UNIVERSITI PUTRA MALAYSIA

A STUDY ON THE POTENTIAL OF USING SEAWEED AS BIOMONITORING INDICATOR IN KISH ISLAND, IRAN

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By

ALI DADOLAHI-SOHRAB

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

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DEDICATION

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To

Memory of my parents and my sister Maryam whom their spirits will always be a part of mine

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My wife Mojgan for years of love and dedication, and my daughter Pardise whom her presence enriched my life

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and

My sisters whom taught me how to work hard and be happy

****

Thanks to Allah

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Doctor of Philosophy

A STUDY ON THE POTENTIAL OF USING SEAWEED AS BIOMONITORING INDICATOR IN KISH ISLAND, IRAN

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Chairman: **Misri Kusnan, Ph.D.**

Faculty: **Science and Environmental Studies**

The study was carried out to evaluate the use of seaweed as biomonitoring in Kish Island, Iran. Seaweed, sediment and seawater samples were collected bimonthly from June 1999 to April 2000 at 5 different sites. Seaweed samples were collected, identified and biomass recorded for 4 seasons from April 1999 to March 2000. Diversity and biomass differed within sites and seasons. The highest seaweed biomass were recorded from northwest and west sides of study area.

The status of selected heavy metals (Cd, Cu, Ni, Pb, V and Zn) were determined in seawater, sediment and 10 dominant seaweed species. Metals level in seawater ranged from 0.02-0.10, 0.09-1.22, 0.11-0.18, 0.27-2.04 and 0.17-0.27 $\mu g\ l^{-1}$ for Cd, Cu, Ni, Pb and Zn, respectively, the metals concentrations were higher during cold seasons compared to the warm seasons. Metal concentrations in sediments ranged from 0.18-0.39, 2.39-4.55, 2.30-11.92, 2.92-5.92, 1.69-4.76, 4.04-9.51 $\mu g\ g^{-1}$ dry weight for Cd, Cu, Ni, Pb, V and Zn, respectively. Higher variations in metal concentrations were observed at sites Symorgh and Darakht-e-Sabz compared to other sites.

Metal levels in seaweeds showed considerable variations ranging from 0.44-1.74, 0.76-3.42, 0.37-2.23, 0.96-4.47, 0.53-2.16 and 3.44-10.23 μg g^{-1} dry weight for Cd, Cu, Ni, Pb, V and Zn, respectively. Cadmium was lower in Chlorophyta than the other groups. Chlorophyta accumulated more Zn, V, Pb, Ni and Cu than other groups. In addition, variations in metals contents between species were obvious from the same habitat and in several cases within the same taxonomic groups. Generally, heavy metals level in this study were relatively lower than the other parts of the world and in some cases lower than the other parts of the Persian Gulf.

Toxicity test experiments were carried out using *Cystoseira myrica* from Kish Island, Iran and *Sargassum ilicifolium* species from Port Dickson, Malaysia. All selected concentrations of Cd and V and Cu concentrations at above 0.01 mg l^{-1} showed toxic effects to both species. The toxic effects of Ni and Zn on the *C. myrica* and *S. ilicifolium* were at higher concentrations than the other metals and in addition Cu and V appeared to be more toxic than the other elements.

Using both species bioconcentration factors of Pb, Zn and Cu were higher than the other metals. This could be related to their electronegativity values. Elements uptake by different parts of *S. ilicifolium* during light period decreased in the following order: fronds > receptacles > stipes, whereas during dark period, accumulation of Cd, Cu, V and Ni exhibited similar trend to the above order, but Zn and Pb were higher in receptacles followed by fronds and stipes.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KAJIAN MENGGUNAKAN RUMPAIRLAUT SEBAGAI PENUNJUK BIOPEMONITORAN DI PULAU KISH, IRAN

Oleh

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Kajian telah dijalankan untuk menilai kegunaan rumpai laut sebagai penunjuk pencemaran di Pulau Kish, Iran. Sampel rumpai laut, sedimen dan air laut telah diambil setiap 2 minggu dari Jun 1999 hingga April 2000 dari 5 kawasan berlainan. Sampel rumpai laut diambil, dikenal pasti dan biomassnya direkodkan untuk 4 musim dari April 1999 hingga March 2000. Diversiti dan biomass berbeza di antara kawasan dan musim. Biomass rumpai laut tertinggi telah direkodkan dari kawasan Barat laut dan Barat kawasan kajian.

Status logam berat pilihan (Cd, Cu, Ni, Pb, V dan Zn) telah ditentukan pada air laut, sedimen dan 10 spesis rumpai laut utama. Paras logam di dalam air laut berada di antara 0.02-0.10, 0.09-1.22, 0.11-0.18, 0.27-2.04 dan 0.17-0.27 $\mu g\ l^{-1}$ untuk Cd, Cu, Ni, Pb dan Zn, logam-logam berada pada paras tertinggi semasa musim sejuk berbanding semasa musim panas. Kepekatan logam dalam sedimen berada di antara 0.18-0.39, 2.39-4.55, 2.30-11.92, 2.92-5.92, 1.69-4.76, 4.04-9.51 $\mu g\ g^{-1}$ berat kering untuk Cd, Cu, Ni, Pb, V dan Zn. Variasi kepekatan logam yang tinggi diperolehi dari kawasan Symorgh dan Darakht-e-Sabz berbanding dengan kawasan-kawasan lain. Paras logam dalam rumpai laut menunjukkan varisi antara 0.44-1.74, 0.76-

3.42, 0.37-2.23, 0.96-4.47, 0.53-2.16, dan 3.44-10.23 μg g^{-1} berat kering untuk Cd, Cu, Ni, Pb, V dan Zn. Kadmium adalah rendah dalam Chlorophyta berbanding kumpulan-kumpulan lain. Chlorophyta mengumpul Zn, V, Pb, Ni dan Cu yang lebih tinggi berbanding dengan kumpulan-kumpulan lain. Selain itu, variasi dalam kandungan logam-logam antara spesis-spesis adalah ketara sekiranya berasal dari habitat yang sama dan dalam sesetengah kes, dari kumpulan taksanomi yang sama. Secara umumnya, paras logam berat dalam kajian ini adalah rendah berbanding kawasan-kawasan lain di dunia dan dalam sesetengah kes ianya adalah rendah berbanding kawasan lain di Telak Parsi.

Ujian ketoksikan telah dilakukan dengan menggunakan spesis *Cystoseira myrica* dari Pulau Kish, Iran dan *Sargassum ilicifolium* dari Port Dickson, Malaysia. Kesemua kepekatan pilihan untuk Cd, V dan Cu kepekatan melebihi 0.01 mg l^{-1} adalah toksik kepada kedua-dua spesis. Kesan toksik untuk Ni dan Zn terhadap *C. myrica* dan *S. ilicifolium* adalah pada kepekatan yang tinggi berbanding dengan logam-logam lain, dan umumnya Cu dan V terbukti lebih toksik berbanding elemen lain.

Faktor biokepekatan bagi Pb, Zn dan Cu adalah tinggi berbanding logam lain. Ini mungkin ada perkaitan dengan nilai elektronegativiti mereka. Pengambilan elemen oleh bahagian yang berlainan bagi *S. ilicifolium* semasa waktu siang berkurangan mengikut turutan berikut: daun (fronds) > organ seks (receptacles) > batang (stipes), manakala sewaktu malam, pengambilan Cd, Cu, V dan Ni menunjukkan bentuk yang sama seperti di atas, tetapi Zn dan Pb adalah tinggi di organ seks, diikuti dengan daun dan batang.

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A.A.S.	=	Atomic Absorption Spectrophotometer
ANOVA	=	Analysis of Variance
APDC	=	Ammonium Pyrrolidine Dithiocarbamate
COMAS	=	Center for Oceanography and Mariculture Studies
CV	=	Coefficient of Variations
D.O.	=	Dissolved Oxygen
D W	=	Dry weight
EC_{50}	=	Effective Concentration resulting 50% mortality of test Organism
EN	=	Electronegativity
g wet wt m^{-2}	=	Grams Wet Weight per square meter
I.C.P-A.E.S	=	Inductively Coupled Plasma-Atomic Emission Spectrophotometer
mg l^{-1}	=	milligram per liter
MIBK	=	Methyl Iso-Butyl Ketone
MPI	=	Metal Pollution Index
NED	=	Naphthylethylenediamine dihydrochloride
ROPME	=	Regional Organization for the Protection of the Marine Environment
St.	=	Site
µg l^{-1}	=	microgram per liter
mg g^{-1}	=	milligram per gram
µg g^{-1}	=	microgram per gram
ppm	=	Part per million
ppb	=	Part per billion

P	=	Probability
P.S.	=	Photosynthesis System
TES	=	Titrisol Eisen Standard
Vs	=	Versus
UAE	=	United Arab Emirates
Wet wt.	=	Wet weight