CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Every day, there are thousands of chemicals discharged directly and indirectly into water bodies without further treatment for elimination of the included harmful compounds (Salim et al., 2008). Heavy metals are without doubt well thought-out as the most hazardous and harmful metals even if they are present as traces, since they accumulate in the tissue of living organisms (Rao et al., 2010; Khairy et al., 2014).

Conventional processes for removal of metals from water include chemical precipitation oxidation-reduction, filtration, electrochemical methods and other complicated separation procedures using membranes. Such methods showed to be not effective and not economically possible for the treatment of low heavy metals concentrations (Kelly-Vargas et al., 2012; Lim and Aris, 2014). Therefore, new alternative methods are needed to find the best ecological and economical techniques for biosorption of heavy metals from water.

Biosorption describes any system which includes a sorbate working together with a biosorbent resulting in an accumulation at the sorbate–biosorbent interface, and therefore a decrease of sorbent concentration in the solution (Sasaki et al., 2013). Biosorption is a property of both living and dead organisms, and has been exploited as a promising biotechnology because of its simplicity (Bilal et al., 2013). Accordingly, biosorption can be defined as the removal of substances from solution by biological materials (Gadd, 2001).

Moringa oleifera is a native tree of the sub-Himalayan parts of Northwest India, Pakistan and Afghanistan. It is now widely cultivated across Africa, South America, most parts of South - East Asia for example: Malaysia, Indonesia and Thailand (Reddy et al., 2011).

Moringa oleifera is a multipurpose tree with most of its parts being useful for a number of applications. It is generally used in a number of developing countries as a vegetable, medical plant and a source of vegetable oil. It has an impressive range of medicinal uses with high nutritional value (Anwar et al., 2007). On the other hand, *Moringa oleifera* seeds have been found to be a natural coagulant, flocculants, softener, disinfectant, and sludge conditioner (Jahn et al., 1986; Suarez et al., 2003; Nand et al., 2012), heavy metal remover in water and wastewater treatment (Alves and Coelho, 2013; Obuseng et al., 2012).

One of the heavy metals in water is Cadmium (II); it is naturally present in the environment by the gradual process of erosion and abrasion of rocks and soils, and from singular events such as forest fires and volcanic eruptions. It is therefore naturally present everywhere in air, water, soils and foodstuffs (Mahvi et al., 2008).

Cadmium is one of the heavy metals which is highly toxic to humans, plants and animals and it is responsible for causing kidney damage, renal disorder, high blood pressure, bone fractures, and destruction of red blood cells (Drasch, 1983; Purkayastha et al., 2014). According to the World Health Organization (WHO), the maximum accepted level of Cd (II) in water is 0.005 mg/l (Abaliwano et al., 2008) Meanwhile, Ministry of Health Malaysia (MOH) recommends that Cd (II) limits in drinking water should be 0.003 mg/l (MOH, 2015).

Another heavy metal is iron, which is the most plentiful element on earth. It is an essential element in human nutrition and plant metabolism, and it is used in a variety of industrial processes. In industries, it is used as a construction material and to create pigments. For humans, it is required for haemoglobin to transport oxygen from lungs to cells. However, high levels of iron can be fatal. Iron is commonly found in many industrial wastewaters. Generally, it is present in the water in the ferric state and enters the water bodies in the form of ferrous ion Fe (II), which can be oxidized to ferric ion Fe (III) by oxygen dissolved in water (Ahalya et al., 2003). The maximum accepted level of Fe (III) in water is 0.3 mg/l (Colter and Mahler, 2006), Meanwhile, Ministry of Health Malaysia recommends that Fe (III) limits in drinking water should be 1 mg/l (MOH, 2015).

Copper is both an essential nutrient and a drinking water contaminant. It is an important trace element required by humans for its role in enzyme synthesis, tissue

and bone development (Nand et al., 2012). However, excessive amounts of copper consumed is toxic and carcinogenic and it leads to its deposition in the liver and causes many diseases such as Wilson disease, liver and kidney failure and finally gastrointestinal bleeding (Al Bsoul et al., 2014).

The excessive amounts of Cu (II) in fresh water resources and aquatic ecosystem damage the osmo-regulatory mechanism of the freshwater animals and cause mutagenesis in humans (Bilal et al., 2013). Large quantities of copper are released to the environment by discarding industrial waste without further treatment (Demirbaş et al., 2008). According to World Health Organization (WHO) the permissible limit of Cu (II) in water is 1.5 mg/l (Bilal et al., 2013). According to the Ministry of Health Malaysia the acceptable limits of Cu (II) in drinking water should be 1 mg/l (MOH, 2015).

Lead occurs in water due to numerous industrial and mining sources and is the most widely spread of all toxic metals. The overload amount of lead in water causes severe problems such as anaemia, encephalopathy, hepatitis and kidney disease (Shafaghat et al., 2014; Putra et al., 2014). According to World Health Organization (WHO) the highest desirable limit of Pb (II) is 0.05 mg/l (Mataka et al., 2006). Meanwhile, Ministry of Health Malaysia recommends that Pb (II) limits in drinking water should be 0.01 mg/l (MOH, 2015).

Since Malaysia is widely recognized as one of the centres of biological diversity, rich with wild plants, it will be beneficial for the researchers to further screen the valuable biosorbent. All of these resources could provide renewable useful products not only for the current generation but also for the future generations to come. Hence, this study is initiated to target the miracle tree *Moringa oleifera* to be used as a potent biosorbent for the Cd (II), Pb (II), Cu (II) and Fe (III) ions. To help in finding an alternative methods to treat water, which could be economically and environmental friendly techniques.

1.2 PROBLEM STATEMENTS

Cadmium and other heavy metals present in water are harmful and poisonous and need to be removed from water; using natural biosorbent is one of the solutions.