Water pollution by heavy metals has become prime concern for many years. Heavy metals are not biodegradable and their presence in streams and lakes leads to bioaccumulation in living organisms causing health problems in animals, plants and human beings. In order to protect the environment, the environmental scientists are concerned for the development of effective technologies for the removal of toxic materials like heavy metals from water/wastewater. Different treatment technologies such as solvent extraction, chemical precipitation, ion exchange, coagulation, chemical oxidation/reduction and biosorption methods are available for the removal of metal ions from aqueous solutions. Among these methods, biosorption is a potential alternative to conventional processes for the removal of metals due to less chemical usage as well as the low operation and maintenance cost. Biosorption has become an invaluable technology for removing metal from water. The development of adsorbents from natural materials or waste by-products that exhibit high sorption potential with low cost has become a priority area of research by the environmental scientists. Keeping in view of the aforesaid aspects attempts have been made for the development of new adsorbents. The results are presented as six chapters in the thesis.

This study concerns on the preparation of new biosorbents namely Wood apple shell (WAS) powder, citric acid modified Manilkara zapota leaves (CAMMZL) powder and Sapindus saponaria bark powder (SSBP) and their application for removal of Pb(II), Cu(II), Cd(II) and Ni(II) from aqueous solutions. Biosorption studies were carried out by batch method.

The biosorbents were characterized by FTIR (Fourier Transform Infrared Spectroscopy), SEM (Scanning Electron Microscopy), XRD (X- Ray diffraction) and Elemental analysis to assess the physico-chemical properties of biosorbents. Three adsorbents are amorphous in nature, which is an advantageous factor for well defined adsorbents. The presence of carboxyl, hydroxyl, phenolic and amine groups
on the adsorbent surfaces served as good binding sites for coordination with metal ions. The experimental results were analyzed by kinetic and isotherm models. The sequence for metal ion removal by the studied three biosorbents was CAMMZL>WAS>SSBP. Among these CAMMZL shows higher adsorption capacity than the other two biosorbents due to chemical modification of the adsorbent. Chemical modification has shown great promise in improving the adsorption and the cation exchange capacity of agricultural by-products.

In these studies attempts were made the biosorption process to understand and modeling of the equilibrium biosorption. For this the influence of operating parameters such as pH, biosorbent dose, initial metal ion concentrations and contact time was investigated. The solution pH played a very important role on the removal of Pb(II), Cu(II), Cd(II) and Ni(II). For four heavy metals studied, the maximum removal was achieved in the pH range of 5.0-6.0, which was higher than pHpzc values of the WAS, CAMMZL and SSBP. At higher pH values the metals are precipitated as their hydroxides and prevented further adsorption. More over the sorption process is kinetically faster than the precipitation.

Experimental data are tested in terms of adsorption kinetics using pseudo-first-order, pseudo-second-order and intraparticle diffusion kinetic models. The analysis of kinetic data showed that removal of Pb(II), Cu(II), Cd(II) and Ni(II) by Wood apple shell (WAS) powder, citric acid modified Manilkara zapota leaves (CAMMZL) powder and Sapindus saponaria bark powder (SSBP) followed a pseudo-second-order kinetics. The values of correlation coefficients of pseudo-second-order kinetic model were closure to unity and also calculated experimental ‘q’ values were comparable with theoritically calculated ‘q’ values in second - order kinetic model than compared with pseudo-first-order and intraparticle diffusion kinetic models.

The sorption equilibrium data of Pb(II), Cu(II), Cd(II) and Ni(II) onto three biosorbents such as WAS, CAMMZL and SSBP were analyzed by Langmuir, Freundlich and Dubinin–Radushkevich isotherm models. The sorption data of four metal ions better fitted by Langmuir isotherm model with higher correlation coefficients and low chi-square values compared to Freundlich and Dubinin–
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Radushkevich isotherm models. The adsorption isotherms of the three adsorbents showed identical shape indicating similar type sorption. The monolayer adsorption capacity was observed onto three biosorbents in the order of CAMMZL > WAS > SSBP. The CAMMZL showed higher sorption capacity than the other two biosorbents because of high surface area and high binding sites on the surface of CAMMZL. The calculated E values from Dubinin–Radushkevich isotherm model showed that the sorption process of Pb(II), Cu(II), Cd(II) and Ni(II) onto three biosorbents was through chemisorption mechanism.

Desorption studies were carried out with dilute hydrochloric acid for quantitative recovery of the metal ion as well as to regenerate the adsorbent.