Chapter 4
Assessment of Phytoremediation Efficiency of *Coriandrum sativum* in Metal Polluted Soil and Sludge Samples: A green approach

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ABSTRACT

A greenhouse pot experiment was conducted to evaluate the phytotoxic effect of heavy metals (Zn, Cu, Ni, and Cr) on the growth (plant height, plant and seed weight) of Coriandrum sativum and uptake of metals. For this purpose, the polluted soil and sludge samples were collected from three sites of Moradabad: Karula nala (KS), Dhauri nala (DS), and Karula nala sludge (KSL). Metal content in the plant and soil was determined by AAS technique. The plants were also hydrodistilled using Clevenger apparatus and

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the extracted oil was analyzed by GC and GC/MS. The content of copper in KS and KSL, Zn in KS, Ni in DS and KSL, and Cr in KS was above the permissible limits according to Indian standards. Plant weight was significantly affected in the different soil samples. Among all the collected polluted soil and sludge samples, DS sample showed the highest metal accumulation, while in the KSL sample, the plant could not survive. The study revealed that coriander can be used to remediate the contaminated soil with economic return and metal free final product, essential oil.

INTRODUCTION

One of the major health and environmental problems of our modern society is heavy metal toxicity and the danger of their bioaccumulation in food chain. Fertilizers, pesticides, sewage sludge, burning of fossil fuel, mining and smelting of metallic ferrous ores and municipal waste are the main sources of metal contamination (Peng et al., 2006). Copper (Cu), zinc (Zn), nickel (Ni), chromium (Cr), mercury (Hg) and lead (Pb) are the most common heavy metals (USEPA, 1997). Metals and metalloids having densities greater than 5g cm^{-3} are known as heavy metals and generally associated with pollution toxicity. Although some of these elements (essential metals) are necessary to the organisms in low concentrations (Adriano, 2001). Zinc is used in the metabolism of carbohydrates proteins, auxins, phosphate, in RNA and ribosome formation in plants. It is also the key component in several enzymes (peptidases, dehydrogenases, proteinases) (Mengel and Kirkby, 1982). Copper involves in many physiological processes in plants as respiration, photosynthesis, carbohydrate distribution, nitrogen, cell wall metabolism and seed production along with disease resistance (Kabata and Pendias, 1992).

The utilization of plants and related microbes for environmental cleanup is known as phytoremediation (Rupassara et al., 2002). As this technology is cost effective and eco-friendly, it has a significant application in environmental and ecological research. One main disadvantage of phytoremediation is that it requires a long-term promise, depending on plant growth, bioaccumulation capacity and tolerance to toxicity (Burken et al., 2011). Research and application of phytoremediation for the treatment of petroleum hydrocarbon pollution over the past decades has given much helpful information that can be applied to plan effective remediation systems and for more improvement and innovation (Kamath et al., 2007). The random use of chemicals at production process increase substances over maximum permissible concentrations in air, soil, water and meal. Industrial and agricultural activities in several area destroyed soil and water quality (Wosten, 1997).

The volatile organic components of fragrant plant matter, which can be isolated by physical processes, contribute to both fragrance and flavour (Waterman, 1993). *Coriandrum sativum* L. belonging to the family Apiaceae (Umbelliferae) is also known as dhania, dhanya, coriander, collender, chinese parsley, coriandro, cilantro, cilandrio, cilantro, yuan sui, hu sui, coriandolo, dhanayaka, kusthumbari, koriannon, korion, Koriander, Wanzendill, Schwindelkorn and koendoro. Several medicinal uses of coriander have been reported including anticonvulsant (Karami et al., 2015), effect on memory (Cioanca et al., 2013), neuroprotective (Vekaria et al., 2012), antibacterial and antifungal (Baratta et al., 1998), antimicrobial (Casetti et al., 2012), antioxidant (Wong and Kitts, 2006), anti-inflammatory and analgesic (Hashemi