84% and hardness 89% was observed. At initial when dosing is 30, 50, 80 mg/l the arsenic percentage reduction 48, 54, 68% and hardness 55, 60, 72% were noted. When dosing was beyond the 110 mg/l the percentage of arsenic 79% and hardness 81% was found. This attribute those at maximum dosing restabilisation of colloidal and minimum dosing were not sufficient to neutralize the colloid in drinking water sample.

3.4. Effect of Retention Time

Retention time indicated that time required to proper contact the charge ion with pollution anion. To determine the effect of M. oleifera on the retention time on percentage reduction of arsenic and harness was shown in Figure. It was observed that percentage reduction or arsenic and harness were increase with increase with time when retentions time 15, 30, 45, 60, 75, 90, 105 min, percentage reduction of arsenic 12, 20, 28, 34, 48, 61, 91% and harness 15, 24, 32, 37, 54, 68, 93% respectively. Further increase in retention time 120 min the percentage reduction of arsenic 91% and harness 93% was observed. It means that in short time the reaction between the cation and anion was not completed, at optimum time its shows maximum efficiency and further increase the time it maintain the constant treatment performance.

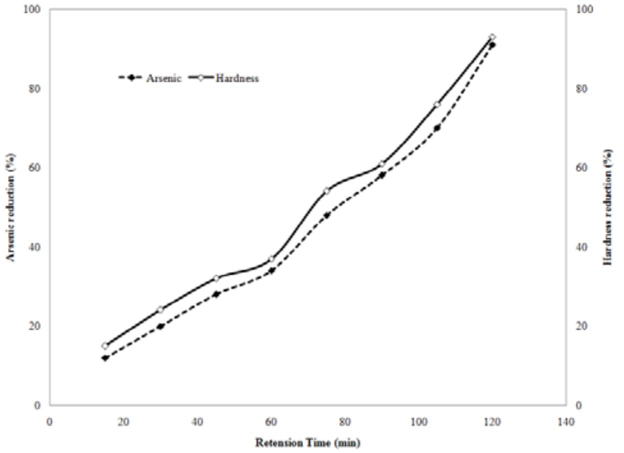

Figure 6. Effect retention time on arsenic and harness removal mixing time = 30 min, mixing speed = 90 rpm, dosing = 30 mg/l

3.5. X-Ray Diffraction

To determine the percentage of arsenic and other component in drinking water before and after treatment with the M. oleifera was shown in Figure. It seen from the x-ray diffraction peak that before treatment the percentage of arsenic (As) component which causes harness in water i.e. calcium (Ca) are have been high. After treatment with M. oleifera the peaks in x-ray diffraction were reduced.

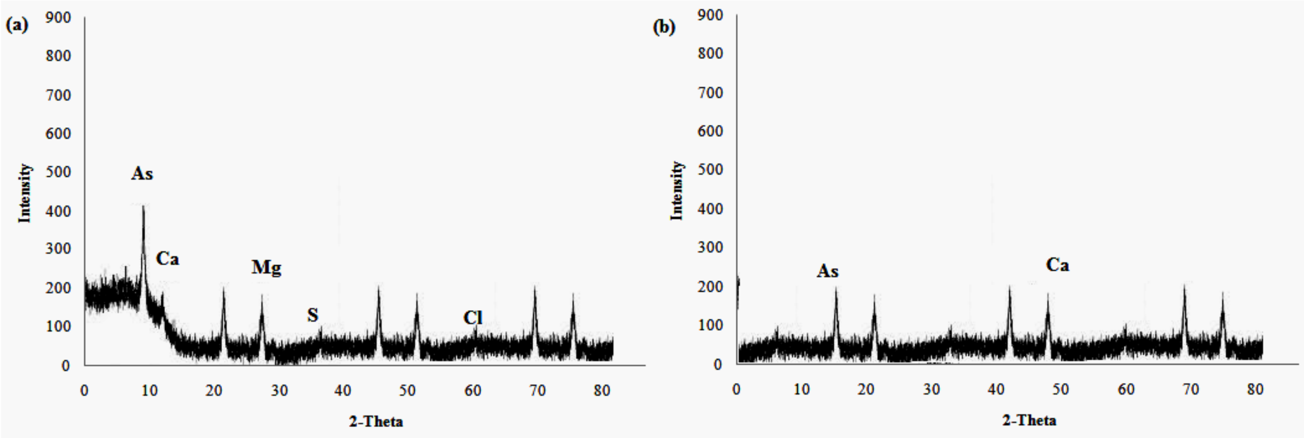

Figure 7. X-ray diffraction study (a) before treated drinking water (b) After treatment with M. oleifere at mixing time = 30 min, mixing speed = 90 rpm, dosing = 30 mg/l and retention time 75 min

4. Conclusion

Coagulation with Moringa oleifere is good alternatives for removal the toxic compounds from drinking water. Moringa oleifere can be successfully used in treatment to degrade the arsenic and harness in drinking water. It was conclude from the experiment that optimum dose 110 mg/l, mixing speed 150 rpm, mixing time 60 min. and retention time almost 105 min. the percentage reduction of arsenic 91% and hardness 93% can be achieves. Moringa oleifere is available in local market as well as affordable price for everyone. The preparation of power or solution can be prepared easily in home also. The treatment steps are short and less time required as compared to other methods.

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