BIOACCUMULATION AND TOXICITY STUDIES OF HEAVY METALS IN *Ankistrodesmus convolutus* CORDA

by

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"Man's work can make of him a slave
And lead him to an early grave,
But if it's done as to the Lord
His labours bring him great reward" - DID

ABSTRACT

Nine freshwater microalgal species of Malaysia, *Chlorella vulgaris* (isolate 001), *Scenedesmus* sp. (isolate 039), *Mougeotia* sp. (isolate 069), *Ulothrix* sp. (isolate 071), *Chlorella* sp. (isolate 078), *Ankistrodesmus convolutus* (isolate 101), *Chlorococuum* sp. (isolate 110), *Synechococcus* sp. (isolate 075), *Euglena* sp. (isolate 058), and including two species *Oocystis polymorpha* UTEX 1645 (isolate 169) and *Ankistrodesmus arcuatus* UTEX LB 1379 (isolate 170) from the UTEX Collection, Texas, were used in 96 h single heavy metal (Cd, Co, Cr, Cu, Fe, Mn and Zn) exposure static studies for preliminary toxicity test. This was done by incubating the microalgae in a range of metal concentrations in Bold Basal Medium (BBM) in multiwell plates. Of these species *Ankistrodesmus convolutus* Corda (isolate No. 101) was selected for further toxicity and bioaccumulation tests.

Toxicity tests were conducted to investigate the toxic effect of Cd, Co, Cr, Cu, Fe, Mn and Zn on the growth of *A. convolutus*. Results from the toxicity tests showed that *A. convolutus* is tolerant to most of the heavy metals. The order of toxicity in *A. convolutus* based on 96 h IC_{50} and IC_{25} are Zn = Mn > Cu > Cd > Cr > Co > Fe. *A. convolutus* was most sensitive to Fe (IC_{50} = 0.52 mgL^{-1}) and most tolerant to Mn (IC_{50} = 16.14 mgL^{-1}).

Ankistrodesmus convolutus was exposed to different concentrations of seven metals (Cd, Co, Cr, Cu, Fe, Mn and Zn) to observed patterns of heavy metal uptake (bioaccumulation) in short-term test.

Four main metal accumulation patterns were observed in this study: **Pattern 1** : rapid metal uptake during the first hour of exposure and followed by a gradual release; **Pattern 2** : continuous uptake appears during the entire hour of exposure till an equilibrium level; **Pattern 3** : rapid uptake during the first hour exposure and followed by a gradual release till equilibrium level is reached; **Pattern 4** : alternating uptake and release of metal.

In general, maximum uptake occurred in the first hour of exposure, followed by further gradual uptake, or gradual release, or an alternating uptake – release pattern. Metal bioaccumulation increased with increasing concentration of metal in the medium. Cells in logarithmic growth were more active in metal bioaccumulation than cells at stationary growth.

ABSTRAK

Sembilan spesis mikroalga air tawar Malaysia, *Chlorella vulgaris* (isolate 001), *Scenedesmus* sp. (isolate 039), *Mougeotia* sp. (isolate 069), *Ulothrix* sp. (isolate 071), *Chlorella* sp. (isolate 078), *Ankistrodesmus convolutus* (isolate 101), *Chlorococuum* sp. (isolate 110), *Synechococcus* sp. (isolate 075), *Euglena* sp. (isolate 058), dan termasuk dua spesis *Oocystis polymorpha* UTEX 1645 (isolate 169) dan *Ankistrodesmus arcuatus* UTEX LB 1379 (isolate 170) dari Koleksi UTEX, Texas, digunakan untuk ujian dalam logam berat tunggal untuk setiap logam berat berikut (Cd, Co, Cr, Cu, Fe, Mn and Zn) selama 96 jam, dalam kajian statik bagi ujian peringkat awal ketoksikan. Ini telah dijalankan dengan menumbuhkan mikroalga di dalam bekas 'multiwell plates' dengan satu siri kepekatan logam berat dalam media 'Bold Basal (BBM)'. Daripada spesis tersebut, Ankistrodesmus convolutus Corda (isolate No. 101) telah dipilih untuk ujikaji ketoksikan dan bioakumulasi yang seterusnya.

Ujian ketoksikan dijalankan bagi tujuan mencari kesan toksik Cd, Co, Cr, Cu, Fe, Mn dan Zn ke atas pertumbuhan *A. convolutus*. Keputusan *mendapati A. convolutus* mempunyai daya tahan yang kuat menentang hampir semua ketoksikan logam berat tersebut. Susunan ketoksikan berdasarkan nilai IC_{50} dan IC_{25} selama 96 jam kepada *A. convolutus* adalah seperti berikut : Zn = Mn > Cu > Cd > Cr > Co > Fe. *A. convolutus* sangat sensitif terhadap Fe (IC_{50}= 0.52 mgL^{-1}) dan paling tahan dengan Mn (IC_{50}= 16.14 mgL^{-1}).

Ankistrodesmus convolutus didedahkan dalam berbagai kepekatan daripada tujuh logam berat (Cd, Co, Cr, Cu, Fe dan Zn) bagi memerhati corak penyerapan (bioakumulasi) logam berat dalam jangka masa yang singkat. Empat corak akumulasi yang asas telah diperolehi dalam kajian ini: **Corak 1** : penyerapan yang kerap pada waktu pendedahan jam yang pertama diikuti oleh pelepasan yang bersiri; **Corak 2** : pengambilan yang berterusan sepanjang waktu pendedahan sehingga mencapai tahap

yang seimbang; **Corak 3** : penyerapan yang kerap dalam jam yang pertama diikuti dengan pelepasan yang bersiri sehingga mencapai tahap yang seimbang; dan **Corak 4** : penyerapan dan pelepasan logam berat yang berselang-seli.

Secara umum, penyerapan logam berat yang maksimum berlaku pada waktu jam pendedahan yang pertama diikuti dengan penyerapan yang bersiri, atau pelepasan yang bersiri, atau corak penyerapan dan pelepasan yang berselang-seli. Akumulasi logam berat bertambah dengan bertambahnya kepekatan logam berat dalam media. Bioakumulasi yang aktif berlaku pada pertumbuhan sel yang muda berbanding dengan fasa tua (stationari).

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