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cations, such as toxic metal ions. Exploitation of green algae in waste water treatment technology may hence be cost-effective. Adsorptive elimination of heavy metals from effluents which have received much consideration in latest years is generally attained by using activated alumina or carbon [19,20]. Activated carbon is a spongy matter with an exceptionally large surface area and fundamental adsorption to different chemicals. It is only able to eradicate almost 30-40 mg/g of Zn, Cd and Cr in water and is non-regeneratable, which is pretty expensive to wastewater treatment. A number of allied processes are operating in this process, such as reverse osmosis, electro-dialysis, ultra-filtration, precipitation, etc. But most of these are expensive as far as removal of heavy metal ion is concerned. This is created a need to consider other options. Researchers have diverted attention to living organisms in the recent decades and the capacity of biological tool in this context has been tested in a number of rent studies which are abundantly available

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concentration, etc. The biosorption capacity of *P. oedogonia* was studied under variable conditions.

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The efficiency of biosorption increased in the contact time during the first 30 minutes, followed by slower uptake up to 90 min and thereafter equilibrium was obtained because of no significant uptake of Cr (VI) ions after 90 minutes (biosorbent concentration at 10 mg/L; initial sorbate concentration at 100 mg/L; pH 4.0) (Figure 1).

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Effect of biosorbent dosage on uptake of the Cr (VI) was observed by using different concentration of the algal biomass, 10, 20, 30 mg/L. The concentration of the algal biomass was found to be directly proportional to the Cr (VI) biosorption. But the maximum uptake of Cr (VI) ion was observed at the minimum exposure of algal biomass like 10 mg/L (Figure 2).

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Freundlich and Langmuir isotherm were used to interpret the data of biosorption as well as parameters of kinetic and thermodynamic studies were also used to evaluate mechanistic aspect.

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Equilibrium data is associated with the help of Langmuir isotherms.

The Langmuir equation is given below:

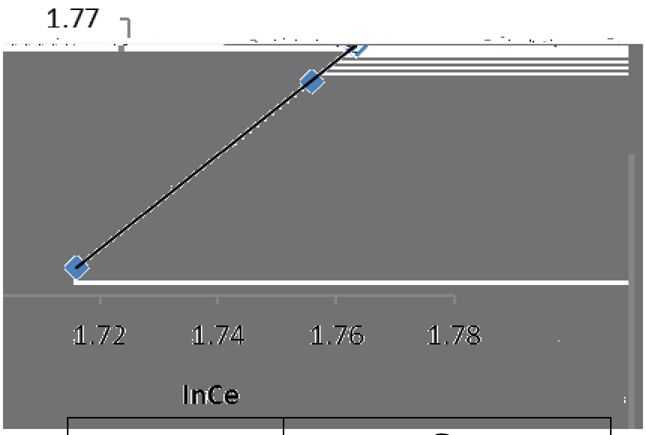
$$q_e \quad \frac{q_e.\, b.\, C_e}{1} \quad b \quad C_e$$

Here, C_e=Equilibrium conc. Of heavy metal ion; q_e=Equilibrium const. of metal ion on biosorbent surface (mg/g); K2=saturation const. (mg/L).

Values of C_e, q_e and K2 were obtained by calculation of linear plot slop and intercept of $1/C_e$ versus $1/q_e$. The value of distribution coefficient (K) between aqueous solution and sorbent could be found out by following equation:

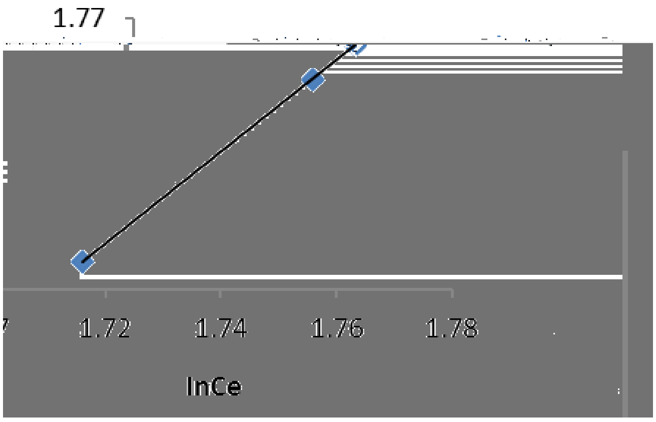
$$K \quad \frac{q_e}{C_e}$$

Adsorption intensity among sorbate and adsorbent could als



	Cr		
Biosorbent	**N**	**K_F**	**R^2**
P. oedogonia	1.74	0.15	0.73
P. oedogonia	57	0.016	0.77

Figure 4: Freundlich isotherm for sorption of Cr (VI) ion onto *P. oedogonia*.



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Biosorption of heavy metal, chromium by *Pithophora oedogonia* has been taken under investigation at different pH values i.e., 3.0, 4.0, 5.0, *P. oedogonia* shows maximum uptake of heavy metals such as Cr (VI) at optimum pH 4. this can be explained by the fact that at pH above this, viz: pH 6, 7, 8, 9, 10 etc., the cations tend to participate, and eventually the biosorption is affected; whereas, at pH lower than the optimum pH i.e., 3.0, 2.0, and 1.0 the aqueous solution tends to get protonated and the test cations have to compete with these protons. As a result, lower biosorption has been recorded at lower pH optimum time period required to achieve equilbrium in the aqueous solution was found to be 90 for Cr (VI). The most perfect explanation is that binding sites located on the surface of algal biomass are fully free at the start of the experiment; they then start getting saturated when exposed to aqueous solution of metal ions. In the first 30 minutes, quick uptake of metal ions has been observed. The following 60 minutes (up to 90 minutes of contact time) relatively slower uptake of Cr (VI) was observed by *Pithophora oedogonia*. This is the time period when cations have to compete with each other as well as hydrogen ions (H^+), naturally existing in the aqueous solution. Up to 60 minutes of contact time, almost all the binding sites are fully saturated and hence equilbrium is achieved. Therefore, no further biosorption was recorded after 60 minutes of contact time. Time required to attain q_{max} in the present study (90 minutes) did not vary significantly in the present study to those reported previously conducted similar studies. Gupta and Rastogi observed that maximum adsorption took place within first 30. The possible explanation of this could be the variation in cell wall biochemistry of the biosorbents used in the above mentioned reports. Aqueous solution is another parameter which is affecting the process of biosorption. The metal uptake was recorded directly proportional to the biosorbent concentration. However, of the three concentrations used in the present study,10 mg/L of biomass concentration has shown optimum biosorption capacity (q_{eq}) values followed by 20 mg/L and 30 mg/L respectively. It can be inferred that the adsorption of cations per unit mass is maximum in case of 10 mg/L. Moreover, equilibrium was found to achieve relatively quickly at biosorbent concentration of 10 mg/L as compared to 20 mg/L and 30 mg/L. similar trend was suggested by the previously performed similar studies [23]. Optimum biomass dosage for biosorption was found to be 1 mg/L. The most probable reason may be the difference of biosorbent used for biosorption. Of the various adsorption isotherm models employed to the experimental data. Langmuir's isotherm was found to be best fitted followed by Temkin isotherm whereas Freundlich isotherm was not found to be fitted as good as the others. Experimental values were in agreement with the values obtained from Langmuir isotherm, thus showing monolayer sorption. This finding is in agreement with the previously performed similar studies [23]. Pseudo-second order kinetic model was found to be suitable for the study of kinetics of biosorption of Cr (VI) by *Pithophora oedogonia*. The values of Pseudo-second order constants, such as K_2, R_2, and q_{eq} Cal are showing good values. Similar findings have also been reported by the other researchers of biosorption [24]. The cell wall of filamentous algae, such as *P. oedogonia*, etc. may consist of macromolecules, such as cellulose in many (b-1, 4-glucopyroside) [25]. Moreover storage compounds, such as amylase and amylopectin may also be present on the cell wall. These compounds possess many functional groups, such g as carboxyl, hydroxyl, carbonyl, etc. These functional groups are the biosorptive binding sites for the cations, such as Cr (VI). Various mechanisms have been proposed as mechanism of the studies of biosorption by algae, such as complexation, chelation, coordination, ion exchange, precipitation, reduction etc. However, in the present study some of these seem to be more plausible discussed as follows. Ion exchange is a reversible chemical reaction where an ion within a solution is replaced by a similarly charged ion attached onto an immobile solid particle. In general; the ion exchange mechanism can be represented by the following equation:

$$M^{X+} + X\,(HY) \qquad XH^{+} + MY_{X}$$

Here HY corresponds to the number of acid sites on the solid surface, M^{X+} is metal ion, and MY^{X} is the sorbed M^{X+}. By considering the above equation, the ion-exchange equilibrium constant can be determined [23]. Hence, filamentous green alga *P. oedogonium* which has shown promising results in the present study is expected to contribute to the bioremediation of polluted water. Future studies of biosorption of toxic heavy metal cations may also help to eliminate the mechanism of removal of heavy metals using algal biomass. Further studies based on commercial usage of *Pithophora oedogonia* in biosorption technology needs special emphasis on mechanistic studies, such as kinetics, thermodynamics, etc. FTIR spectra clearly show the presence of electronegative functional groups, the peaks of which seems to shift, when loaded with Cr (VI) ion. These findings are in agreement with previously performed similar studies [23]. The cell wall of filamentous algae, such as *P.* [illegible]

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