

## DISTRIBUTION OF ELEMENTS IN MARINE ALGAE OF KARACHI COAST

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### Abstract

Seventeen species of green, brown and red seaweeds collected from Manora, Buleji and Paradise Point near Karachi coast of Pakistan were analyzed for their elemental composition with the help of Perkin Elmer 3100 Atomic Absorption Spectrometer. Several significant elements e.g., Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Na, Pb and Zn were detected quantitatively. Ca, Fe, K, Mg and Na were found in large amounts (223.79-13129.56 ppm), Cr, Cu, Pb and Zn were present in small quantities (1.27-10.49 ppm), while Cd and Co were detected in extremely small amounts (0.39-1.10 ppm). The average quantity of Na was found to be the highest among these algae (13129.56 ppm), followed by K (11655.71 ppm) and Ca (4242.17 ppm) with low quantity of Cr (1.27 ppm), Co (1.10 ppm) and Cd (0.39 ppm).

### Introduction

Algae concentrate minerals and trace elements from marine water which are in an organic form (Chapman & Chapman, 1980). Seaweeds grow in a mineral rich medium. The numerous elements coming from the sea are Ca, Cl, Cu, I, Mg, Mn, Na, P, S and Zn (Jarvis, 1976). The green, brown and red algae have relatively high mineral contents of Ca, K, Mg, Na and trace elements upto 38.9 % (Marderosian, 1972). There are reports where algal flora of India is considerably rich in Bromine, Iodine, Potash and Soda which show a wide range of organization, function and elemental composition (Biswas, 1980). Brown algae have been found to accumulate strontium and *Sargassum* spp., from Gujarat coast contain 200-500 ppm iodine (Ahmad *et al.*, 1989). It seems that the tropical seaweeds tend to accumulate more Fe than Cu, Mn and Zn (Ganesan *et al.*, 1991). The variation of elements is attributed to environmental fluctuation in the form of availability of Ca, K, Mg and Na in seawater or it may be a function of metabolic activity within the cellular matrix of the seaweeds (Ilyas & Sukan, 1994). The marine algae such as *Ascophyllum nodosum*, *Fucus distichus*, *F. vesiculosus*, *Laminaria longicruris*, *Palmaria palmata* and *Ulva lactuca* were analyzed for metals such as As, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Pb and Zn (Phaneuf *et al.*, 1999). In general the health risks associated with concentration of these elements in the algae growing at the Gulf of Saint Lawrence were not very high. For regular consumers it would be preferable to use *Palmaria palmata* and *Ulva lactuca* in order to prevent potential problems. Algal consumption has been found to have beneficial health effects (Phaneuf *et al.*, 1999).

Karachi, being the biggest city of Pakistan has a coastline of about 100 km at the northern boundary of the Arabian Sea. It includes beaches and numerous islands. The coastal waters around Manora, Sandspit, Hawkesbay, Buleji, Paradise Point, Pacha,

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Nathiagali and Cape Monze inhabit a variety of marine benthic algae (Shameel & Tanaka, 1992). Although a lot of work has been done on their taxonomy, distribution, morpho-ecological studies, phycochemistry and pharmacology but not much data related to their elemental composition is available (Rizvi *et al.*, 2000; Qari & Siddiqui, 2001). Studies were therefore carried out to examine the distribution of elements in marine algae on the coast of Karachi, Pakistan.

### Materials and Methods

**Collection of marine algae:** The healthy and mature specimens of different species of marine algae were collected from sandy bays, large and shallow sand bottom flats, small and large pools with rocky or sandy bottom and at the rocky ledges on various coastal areas of Karachi, Pakistan *e.g.*, Manora, Buleji and Paradise Point during September 1998 to December 1999. The sub-littoral algae were picked up as drift material. The collected seaweeds were brought to the laboratory where they were washed immediately with running water to remove epiphytes and attached debris and later by distilled water.

**Ashing and digestion of the seaweeds:** The algal material was dried under shade and 1 g of the ground seaweeds was placed into a porcelain crucible and ignited in a muffle furnace at 500 °C for two hours (Fig. 1). The ash was cooled at a room temperature, wet with ten drops of distilled water and dissolved in 3 mL of HNO<sub>3</sub> (1:1). The sample in acid solution was then heated gently on a hot plate at 100-120°C till nearly dry. The crucible was returned to muffle furnace and ashed again for one hour at 500°C. It was then cooled and dissolved in 10 mL HCl (1 : 1) and the solution was filtered through an acid washed Whatman filter paper into a 100 mL volumetric flask. The solution was then diluted to final volume with distilled water, mixed well and made ready for AAS reading (Jones, 1984).

**Elemental assay:** A flame atomic absorption spectrometer (AAS, Model Perkin - Elmer 3100, USA) was used for estimating Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Na, Pb and Zn. Instructions for instrument setting, calibration and assay for specific element as laid down in the operational manual were strictly followed (for details see Rizvi *et al.*, 2000).

### Results and Discussion

Seventeen species of marine benthic algae were investigated, out of which six belonged to Chlorophyta, three to Phaeophyta and eight to Rhodophyta. The amounts of all the elements detected in these species have been presented in Table 1. Among these elements Ca, Fe, K, Mg and Na were found in large amounts (average between 223.79 - 13129.56 ppm). *Gracilaria verrucosa* from the Izmir Bay was observed to be rich in Calcium showing a maximum value in August (Ilyas & Sukan, 1994). The values of Magnesium were present as low as 36.0 ppm in February. Iron was found in highest concentration among the trace elements without any correlation with season, the maximum value (1702 ppm) was found in November and minimum (521.48 ppm) in June (Ilyas & Sukan, 1994). The trace metal distribution in seaweeds of Indian Ocean has been reported to be 25.09-3420.56 ppm Mn, 128.09-1796.22 ppm Fe, 3.17-80.41 ppm Cu and

Table 1. Distribution of elements in marine algae of Karachi coast.

Marine algae	Ca	Cd	Co	Cr	Cu	Fe
	(ppm)					
<b>Chlorophyta</b>	32312.5	1.84	5.92	8.65	9.9	2186.25
<i>Bryopsis pennata</i> Lamour.	80800	3.15	8.05	9.925	12.9	3795
<i>Caulerpa racemosa</i> (Forsk.) J. Ag.	70300	2.2	6.8	12.525	11.25	2542.5
<i>Caulerpa taxifolia</i> (Vahl) C. Ag.	14755	0.975	4.0	10.425	8.5	2840
<i>Codium iyengarii</i> Borg.	14730	1.925	9.55	2.825	5.65	862.5
<i>Enteromorpha intestinalis</i> (L.) Nees	4745	0.5	0.5	23.325	14.0	2695
<i>Ulva lactuca</i> L.	8545	2.3	2.3	1.85	7.125	382.5
<b>Phaeophyta</b>	27351.6	2.67	6.16	7.01	9.7	673.5
<i>Cystoseira indica</i> (Thivy et Doshi) Mairh	19050	3.95	5.125	4.7	8.125	249
<i>Padina tetrastrum</i> Hauck	46950	2.875	6.375	16.15	12.375	3105
<i>Sargassum vulgare</i> C. Ag.	16055	1.2	7	0.18	8.6	1740
<b>Rhodophyta</b>	12452.81	2.24	6.78	5.99	9.66	944.78
<i>Botryocladia leptopoda</i> (J. Ag.) Kylin	9055	2.9	8.05	3.4	13.6	499.5
<i>Champia compressa</i> Harv.	10630	2.0	10.6	6.825	8.275	587.5
<i>Gracilaria corticata</i> (J. Ag.) J. Ag.	11725	1.875	5.55	7.1	8.375	1105
<i>Hypnea musciformis</i> (Wulf.) Lamour.	7977.5	1.975	5.1	2.325	6.675	230.5
<i>Hypnea valentiae</i> (Turn.) Mont.	10350	2.7	7.75	10.625	11.625	1825
<i>Sarconema furcellatum</i> Zanard.	7447.5	2.55	7.45	5.425	12.7	340.75
<i>Scinaia saifullahii</i> Afaq. et Shameel	8350	1.15	2.85	4.55	4.2	1070
<i>Solieria robusta</i> (Grev.) Kylin	34087.5	2.8	6.9	7.7	11.9	1900
<b>Average amount</b>	4242.17	0.39	1.10	1.27	1.72	223.79

Table 1 (Contd.)

Marine algae	K	Mg	Na (ppm)	Pb	Zn
<b>Chlorophyta</b>	<b>54855</b>	<b>12366.58</b>	<b>67977.5</b>	<b>23.47</b>	<b>33.93</b>
<i>Bryopsis pennata</i> Lamour.	10855	6660	28535	43.875	37.425
<i>Caulerpa racemosa</i> (Pörssk.) J. Ag.	19625	764.5	155950	23.675	21.725
<i>Caulerpa taxifolia</i> (Vahl) C. Ag.	15810	6870	110400	19.1	25.05
<i>Codium iyengarii</i> Berg.	231700	9605	9605	26.075	18.25
<i>Enteromorpha intestinalis</i> (L.) Nees	18590	13400	13400	19.6	81.55
<i>Ulva lactuca</i> L.	32550	36900	36900	8.55	19.15
<b>Phaeophyta</b>	<b>68470.33</b>	<b>16030.33</b>	<b>36998.23</b>	<b>10.05</b>	<b>117.63</b>
<i>Cystoseira indica</i> (Thivy et Doshi) Mairh	118125	9425	80562.5	8.1	33.625
<i>Padina tetrastrum</i> Hauck	26620	24500	20530	15.25	44.475
<i>Sargassum vulgare</i> C. Ag.	60666	14166	9902.2	6.8	274.8
<b>Rhodophyta</b>	<b>74821.87</b>	<b>12553.43</b>	<b>118226.87</b>	<b>13.57</b>	<b>26.83</b>
<i>Botryocladia leptopoda</i> (J. Ag.) Kylin	65925	27040	202375	7.2	26.375
<i>Champia compressa</i> Harv.	21475.0	7985	10085	22.55	15.05
<i>Gracilaria corticata</i> (J. Ag.) J. Ag.	114750	4580	26290	13.325	35.3
<i>Hypnea musciformis</i> (Wulf.) Lamour.	62125	4930	129687.5	3.85	15.675
<i>Hypnea valentiae</i> (Turn.) Mont.	112937.5	15260	154187.5	14.1	29.925
<i>Sarcinoma furcellatum</i> Zanard.	136375	19820	220187.5	16.05	20.775
<i>Scinaia saifullahii</i> Afaq. et Shameel	14925	12350	18690	13.45	47.875
<i>Solieria robusta</i> (Grev.) Kylin	70062.5	8462.5	184312.5	18.1	23.6
<b>Average amount</b>	<b>11655.71</b>	<b>2408.84</b>	<b>13129.56</b>	<b>2.77</b>	<b>10.49</b>

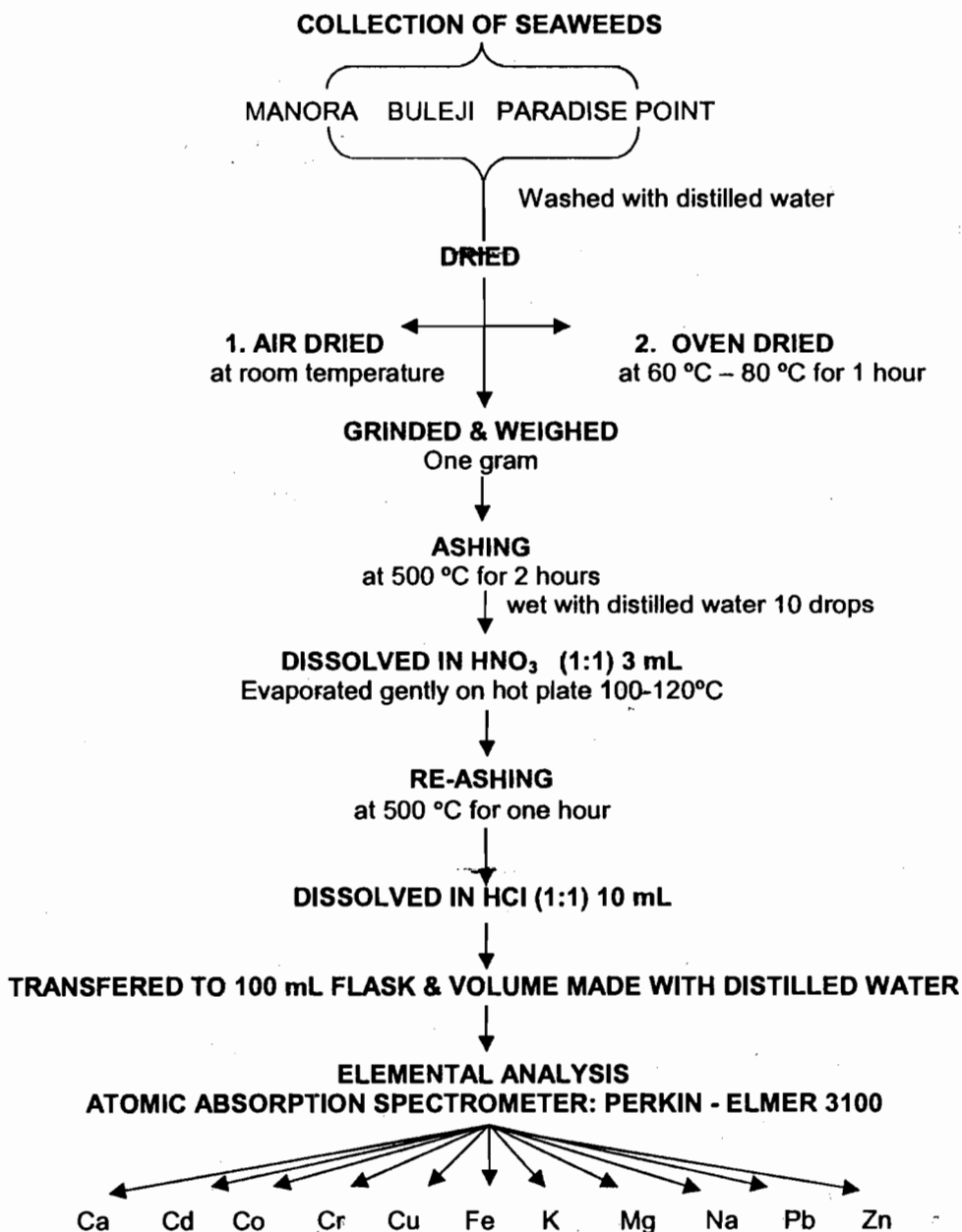


Fig. 1. Scheme for the elemental composition of seaweeds of the Karachi coast.

3.69-203.88 ppm Zn (Agadi *et al.*, 1978). Iron was also found in large quantity, Cr and Zn in medium quantity and Co in small amount in several brown seaweeds of the Saronic Gulf, Greece (Kanas *et al.*, 1991). In the present study the average quantity of Na was found to be the highest among these algae (13129.56 ppm), followed by K (11655.71 ppm) and Ca (4242.17 ppm) with an average amount of Cr (1.27 ppm) and quite low amount of Co (1.10 ppm). Cd was detected in the lowest quantity (0.39 ppm). The concentration levels of Cd, Cr, Cu, Pb and Zn were also low. Their ranges in *Ptilota serrata* were 1.77-3.75 ppm in wet tissue weight and approximately 7.0-15.0 ppm in dry tissue weight; Cu levels in *Polysiphonia urceolata*, *Phycodrys rubens* and *Laminaria saccharina* were similar to the concentration level in *Ptilota serrata* (Sears *et al.*, 1985). Sodium was found to be in highest amount in the Rhodophyta (118226.87 ppm) and Chlorophyta (67977.5 ppm) while K was detected in highest quantity in Phaeophyta (68470.33 ppm). However, Cd was present in smallest amount in Chlorophyta (1.84 ppm) as compared to Phaeophyta (2.67 ppm) as well as Rhodophyta (2.24 ppm). Previously, Rizvi *et al.*, (2000) determined the average amount of Co as 4.39 ppm, Cr as 1.91 ppm and Cd as 1.18 ppm in the seaweeds of Karachi.

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