CHAPTER I

INTRODUCTION

1.0 INTRODUCTION

Availability of adequate amount of safe water is the basic need of human being. Access to safe drinking water is the basic human right. It is a right of people to get the safe water for their livelihood. But, unfortunately, the situation of India regarding safe water supply is not satisfactory. Many people living in rural as well as in urban area are compelled to drink contaminated water.

Arsenic, the king of poisons, has probably influenced human history more than any other element or toxic compound. This enigmatic metal began its long association with human culture by poisoning the god (Hephaestus) who first endeavored to find some beneficial use for it.

Arsenic is a member of the Nitrogen family with both metallic and non-metallic properties, and is a naturally occurring element in the earth’s crust, air, and all living matters [1]. The name Arsenic is derived from the Greek word “arsenikon”, which means “yellow Orpiment” [2]. Arsenic compounds have been mined and used since ancient times. In the Victoria era, arsenic was mixed with vinegar and chalk and was eaten by women to improve the complexion of their faces, making skin fairer. During the Bronze Age, arsenic was often included in the bronze, which made the alloy harder. Arsenic has six specific characteristics [3]:

- It is a virulent poison on acute ingestion.
- It is extremely toxic on long term exposure to very low concentrations.
- It is not visible in water and food.
- It has no taste.
- It has no smell.
- It is difficult to analysis, even when occurring in concentration twice as high as WHO guidelines.
Arsenic is present in more than 200 mineral species and is widely distributed in the environment; especially as arsenopyrite or as metal arsenates [4]. It has been estimated that about one third of the atmospheric flux of arsenic is of natural origin. It is introduced into water through natural sources [4] e.g. volcanic emissions, dissolution of mineral ores, atmospheric deposition etc. as well as through anthropogenic sources, e.g. nonferrous smelting, petroleum-refining, fossil fuel power plants and the use of arsenical pesticides and herbicides [5,6]. Even though the use of arsenic-containing products such as pesticides and herbicides has been decreased significantly in the last few decades, their use for wood preservation is still common [7]. The impact of the environment of the use of arsenical compounds, at least locally, will remain for some years. Arsenic occurs in two primary forms: organic and inorganic. Organic species of arsenic are predominantly found in foodstuffs and marine organisms, such as shellfish in the form of monomethyl arsenic acid, dimethyl arsenic acid, arsenu-sugars, and arsenobetaine. Organic arsenic forms may be produced by biological activity, mostly in surface waters, but are rarely quantitatively important [8]. Arsenic is found in four oxidation states, -3 (arsine), 0 (arsenic) +3 (arsenite) and +5 (arsenate) and in the aquatic environment both the organic and inorganic forms are found. In oxidized environment arsenic appears mostly as oxyanions [9]. Arsenic cannot be easily destroyed and can only be converted into different forms or transformed into insoluble compounds in combination with other elements, such as iron. Many impurities such as lead, iron and selenium may be mixed up together with arsenic wastes and make it uneconomic to remove. It has been well-established that arsenic compounds have detrimental effects on health of living beings. Incidents of arsenic contamination in groundwater have been reported from all over the world [10]. Chronic exposure to arsenic concentrations above 100µg/L can cause vascular disorders, such as dermal
pigments (Blackfoot disease) and skin, liver and lung cancer [11,12]. Naturally occurring arsenic, however, is of great concern in some regions of Bangladesh, India and Nepal, where hazardous concentrations of arsenic have appeared as a result of strong water-rock interactions and the physical and geochemical conditions for arsenic mobilization in aquifers[8].

Of various sources of arsenic in the environment, drinking water probably poses the greatest threat to human health and high arsenic concentrations can be found in groundwater. In water it is commonly found in inorganic species such as arsenite (AsO\textsubscript{3}\textsuperscript{3-}) and arsenate (AsO\textsubscript{4}\textsuperscript{3-}), referred to as As(III) and As(V), respectively [13], which have harmful effects on humans, plants and animals as well. In 1993, based on human health data, the World Health Organization (WHO) has recommended a maximum contaminant level for arsenic (10\(\mu\)g/L) in drinking water but many countries have retained the earlier WHO guideline of 50 \(\mu\)g/L including Bangladesh, India and China [14]. Greater attention is required for the removal of As(III) from groundwater due to 60 times more toxic and mobile than arsenate [As(V)], which mainly arise from its neutral state (H\textsubscript{3}AsO\textsubscript{3}) in groundwater as compared to the charged As(V) species. The toxicity of trivalent arsenic is related to its high affinity for the sulfurydyl groups of bio-molecules such as glutathione (GSH) and lipoic acid and the cysteinyl residues of many enzymes. The formation of inorganic As (III)–sulfur bonds results in various harmful effects by inhibiting the activities of enzymes such as glutathione reductase, glutathione peroxidases, thioredoxin reductase and thioredoxin peroxidise.
1.1 RESEARCH OBJECTIVES

1. The current study was carried out to characterize a novel and easily available indigenous bio adsorbents for the efficient removal of As(III) from groundwater by batch method.

2. To study the Arsenic removal efficiency of four indigenous and low cost adsorbents viz., activated carbon of *Cassia tora*, *Spinacia oleracea*, *Moringa oleifera* and *Clerodendrum inerme* and establishing the mechanism of Arsenic removal.

3. To determine the percentage of Arsenic removal was enhanced by Folic acid impregnated *Clerodendrum inerme*.

4. The analysis of the As(III) adsorption kinetics (the pseudo-first-order, pseudosecond-order, Elovich model, Weber and Morris model, Fractional attainment of equilibrium, Bangham’s equation and Reichenberg equation) and various isotherm models (Langmuir, Freundlich, Temkin, Dubinin–Radushkevich (D-R) and Flory–Huggins (F-H)) are performed.

5. To evaluate the impact of bio adsorbents dosage, pH, temperature, contact time, initial As(III) concentration and various co-ion concentration on the As(III) removal kinetics and/or capacities.

6. To describe and explain some important thermodynamic parameters.

7. To confirm the adsorption process with various analytical analysis, viz., FTIR, XRD and SEM with EDAX.

8. To study the regeneration capacity of the adsorbents.

9. To design a domestic household arsenic removal filter.