Bioaccumulation and Toxicity Studies of Heavy Metals in Selected Malaysian Seaweeds

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Dissertation submitted to
The Institute of Postgraduate Studies and Research,
University of Malaya, 50603 Kuala Lumpur, Malaysia,
in partial fulfilment of the requirements for the
Degree of Master of Philosophy
August 1997

ACKNOWLEDGEMENTS

First and foremost, my sincerest gratitude to Associate Professor Dr. Phang Siew Moi for her supervision, invaluable guidance and constant encouragement.

My sincere appreciation to my co-supervisor, Associate Professor Dr. Tong Soo Loong for his guidance and valuable suggestions.

Thanks are due to The National Institute of Environmental Science, Japan for providing the certified reference material No. 9 Sargasso.

Heartfelt appreciation are due to the past and present members of the Algae Laboratory, namely Sheila, Chu, Susila, Samina, Melor, Ching Lee, Saras, Zuraini, Albert, Sudesh, Seok Min, Gan, Annie, Viji, Ong, Rohani and Ahsan for their help, support and delightful company.

I would like to record a very special thank you to Prem, Suresh, Ram, Raj, Basky, Satheesh, Valerie and Dr. Vijay for their moral support.

I am also grateful to Encik Wan and Jasmi, respectively for helping out in field trips and running of the ICP.

Lastly, I would like to thank my mother and other

family members for their continual support and patience during all these years.

This project was sponsored by the "The Working Group on Environmental Biotechnology, National Biotechnology Committee", Ministry of Science, Technology and the Environment.

Abstract

Seven seaweed species of Malaysia; *Chaetomorpha linum, Padina tetrastomatica, Sargassum baccularia, S. siliquosum, Gracilaria changii, G.edulis* and *G.salicornia*, were used in 24 h single metal exposure static studies to characterise the heavy metal (Cu, Zn, Mn and Cd) accumulation patterns in the seaweeds. This was done by incubating the seaweeds in a range of metal concentrations in sea water and by determining the metal content, at fixed time intervals, in the seaweeds and seawater over a 24 h exposure period. Five metal accumulation patterns were observed in this study; Pattern 1 : An initial rapid uptake, followed by a gradual accumulation till 24 h; Pattern 2 : A continuous gradual accumulation pattern for the entire 24 h; Pattern 3 : An initial rapid uptake, followed by a release-uptake pattern before a maintenance pattern or gradual accumulation continued till 24 h; Pattern 4 : An alternating uptake-release or vice-versa pattern throughout the 24 h; Pattern 5 : An initial net accumulative pattern, followed by a continuous regulatory discharge till 24 h.

Based on the three criteria; i) seaweed should possess net accumulation pattern; ii) seaweed should have strong positive correlation between metal accumulated in tissues and

time of exposure; iii) seaweed should have strong positive correlation between metal accumulated in tissues and available metal concentration in seawater; which characterise organisms as potential bioaccumulative indicators of selected heavy metals, the Phaeophytes were most suitable, followed by the Chlorophyte *C. linum* and then the Rhodophytes, the *Gracilaria* species.

Exposing three seaweed species, *C. linum*, *S. siliquosum* and *G. changii* to a single metal concentration of 1 mgL^{-1} (Cu, Zn, Mn and Cd) for 2 h, respectively at differing salinities of 20, 25, 30 and 35 ppt concentration, showed that decreasing salinity levels correlated ($p<0.05$) with increased accumulation of metals in seaweeds.

Exposure of the same three seaweed species to a single metal concentration of 1 mgL^{-1} at differing pH (4, 5, 6, 7 and 8) did not show any corresponding trend for the effect of pH on metal accumulation in seaweeds for the 2 h exposure. However, pH above 4 produced significantly ($p<0.05$) higher accumulation generally.

Toxicity studies showed that IC_{50} values using growth parameters (Chlorophyll-a content and dry weight) , can vary greatly, depending on the incubation time used. *G. changii* was the most sensitive species to Cd exposure. In the range

finding test, there was 50% inhibition in dry weight after 96 hours in *G. changii*. Toxicity results for Cd exposure in 96 h definitive test conducted on *G. changii* : IC_{50} = 31.071 $mgCdL^{-1}$, LOEC = 15 $mgCdL^{-1}$ and NOEC < 15 $mgCdL^{-1}$. In contrast, exposure of *C. linum* and *S. baccularia* to Cd in 96 h range finding test did not produce 50% inhibition in chlorophyll-a content and dry weight respectively. Further exposure to Cd for 7 and 10 days in the definitive tests showed that *G. changii* was still the most sensitive species. However, the inhibitory concentrations decreased with the incubation time used. The order of decreasing sensitivity to Cd exposure according to species is as follows : *G. changii* > *S. baccularia* > *C.linum*.

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