ISSN: 2155-6199

Research Article Open Access

Keywords: Optimization; Cadmium; Oryza sativa; Dracaena draca; Response surface methodology

Introduction

e availability of water resources are becoming increasingly scarce; the consumption and exploitation of water resources, along with exponential increase in population have caused water pollution [1]. Toxic metals of particular concern in treatment of industrial wastewaters include: mercury, lead, cadmium, zinc, copper, nickel, and chromium [2]. So this study focuses on Cadmium (Cd(II)) that is attracting wide attention of environmentalists as one of the most toxic heavy metals. Currently methods that are being used to remove heavy metal ions include chemical precipitation, ion-exchange, adsorption, membrane ltration, electrochemical technologies. ese methods are usually inadequate and expensive [3].

Biosorption is an emerging technology that is used to sequester toxic heavy metals and is particularly useful for the removal of contaminants from industrial e uents [4]. e biosorbent term refers to material derived from microbial biomass, seaweed or plants that exhibit adsorptive property [5]. Many biosorbents have been used in

Batch experiments were conducted with the following conditions: 0.5 g of each biomass and 100 ml of Cd(II) solution with an agitation speed 300 rpm (round per minute) at room temperature. e in uence of three factors i.e., initial metal ion concentration (X), hydrogen ion concentration (pH) of the solution, biomass dose (BD) have been investigated. e range and the levels of the variables investigated in this research are given in Table 1.

en samples were collected a er 2 hours to reach equilibrium in biosorption. Control samples were prior to batch biosorption experiment to determine initial metal concentration and all samples were conducted in triplicate. e metal ions contents in all the samples prior to and a er batch biosorption experiments were analyzed by Varian Inductively Coupled Plasma (ICP-AES).

Removal e ciency (RF%) of biosorbent was calculated using the following equation

$$\text{Removal effeciency\%} = \frac{Ci - Cf}{Ci} \times 100 \qquad (2)$$

Where: C_i= Initial concentration of metal in solution, before the sorption analysis (mg/l), C_f= Final concentration of metal in solution, a er the sorption analysis (mg/l).

Characterization of biosorbents

Energy Dispersive X-Ray Spectroscopy (EDAX): EDAX spectra can be collected from a speci c point on the sample, giving an analysis of a few cubic microns of material. Each biosorbent was characterized by EDAX before and a er Cd(II) biosorption.

Results and Discussion

Biosorption experiments

Batch experiments were conducted as tabulated in Table 2, '+1' for the higher level and ' 1' for the lower level of the studied factors. Removal e ciency percentage (RF%) were calculated according to Eq.(1).

Regression coef cients (Coef) and the associated standard errors (SE Coef) of results are shown in Table 3. Results revealed that all the studied factors together with their interactions were signi cant at 95% con dence limits (P>0.05). e response variable (Cd(II) removal %) was tted by the following equation:

$$Y = A + a_1x_1 + a_2x_2 + a_3x_3 + a_4x_1x_2 + a_5x_1x_3 + a_6x_2x_3 + a_7x_1x_2x_3 \qquad (3)$$

Where: Y: Estimated of the response, A: represents the global mean (constant), a: Coef cients and x: Experimental Factors.

At X=10 ppm, pH=7 and BD=0.5 g, the highest percentage of Cd(II) removal by rice straw was 82.60% while that for dragon tree leaves was 79.60% (Table 2).

It worth noting that the e ect of all the studied main factors (X, pH, BD) was identical for both biosorbents. As such, our results demonstrated that the factor (X) had the largest e ect on biosorption process by rice straw and dragon tree leaves (Table 53.265(e le)0.177(y r)l idts. As65(6(h)3(ac56(T)>o)1o)12(r (Xo)11v4.9(l)8ed t5-6 concentration, pH: hydrogen ion concentration, BD: biomass dose).

Cd^{2+} removal% by dragon tree leaves

Cd^{2+} removal% by dragon tree leaves

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Cd^{2+} removal% by rice straw

Cd^{2+} removal% by dragon tree leaves

(J)

Cd^{2+} removal% by rice straw

Cd^{2+} removal% by dragon tree leaves

Figure 3: Response surface plots showing the effect of (X) and (pH) on Cd(II) removal percentage by rice straw at (I) BD=0.5 and (J) BD=0.1 and dragon tree leaves at (K) BD=0.5 and (L) BD=0.1.

Figure 4: EDAX images of; (A) Raw rice straw, (B) Rice straw after Cd(II) biosorption, (C) Dragon tree leaves and (D) Dragon tree leaves after Cd (II) biosorption.

Figure 5:

14. Pavan FA, Gushikem Y, Mazzocato AC, Dias SLP, Lima EC (2007) Statistical design of experiments as a tool for optimizing the batch conditions to methylene blue biosorption on yellow passion fruit and mandarin peels. Dyes and Pigments 72: 256-266.

15. Saadat S, Karimi-Jashni A (2011) Optimization of Pb(II) adsorption onto modifed walnut shells using factorial design and simplex methodologies. Chemical Engineering Journal 173: 743-749.

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