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Batch biosorption studies for the biosorption of chromium using cherry leaves (*Muntingia calabura* L.)

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Chromium is a heavy metal which is commonly used in many industries such as chemical, metallurgical and electroplating industries.The discharge of effluents from these industries constitutes one of the major causes of land and water pollution and degradation. Therefore, biosorption is a potential technique generally used for the removal of heavy metals from the solutions and recovery of precious metals. In the present study, batch biosorption studies was conducted at different conditions such as varying pH (4, 5, 6), temperature (30, 40, 50°C), biomass concentration (0.5. 0.75, 1.0, 1.25 g) and initial metal concentration (50, 100, 150, 200 mg/l) for the biosorption of chromium by cherry leaves. From the experiments it was found that the biosorption efficiency increases with increased temperature and biomass concentration but decreased with increased pH and chromium concentration

Keywords: Cherry leaves, batch biosorption, chromium, metal uptake, correlation

There are three main ways that industries contribute to water pollution. They pollute by disposing of different waste directly into waterways, emitting toxic gases and its causes acid rain and changing the temperature of water with their disposals into waterways. Chromium is a chemical element discovered in 1797 by Louis Nicolas Vauquelin which has the symbol Cr. Its atomic number is 24. It is a hard metal of steely gray colour and also it has a high melting point of 1907°C. It is odourless and tasteless metal. Many of its compounds are intensely coloured. Chromium is an important metal due to its high corrosion resistance and hardness. Chromium compounds which has a greater economic importance which is widely used in many industries such as chemical, metallurgical and electroplating industries. For example it is used in the tanning of hides and skins, as an alloy in the manufacture of stainless steel, in electroplating, in textile dyeing and as a biocide in the cooling waters of nuclear power plants (Bai and Abraham, 2001).

Use of plant resources for the detoxification of industrial effluents for environmental protection and recovery of valuable metals offers a potential alternative to existing treatment technologies. Bio-sorbents of plant origin are mainly agricultural by-products such as, maize cob,

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sunflower stalk, *Medicago sativa*, wild cocoyam. *Anabaena* and *Vetiveria chenille,* orange bagasse, neem, coconut coir and banana leaves are some of the plants used in biosorption (Abhradip and Ardhendu, 2012). Xingjian *et al.*(2012) stated that a number of common techniques have been used in removing heavy metals from contaminated environments, including ion exchange, chemical precipitation, electrochemical treatment, reverse osmosis, evaporative recovery and micellar-enhanced ultra-filtration. Vijayaraghavan and Yeoung (2008) stated that for the continuous treatment of highly toxic organic and inorganic contaminants use of living organisms may not be an option. Amount of toxicant accumulated will reach saturation when toxicant concentration becomes too high or the process operated for a long time. In the present work deals with the batch biosorption studies was conducted for the biosorption of chromium by using cherry leaves.

Materials and methods

Selection of the plant

Cherry leaf was selected as adsorbent for removal of chromium ion in this study. The leaves were obtained from a Cherry tree located in K. S Rangasamy College of Technology (Autonomous), Tiruchengode. The plant was identified and authenticated by Botanical Survey of India Southern Circle, Tamil Nadu Agricultural University, Coimbatore. The binomial name of cherry leaves is *Muntingia calabura* L.

Preparation of leaf adsorbent

Mature Cherry leaves were collected and it was washed thoroughly under running tap water to remove dust and any adhering particles. The leaves were then dried under sunlight for a few days until it became crisp. The dried leaves were crushed and blended to powder form using a blender. It was stored in an airtight plastic for further use to avoid contact with moisture in atmosphere.

Preparation of chromium stock solution

Stock solution of chromium of 1000 mg/L was prepared by dissolving 2.828 g of potassium dichromate in 1 L of distilled water. The working solution was prepared by diluting the stock solution.

Chromium analysis

Chromium content was analyzed by using spectrophotometric method, as described in the Standard methods for the Examination of Waste and Wastewater (APHA), to measure the concentrations of the Cr. The reaction takes place between Cr and 1, 5-diphenycarbazide results in the pink coloured complex. Then it was able to be spectrophotometrically analyzed at 540 nm.

Batch biosorption studies

All batch biosorption experiments were conducted in 100 mL Erlenmeyer flasks with 50mL metal solution.0.1N NaOH and 0.1N Hcl solutions were used to adjust and to maintain the pH of the metal solutions. A control with no biomass was also set up for each run. All experiments were conducted in duplicate and the mean values were used in the analysis of data.

Effect of concentration

A 0.2 g of each Pre-treated strain and 0.5 g of leaf powder was added in 100 ml Erlenmeyer flask containing 50 ml of different chromium concentrations such as 10,20,30,40,50 mg/L and 50, 100, 150, 200 mg/l in an orbital shaker at a speed of 120 rpm. All experiments were conducted in duplicate. After 24 hrs of incubation the Cr concentration was measured spectrophoto-metrically.

Effect of Incubation Temperature

A 0.2 g of each Pre-treated strain and 0.5 g of leaf powder was added in 100 ml

Erlenmeyer flask containing 50 mg/L and 100 mg/l of Chromium separately. Flasks were incubated at different temperature such as 30, 40, 50°C in an orbital shaker at a speed of 120 rpm. All experiments were conducted in duplicate. After 24 hrs of incubation the Cr concentration was measured spectrophotometrically.

Effect of pH

A 0.2 g of each Pre-treated strain and 0.5 g of leaf powder was added in 100 ml Erlenmeyer flask containing 50 mg/L and 100 mg/l of Chromium separately. Flasks were maintained at different pH such as 3,4,5,6 in an orbital shaker at a speed of 120 rpm. All experiments were conducted in duplicate. After 24 hrs of incubation the Cr concentration was measured spectrophotometrically.

Effect of Biomass concentration

Each Pre-treated strain and leaf powder was added in 100 ml Erlenmeyer flask containing 50 mg/L and 100 mg/l of Chromium separately at different biomass concentration such as 0.1,0.2,0.3,0.4,0.5 g of *Aspergillus niger* and 0.5, 0.75, 1.0, 1.25 g of leaf powder in an orbital shaker at a speed of 120 rpm. All experiments were conducted in duplicate. After 24 hrs of incubation the Cr concentration was measured spectrophotometrically.

Pearson's chi-squared test was used to analyze the goodness of fit for pseudo first and second order reactions model. Its properties were first investigated by Karl Pearson in 1900.

Results and discussion

Effect of initial metal concentration

Biosorption of Chromium by using cherry leaves powder was carried out at different concentrations such as 50,100,150,200 mg /l of Chromium at a pH of 6 and with an adsorbent dosage of 0.5 g at a temperature of 37°C (Fig.1).

The biosorption rate of cherry leaves was significantly higher. The rate of biosorption was completed within three hours. The percentage of sorption decreased with increasing concentration but the metal uptake increased with increasing concentration (as shown in Table 1). At lower concentration of ion, the available sites for sorption is low therefore the sorption independent upon initial metal concentration but at higher concentration, the available sites for sorption is more therefore the sorption is dependent upon initial metal concentration (Vijayaragavan *et al.*, 2006).

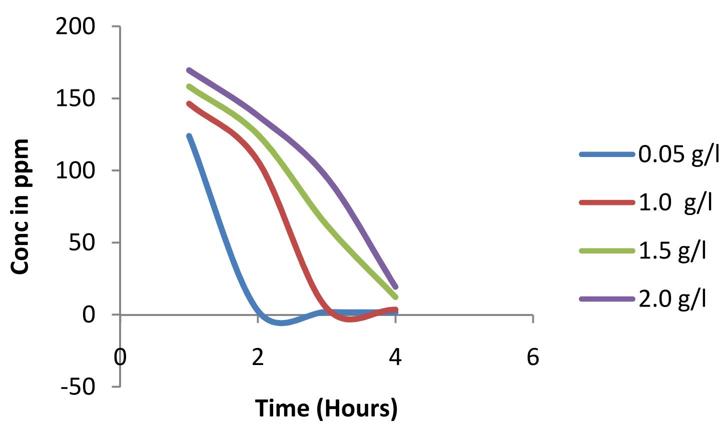

Fig 1: Effect of initial metal concentration for the biosorption of Cr by cherry leaves.

Effect of pH

Biosorption of Chromium by using local cherry leaves powder was carried out at different pH such as 4, 5 and 6. The percentage of biosorption decreases with increased pH and also the metal uptake (q) also decreased with increased pH (Fig.2). From this experiments it indicates that sorption of Cr was more favourable at pH 4.

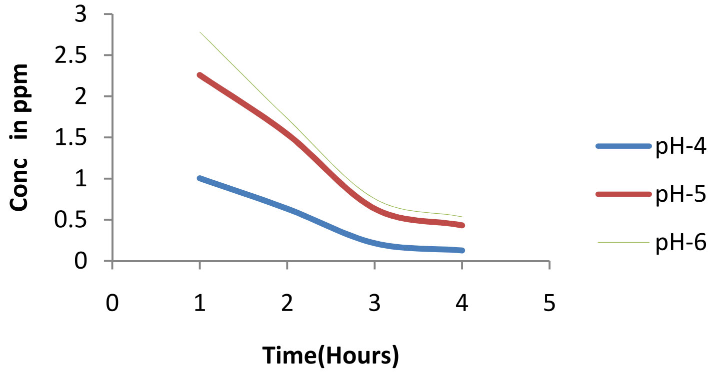

Fig 2: Effect of pH for the biosorption of Cr by cherry leaves.

Effect of Biosorbent dosage

The experiment was performed at different dosage of bioadsordent such as 0.5, 0.75, 1.0, 1.25 g of cherry leaves powder. From the experiments it was noted that increase in biosorbent dosage increases the sorption capacity (Fig. 3). The reason for that is increase in surface area which in turn increases the binding sites for chromium (Esposito *et al*., 2001). The metal uptake is decreased because metal ions are insufficient to cover all the binding sites of bioadsorbent.

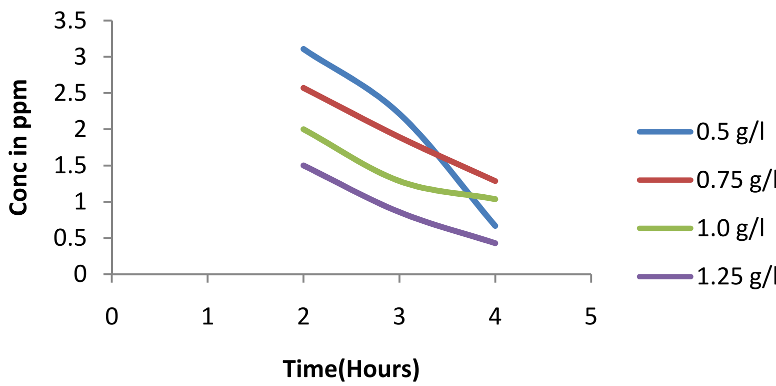

Fig 3: Effect of Bio sorbent- Dosage for the biosorption of Cr by cherry leaves.

Effect of Temperature

At different temperature such as 30, 40 and 50°C the effect of biosorption of cherry leaves powder was studied. The study indicates that increase in temperature increases the biosorption rate and also it increases the rate of metal uptake (q) (Fig.4).Therefore the bioaffinity increases with higher temperature from 30°C.

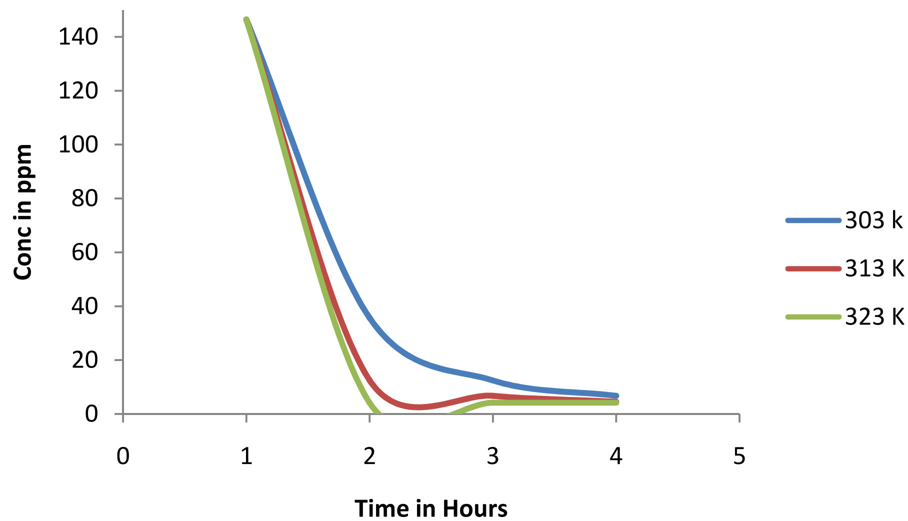

Fig 4: Effect of temperature for the biosorption of Cr by cherry leaves.

Table 1: Extent of Biosorption of cherry leaves

C_0 g/l	% S	q mg/g	D g/l	% S	Q mg/g	pH	% S	q mg/g	T K	% S	Q mg/g
0.05	98.6	12.23	0.5	98.7	12.2	4	96.9	14.19	303	95.4	13.9
0.1	97.6	14.28	0.75	98.9	8.18	5	89.4	13.10	313	96.9	14.1
0.15	92.2	14.6	1.0	99.1	6.15	6	86.9	12.73	323	97.1	14.2
0.2	88.6	15.2	1.25	99.6	4.94						

C_0- Initial concentration, D - Biosorbent dosage. % S- Percentage of biosorption

Conclusion

From the batch studies it was found that increased in the temperature, biomass dosage and also decrease in pH and Initial metal concentration favors biosorption of chromium by cherry leaves effectively.

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