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RESEARCH ARTICLE

Langmuir Kinetics Study for Biosorption of Heavy Metals by Fungi

Aparna Gunjal

Dr. D.Y. Patil, Arts, Commerce & Science College, Pune, Maharashtra, India

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ABSTRACT

The waste water contains many heavy metals viz., zinc, cadmium, lead, nickel, arsenic, etc. Due to this it causes environmental issues. The removal of heavy metals by microorganisms i.e., bacteria, actinobacteria, fungi, algae and yeasts is termed 'biosorption'. The work here mentions Langmuir's kinetics study for biosorption of heavy metals by *Aspergillus clavatus*, *A. oryzae* and *A. fumigatus*. The Langmuir equations as well as constants were determined. The data showed the Langmuir isotherm model best fits the experimental data for biosorption of zinc, cadmium, lead and nickel. The Langmuir kinetics study will help to know the curve of biosorption process. This study of kinetics of biosorption can be used on a big scale.

Keywords: Biosorption, Economical, Eco-friendly, Environment, Pollution.

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INTRODUCTION

Wastewater is contaminated with toxic heavy metals viz., zinc (Zn), cadmium (Cd), lead (Pb), nickel (Ni), arsenic (As), etc. This wastewater harms humans[1] and the environment. The chemical process for the treatment of waste ater has disadvantages. The use of microorganisms for the treatment of waste ater is biosorption. The biosorption process for wastewater treatment is economical, eco-friendly and very easy. Along with the biosorption process, the kinetics study such as Langmuir kinetics is also very important to understand the curve of it. The paper here describes the Langmuir kinetics studies for biosorption of heavy metals Zn, Cd, Pb and Ni by *Aspergillus clavatus*, *A. oryzae* and *A. fumigatus*.

MATERIALS AND METHODS

Kinetics Study

Batch adsorption experiments were carried at 38°C. The biomass (0.5 g) each of *A. clavatus*, *A. oryzae* and *A. fumigatus* was weighed and mixed with 50 mL solution each of Zn, Cd, Pb and Ni the concentration of which ranged from 5 to 25 ppm. The reaction time kept was 20 min and then filtered using Whatman filter No. 1. The metal content was analyzed using Atomic Absorption Spectrophotometer (AAS) (AAS-Varian SpectraA, Germany). The kinetics studied i.e., Langmuir isotherms, was done.[2]

RESULTS AND DISCUSSION

Langmuir isotherm studies

The linear regression equations of Langmuir isotherm for biosorption of Zn, Cd, Pb and Ni by *A. clavatus*, *A. oryzae* and *A. fumigatus* is represented in Table 1.

Langmuir isotherm constants for biosorption of heavy metals

Langmuir isotherm constants for biosorption of Zn, Cd, Pb and Ni by the fungal biomass are represented in Tables 2, 3 and 4 respectively. The equation for Langmuir isotherm (Langmuir 1918) is $C_e / Q_0 = 1 / q_{max} R_L + (C_e / q_{max})$ (1)

where, C_e = equilibrium concentration (mg l^{-1}), Q_0 = amount adsorbed at equilibrium (mg g^{-1}), q_{max} = Langmuir constants related to biosorption capacity and R_L = energy of adsorption. The R values for Langmuir isotherms are shown in Table 5.

This is the first report on Langmuir kinetics study for biosorption of heavy metals viz., Zn, Cd, Pb and Ni by dead biomass of *A. clavatus*, *A. oryzae* and *A. fumigatus*. There is a report on kinetics studies of biosorption of Cr (VI) in aqueous solutions by *Agaricus campestris*.[3] Also, there is a study on equilibrium studies on biosorption of Pb (II) by living and dead biomass of *Penicillium notatum*.[4] There is a report on kinetics study for removal of heavy metals by the agroindustry

**Author for Correspondence: aparnavsi@yahoo.com*

Table 1: Linear regression equations of Langmuir isotherm for biosorption of Zn, Cd, Pb and Ni by fungal biomass

Fungal biomass	*Heavy metals*			
	Zn	*Cd*	*Pb*	*Ni*
A. clavatus	y = -0.005x+105.39	y = -0.379x +101.06	-	y = 0.402x+103.19
A. oryzae	y = -0.005x+105.39	y = -0.379x + 101.06	y = 0.382x+101.0	y = -0.232x+103.43
A. fumigatus	y= -0.27x+105.32	-	-	-

Table 2: Langmuir isotherm constants for biosorption of Zn, Cd, Pb and Ni by *Aspergillus clavatus*

Metals	*Heavy metal conc. (ppm)*				
	5	*10*	*15*	*20*	*25*
	q_{max} *(mg/g)*	q_{max} *(mg/g)*	q_{max} *(mg/g)*	q_{max} *(mg/g)*	q_{max} *(mg/g)*
Zn	0.047	0.094	0.141	0.188	0.235
Cd	0.049	0.099	0.149	0.199	0.249
Pb	-	-	-	-	-
Ni	0.048	0.097	0.146	0.195	0.244

Table 3: Langmuir isotherm constants for biosorption of Zn, Cd, Pb and Ni by *Aspergillus oryzae*

Metals	*Heavy metal conc. (ppm)*				
	5	*10*	*15*	*20*	*25*
	q_{max} *(mg/g)*	q_{max} *(mg/g)*	q_{max} *(mg/g)*	q_{max} *(mg/g)*	q_{max} *(mg/g)*
Zn	0.047	0.094	0.141	0.188	0.235
Cd	0.049	0.099	0.149	0.199	0.249
Pb	0.049	0.099	0.149	0.199	0.249
Ni	0.048	0.096	0.145	0.193	0.242

Table 4: Langmuir isotherm constants for biosorption of Zn, Cd, Pb and Ni by *Aspergillus fumigates*

Metals	*Heavy metal conc. (ppm)*				
	5	*10*	*15*	*20*	*25*
	q_{max} *(mg/g)*	q_{max} *(mg/g)*	q_{max} *(mg/g)*	q_{max} *(mg/g)*	q_{max} *(mg/g)*
Zn	0.047	0.095	0.142	0.190	0.238
Cd	-	-	-	-	-
Pb	-	-	-	-	-
Ni	0.049	-	-	-	-

Table 5: R values for Langmuir isotherm

Fungal biomass	*Heavy metals*			
	Zn	*Cd*	*Pb*	*Ni*
A. clavatus	0.781	0.810	-	0.819
A. oryzae	0.781	0.810	0.812	0.794
A. fumigatus	0.647	-	-	-

by-products.[5] Also, a study was done on Langmuir kinetics for removing heavy metals by the live fungal biomass.[6]

CONCLUSION

Langmuir isotherm models best fit the experimental data for Zn, Cd, Pb and Ni biosorption. Also, Langmuir a pseudo-second-order best models kinetics data kinetics equation.

CONFLICT OF INTEREST

The author declares there is no conflict of interest.

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