CHAPTER V
CONCLUSION

In the present work a series of plants commonly used for the ayurvedic preparation were analyzed for the toxic elements such as lead, cadmium, arsenic, mercury and micro nutrient iron. Materials and methods were standardized and the most suitable method was selected for the analysis.

Lead content in these plants are slightly above than the permitted level of 10 ppm. Also it can be seen that there is considerable variation within the same plant collected from different sources, indicating that the plants are likely to have capacity for adsorption of lead. The source of lead can be from the soil or from exhaust fumes of vehicles. This indicates that even the soil needs to be checked.

The cadmium content in the plants was much below the permitted level. In some plants the cadmium content was slightly beyond the permissible limit. It is also observed that in some plants collected from different sources, the cadmium content was matching quite well. This implies that cadmium is not that easily taken up by the plant under the influence of varying soil and environmental conditions.

The arsenic and mercury content in plant samples taken up for analysis was found to be below the permissible limit. Hence, it can be concluded that these plants can be safely used for the medicinal purposes.

The iron content was found to be similar amongst the plants collected from different sources. It was also observed that there was considerable variation in the same plant collected from different sources. This variations noticed amongst the same plants collected from different sources indicate that the soil conditions as well as the ability of the plant to assimilate the iron, may have a role to play. Some plants
are also called as plant excluders, which prevent metals from entering into them. **Metal indicators:** These plants accumulate metals in their above-ground tissues and the metal levels in the tissues of these plants generally reflect metal levels in the soil. **Accumulators:** These plant species (hyperaccumulators) can concentrate metals in their above-ground tissues to levels far exceeding those present in the soil or in the non accumulating species growing nearby.

Environmental pollution is the main reason for heavy metal contamination which can affect even regular crops like rice, wheat, pulses and vegetables. Therefore they should also be checked for heavy metals. Despite the popularity of traditional medicine scientific research on safety and efficacy is limited. Therefore it is imperative for pharmacists and health care providers to learn about the safety of traditional medical practices. In view of the importance of herbal drugs acceptability by the majority of the population, the identity purity and quality assurance of herbal drugs assumes great significance. The reports on the presence of high content of toxic metals in the herbal drugs needs to be checked again to have clarity of the availability of such drugs in the market. Ayurvedic industry therefore conducts regular quality control to check heavy metals in medicinal plant raw drug and take extra care while preparing medications. In this connection a quality control and certification of all the drugs ready for marketing and dispensing is essential with a view to overcome the adverse publicity on the otherwise useful traditional ayurvedic drugs. Therefore, as a measure of quality control and to ensure safety of the drug, it is necessary that the medicinal plants should be tested for heavy metal content before processing it for the medication.
This thesis was an investigation into the occurrence and uptake of heavy metals by selected Indian medicinal plants. To date, very little work has been done in this field. The experiments cover four broad areas:

a) The random screening of medicinal plants collected from various regions to quantify the levels of heavy metal concentrations.

b) Removal of heavy metals using activated granular activated carbon and nano particles of activated carbon as adsorbents.

c) Determination of antibacterial activity with different solvent extracts such as chloroform, ethyl acetate and ethanol.

d) Screening of medicinal plant extracts phenolic and flavonoid contents, and antioxidant activity.

The present study deals with removal of As (III), Cd(II), Cu(II), Hg(II) and Pb(II) ions by adsorption on commercially Granulated Activated Carbon (GAC) and Nano Particles of Activated Carbon.

Results revealed heavy metal contamination in some medicinal plants traded at informal street markets. Certain species are able to accumulate heavy metals while other species are more sensitive to elevated metal concentrations with their growth being affected. Metal accumulation also has the potential to change the biological activity of the plants. Thus, heavy metal contamination of medicinal plants, due to unregulated trade or poor cultivation regimes, has several consequences that compromise the quality, safety and efficacy of traditional medicines. Firstly, due to potential heavy metal accumulation, consumer safety is compromised. And secondly, both horticultural yield and phytochemical composition may be negatively affected. The findings of this thesis provide valuable information to the small-scale
farmer for the safe and beneficial cultivation of Indian medicinal plant species and increases awareness regarding heavy metal contamination in traditional medicinal plants.

Monitoring programmes for contaminants and toxins provide valuable contributions toward improving food safety, warn of actual and potential food scares, and facilitate assessment of potential health hazards (Dogheim, Ashraf, Khorshid and Fahmy 2004). Whilst laboratory/greenhouse based studies are important for providing an insight into some of the fundamental mechanisms of heavy metal uptake, field trials are essential to gauge adaptation mechanism in plants (Mcgrath, Lombi, Gray, caille, Dunham and Zhao 2006).

Much work needs to be done to improve the various aspects of the current extensive traditional medicinal plant trade. This would not only provide a product of quality and safety to the consumer, but also ensure that the continued use of medicinal plants is sustainable. The findings of this thesis establish a firm groundwork for the need to regulate and monitor the Indian traditional medicinal plant trade against potentially harmful toxins.

The purpose of the current study was to standardize various indigenous medicinal plants for heavy metals contamination and to make awareness among the public regarding its safer use and collection areas, containing high level of heave metals and their adverse health effects.

The some of the plant materials and its various parts have beyond the permissible limits of heavy metals and this study concluded that the plant grown on polluted area has high risk of having the heavy metals concentration above the
permissible limit for each of them as compared to the unpolluted areas. The current findings indicate that the medicinal plant used for various types of ailments must be checked for heavy metals contamination in order to make it safe for human consumption. In other words, for medicinal uses, it should be collected from areas not contaminated with heavy metals. The current study will also provide useful reference data for the standardization of medicinal plant materials.

Granulated activated carbon showed that nearly 100% adsorptive removal of heavy metal ions optimized conditions of dosage 2g/250ml for Granulated Activated carbon and 0.1/100ml for Nano Particles of Activated Carbon.

The Narajan and khalaf, Longumer, Elovich and Intra particle model were found to in good agreement with experimental data on adsorptive behaviour of all metal ions, on activated carbons. The adsorption follows first order kinetics. pH has been found to be a most effective variable, controlling the adsorption of metal ions on activated carbon surface.

Antibacterial activities of various herbs and spices in plant leaves, stems, roots or fruits have been reported by many workers in different solvent extracts (Mau et al. 2001; Uz-Zaman et al. 2006; Al-Bayati and Sulaiman2008; Nair et al. 2009).

From the results it can be concluded that ethanol extracts of the plants screened gave better yield than chloroform and ethyl acetate extracts. It is evident that the Gram-positive microorganisms were more sensitive to the plant extracts than the Gram-negative microorganisms. These findings are in agreement with other researchers (Oboh et al. 2007; Nair and Chanda 2007; Costa et al. 2008; Khan et al. 2009).
The susceptibility of Gram-positive bacteria may be due to their cell wall structure which is of a single layer while the Gram-negative cell wall is a multi-layered structure and quite complex (Essawi and Srour 2000). All the extracts showed varying degrees of antibacterial activity on the microorganisms tested. Some of these plant extracts were more effective than antibiotics to combat the pathogenic microorganisms studied.

The antibacterial activity was more apparent in ethanol than acetone extracts of the same plants. These plants may be a source of new antibiotic compounds. This in vitro study demonstrated that folk medicine can be as effective as modern medicine to combat pathogenic microorganisms. Were more potent plants than other plants screened for antibacterial activity against standard strains of the microorganisms. *Mangifera indica* was the most potent plant than the other three plants screened against clinically isolated bacterial strains, while ethanol extracts of four selected plants did not show antifungal activity against standard and clinically isolated fungal strains.

This study gives an indication of the efficacy of the plants obtained from the traditional healers. The results from this study form a basis for further studies of the potent plants so as to isolate the compounds responsible for the antibacterial activity.

In conclusion of the present investigation the medicinal plants and different parts such as Leaves, Seeds, Tubers, Roots and Bark extracts using different solvents such as Chloroform, Ethyl acetate and Ethanol contains potential antibacterial components that may be of great use for the development of pharmaceuticals industries as a therapy against various diseases. The chloroform, ethyl acetate and
ethanol extracts of medicinal plants and different parts possess significant inhibitory effect against tested pathogens. The result of the study supports the folk for claim along with the development of new antibacterial drugs from the medicinal plants and different parts.

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