contains high content of cellulose (30 - 50%), hemicellulose (20 - 40%) and lignine (15 - 30%) and indicated that cadmium was adsorbed as Cd(II) and attached to O- [30]. 0.6 M HCl solution able to desorb Cd(II) from different adsorbents , about 65% desorption yield was obtained for Cd(II). From these results obtained, it seems that, various metal- binding mechanisms are thought to be involved in the bio sorption process including ion exchange (release of H^+), surface adsorption, chemisorption and adsorption-complexion. Metal-Binding mechanisms may be assumed to involve the following four steps:

- Migration of Cd (II) from bulk of the solution to the surface of the adsorbent.
- Diffusion of Cd (II) through the boundary layer to the surface of the adsorbent.
- Adsorption of Cd (II) at an active site (COOH, -OH) on the surface of different adsorbents and release of protons.
- Intra-particle diffusion of Cd (II) into the interior pores of the adsorbent.

3.9 Comparison of the adsorption capacities of sorbents toward Cd (II)

Table 13 lists the comparisons of maximum adsorption capacities of DS, DL, MACS and MACL obtained in this study with various adsorbents previously used for the adsorption of Cd (II) [31-36]. These adsorbents have a higher adsorption capacity than that of the most other adsorbents reported in the literature, suggesting that it may be effective for Cd (II) removal from aqueous solution.

Table 13: Comparison of the adsorption capacities of Cd (II) onto various adsorbents

Adsorbents	Adsorption capacities (mg/g)	Ref.
MACS MACL DS DL	65.9 58.3 41 26.9	This work
Pomelo peel	21.83	[31]
Akaganeite-type nanocrystals	17.02	[32]
Sugarcane bagasse	6.97	[33]
Rice hus ash	3.02	[34]
Na-zeolitic tuff	18.0	[35]
Sewage sludge for chemical activation with $ZnCl_2$ and pyrolysis.	16.7	
Carbonaceous material	15.0	
ion-imprinted amino-functionalized silica gel	31.6	[36]

4. Conclusion

Dried Water hyacinth (stems, leaves) and Activated carbon (stems, leaves) were successfully evaluated as efficient adsorbents for removal of Cd (II) from aqueous solutions. The results showed that, pH values of solution, contact time, adsorbent dosage, and initial concentration significantly affected the adsorption amount of Cd (II). It was found that the sorption process is pH-dependent and maximum sorption was obtained at pH 5. The sorption studies were carried out using different Cd^{2+} concentrations. It was found that the extent of Cd^{2+} sorption increases upon increasing Cd^{2+} concentration within the range studied. The kinetic studies of cadmium DS, DL, MACS and MACL were performed based on pseudo first-order, pseudo second-order, and intra-particle diffusion rate mechanism. The data indicated that the adsorption kinetics of cadmium on all adsorbents followed the pseudo-second order model at different cadmium concentrations. The equilibrium data were analyzed using the Langmuir and Freundlich isotherms and the characteristic parameters for each isotherm were determined. The results showed that the experimental data were correlated reasonably well by the Langmuir isotherm model. Thermodynamic studies indicated that the adsorption process was an endothermic process.

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