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BIOSORPTION OF COPPER AND LEAD BY NON-LIVING BIOMASS OF Sargassum baccularia (PHAEOPHYTA)

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by

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ABSTRAK

Biopenjerapan kuprum (II) and plumbum (II), dua logam berat yang sering didapati dalam efluen industri, oleh biojisim suatu makroalga perang, *S. baccularia*, yang tidak hidup, telah ditentukan. Isoterma Langmuir telah digunakan untuk mencirikan corak biopenjarapan kedua-dua logam ini. Kebolehan biopenjerapan maksima q_{max} telah dianggarkan menggunakan model ini. Eksperimen kelompok dijalankan untuk menentukan isoterma equilibria dan kebolihan penjerapan maksimum logam-logam tersebut pada awal pH 5.0 dengan saiz zarah biojisim 500-710 μm. Pola-pola biopenjerapan bagi kuprum dan plumbum, dalam kedua-dua sistem komponen individu dan sistem dwi-logam telah ditentukan. Dalam sistem komponen individu, kebolehan biopenjerapan maksima biojisim bagi kuprum, adalah 1.19 mmol/g atau 75.6 mg/g. pH tindakbalas larutan telah berkurangan dari nilai awal 5.0 ke julat 4.1-5.0. Bagi plumbum, *S. baccularia* telah menunjukkan kebolehan untuk menyerap plumbum sebanyak 1.32 mmol/g atau 273.5 mg/g. Bagi kepekatan-kepekatan rendah plumbum, pH telah meningkat dari nilai 5.0 ke julat 6.0-7.0 tetapi bagi kepekatan yang lebih tinggi didapati pH mengurang dari nilai 5.0 ke julat 4.1-4.8. Dalam sistem binari, kepekatan awal kuprum telah ditetapkan pada 0.786 mM (50 mg/L) dan kepekatan plumbum telah ditambahkan dalam nisbah molar kuprum: plumbum 1:0, 1:1, 1:2, 1:5, 1:10. Eksperimen-eksperimen ini kemudian diulangi dengan menetapkan kepekatan

plumbum pada 0.24 mM (50 mg/L) sambil mengubah kepekatan kuprum dalam nisbah molar yang sama seperti dahulu. Keadaan yang berbeza juga didapati bagi biopenjerapan kedua-dua logam dalam sistem dwi logam. Kehadiran plumbum dengan kepekatan yang menaik banyak mengurangkan biopenjerapan kuprum (sehingga 94.7%). Tetapi kepekatan kuprum yang semakin bertambah tidak ada sebarang kesan berertinya keatas biopenjerapan plumbum oleh biojisim. Keputusan-keputusan ini menunjukkan bahawa alga-alga yang tidak hidup boleh di-gunakan sebagai biopenjerapan dengan berkesan bagi logam-logam berat dari efluen industri. Terdapat darjah interferens keatas kebolehan biopenjerapan jika logam-logam seperti kuprum dan plumbum terdapat dalam sistem dwi logam. Keadaan ini boleh diexploitasikan jikalau wujud keperluan untuk mendapatkan semula satu logam atas satu logam yang lain.

ABSTRACT

Biosorption of copper (II) and lead (II), two common heavy metals often present in industrial effluents, by the non-living biomass of *Sargassum baccularia*, a brown macroalga, was evaluated. The Langmuir adsorption isotherm was used to characterise the adsorption patterns for both the metals. The maximum biosorption capacity, q_{max} was estimated using this model. Batch experiments were done to determine the equilibrium isotherm and maximum adsorption capacity of the metals at an initial pH of 5.0 and with a biomass particle size of 500 to 710 μm. The biosorption patterns for copper and lead, in both single and binary components systems were determined. In the single component system, the maximum biosorption capacity of the biomass for copper was 1.19 mmol/g or 75.6 mg/g. The pH of the reaction solution decreased from the initial value of 5.0 to a range of 4.1-5.0. On the other hand the biosorption capacity for lead was 1.32 mmol/g or 273.5 mg/g. While there was a rise in the pH from 5.0 to a range of 6.0-7.0 in the lower concentration ranges of lead, there was a subsequent lowering in the pH from 5.0 to a range of 4.1-4.8 in the higher concentration ranges. In the binary system, the initial copper concentration was fixed at 0.786 mM (50 mg/L) and lead concentration was increased in molar ratios of copper: lead of 1:0, 1:1, 1:2, 1:5, 1:10. Similarly, the experiments were repeated keeping the concentration of lead constant at 0.24 mM (50 mg/L) and varying the copper concentration in similar molar ratios. Different uptake patterns were seen for the two metals in the binary

system. The presence of lead in increasing concentrations reduced the uptake of copper substantially (up to 94.7%). On the other hand, increasing the concentrations of copper did not have any significant impact on the biosorption of lead by the biomass. These results indicate that while the non-living alga may be used as an effective biosorbent for heavy metal removal from industrial effluents, there can be some degree of interference on its biosorptive capacity if metals such as copper and lead are present in a binary system. This phenomenon can however be exploited if there is a need to preferentially recover one metal over the other.

It has not been easy returning to study after 18 years.

It has meant juggling a family and work in the midst of being a student once more.

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Alg	Alginate
C_{eq}	Liquid phase equilibrium metal concentration (mM)
C_i	initial metal concentration (mM)
Cu(II)	Copper (II)
DOE	Department of Environment
g	grammes
HSAB	Hard and soft acids and bases
hr	hour
ICP-AES	Inductively Coupled Plasma-Atomic Emission Spectrophotometry
k	Langmuir equilibrium constant (mM^{-1})
L	litre
M	Weight of biomass (g)
Me	Metal
mg	milligrammes
min	minute
mL	millilitre
mM	millimolar
mmol	millimoles
M	Molar solution
Pb(II)	Lead (II)
q_{eq}	Biosorbent phase equilibrium metal concentration (mmol/g biomass)
q_{max}	Maximum biosorption capacity (mmol/g biomass)
r	Coefficient of correlation
rpm	Revolutions per minute
sec	seconds
µg	microgrammes
µL	microlitre
µmol	micromoles