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ELEMENTAL COMPOSITION IN VARIOUS THALLUS PARTS OF THREE BROWN SEAWEEDS FROM KARACHI COAST

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Abstract

Three brown seaweeds *Stoechospermum polypodioides* (J.V.F. Lamourourx) J. Agardh, *Jolyna laminarioides* Guimarães *in* Guimarães *et al*., and *Sargassum tenerrimum* J. Agardh were collected during January 1997 and July 2002 from coastal areas near Karachi-Pakistan, dried powdered and ashed. From ashes of lower, middle and upper parts of their thalli 11 elements were quantitatively estimated. The results indicated that each species behaved differently. Average quantity tremendously increased more than 4 times in the middle part but suddenly decreased in the terminal part which was lesser than basal portion.

Introduction

Seaweeds concentrate minerals and trace elements from seawater and convert them in organic forms as they grow in mineral rich medium. The numerous elements coming from the sea are Ca, Cl, Co, I, Mn, Mg, P, K, S, Na, and Zn (Jarvis, 1976). Seaweeds selectively absorb elements such as Br, Ca, me, K, Mg, Na, and I from seawater and accumulate them in their thalli. The composition of accumulated elements varies from species to species (Kaur, 1997). The thalli of brown seaweeds are generally rich in K, Na, Ca, Mg, P, Fe and Zn (Mahran, 1991). Therefore, it was felt necessary to investigate the elemental composition in different thallus parts of three brown seaweeds, collected from the coastal areas of Karachi, Pakistan.

Materials and Methods

Ashing and digestion of seaweeds: The locality along the coast of Karachi (Pakistan) and date of collection of the investigated algal species are mentioned in the Table I. They were initially dried under shade at room temperature and later in an oven (Memmert, Germany) at 60-80º C for 1 hr. The material was then powdered through a grinder. Two g of the ground sample was taken in a porcelain crucible and ashed at 500ºC in a muffle furnace to constant weight for 2 hrs as described earlier (Rizvi *et al*., 2000). The ash was cooled at room temperature, moistened with 10 drops of distilled water and carefully dissolved in 3 mL HNO_3 (1:1, 65% RDH). The acid solution of each sample was then heated gently on a hot plate (IKAMAG, Germany) at 100-120º C till nearly dry. The crucible was returned to muffle furnace and ashed again for 1 hr at 500º C. It was then cooled and dissolved in 10 mL HCl (1:1, 37% RDH) and the solution was filtered through Whatman filter paper no. 42 (Schleicher & Schuell, Germany) into a 100 mL volumetric flask (Jones, 1984). If the concentration was very high, it was further diluted, mixed well and made ready for the Atomic Absorption Spectrometric Analysis.

Table 1. Locality and date of collection of the investigated algal species (systematically arranged according to Shameel, 2001, 2008).

No.	Marine algae	Locality	Date of collection
	Phylum Phaeophycota		
	Class: Dictyophyceae		
	Order: Dictyotales		
	Family: Dictyotaceae		
1.	*Stoechospermum polypodioides* (J.V.F Lamou.) J. Agardh	Buleji	20-01-1997
	Class: Laminarophyceae		
	Order: Scytosiphonales		
	Family: Scytosiphonaceae		
2.	*Jolyna laminarioides* Guimarães *in* Guimarães *et al.*,	Buleji	27-07-2002
	Class: Fucophyceae		
	Order: Fucales		
	Family: Sargassaceae		
3.	*Sargassum tenerrimum* J. Agardh	Manora	27-12-1997

Elemental assay: The flame Atomic Absorption Spectrometer (AAS, Model Perkin-Elmer 3100, USA) was used at Environmental Studies Centre, Hamdard University, Karachi for the purpose of estimating Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Na, Pb and Zn (Rizvi & Shameel, 2005). The studies were restricted to the qualitative as well as quantitative estimation of these eleven elements only because their corresponding Hollow Cathode Lamps were present in the centre, while other lamps were not available. The various instrument parameters for these elements have been presented in the Table 2. Instructions for instrument setting calibration and assay for specific elements were strictly followed as laid down in the operational manual.

Results and Discussion

Three species of brown seaweeds *viz*., *Stoechospermum polypodioides*, *Jolyna laminarioides* and *Sargassum tenerrimum* were investigated for the elemental composition in basal, middle and terminal parts of their thalli. The details of these results have been depicted in the Tables 3. The average amount of the investigated elements were almost constant (with a slight increase in the middle portion) in different thallus parts in *Stoechospermum polypodioides*. It gradually decreased from below upwards in *Jolyna laminarioides* and exhibited a tremendous increase in the middle portion in *Sargassum tenerrimum*. This indicates that member of the three classes of Phaeophycota (Dictyophyceae, Laminarophyceae and Fucophyceae) differ from one another in the distribution of elements within their thalli.

The quantities of Cd, Cr, Cu, Fe, Mg and Zn decreased from below upwards in *Stoechospermum polypodioides* (Table 3). The amount of Ca remained constant in basal and middle parts but decreased in terminal portion, Pb also remained constant in the basal and middle parts but increased in the terminal portions. The proportion of Co was almost similar in the basal and terminal parts but decreased in the middle portion; K was also similar in the basal and terminal parts but increased in the middle portion. Sodium (Na) showed a variable quantity in different thallus parts of the seaweed. The average amounts of Na and K in its entire thallus were highest (29,418.33-30,566.66 ppm) as compared to other elements and those of Cd and Co the lowest (8.11-8.31 ppm).

Table 2. Instrument parameters.

Elements	Symbols	Wave length (nm)	Slit width (nm)	Sensitivity (mg / L)
Calcium	Ca	422.7	0.7	0.092
Cadmium	Cd	228.8	0.7	0.016
Cobalt	Co	240.7	0.2	0.078
Chromium	Cr	357.9	0.7	0.041
Copper	Cu	324.8	0.7	0.077
Iron	Fe	248.3	0.2	0.039
Potassium	K	766.5	0.7	0.043
Magnesium	Mg	285.2	0.7	0.008
Sodium	Na	589.0	0.2	0.012
Lead	Pb	283.3	0.7	0.079
Zinc	Zn	213.0	0.7	0.018

The amounts of Cd and K decreased from below upwards in *Jolyna laminarioides* (Table 3). The proportion of Na remained almost constant while those of Co and Cr varied in different parts of the thallus. The quantities of Fe and Zn were similar in basal and terminal parts but decreased in the middle portion, while Cu, Mg and Pb were also similar in amount in the basal and terminal parts but increased in the middle portion of the thallus. Calcium (Ca) was found in a large proportion in the basal part, it decreased in the middle and remained constant in the terminal portion of the seaweed. The average quantity of Na in its entire thallus was largest (35,933.33 ppm) as compared to other elements and those of Co and Cr the smallest (6.36-7.08 ppm).

The proportion of Co decreased from below upwards but Cd varied in different thallus parts in *Sargassum tenerrimum* (Table 3). The quantity of Na remained almost constant throughout the thallus, but that of Cu increased from basal part and then remained similar in the middle and upper parts. The amounts of Ca and Fe were large in the basal parts but decreased in the middle and remained similar in the terminal portion, while that of Cr was similar in the basal and middle parts but increased in the terminal portion. The proportions of Zn, K, Mg and Pb were almost similar in the basal and terminal parts, but Zn decreased and K, Mg and Pb increased in the middle portion of thallus of this seaweed species. The average amounts of Ca and K in its entire thallus were highest (105, 216 - 117, 03.33 ppm) as compared to other elements and those of Co and Cr the lowest (5.01-6.45 ppm). It appeared that the investigated species of brown seaweeds presented a highly varied picture about the distribution of elements in different parts of their thalli. Therefore, no valid conclusion may be drawn about the distribution of individual elements.

Maximum sodium content was recorded for S*argassum swartzii* from Okha Port, India in December and a minimum in January (Murthy & Radia, 1978). Concentrations of Fe, Al, Mn, Cu, Ni, Co and Zn were measured in *Fucus ceranoides* and *Fucus vesiculosus* from Pontedeume, a small estuary on the north-west coast of Spain. It was observed that the concentrations in mature tissues (lower part of the thallus) were higher than in apices for all the metals studied except Cu, for which there were no significant differences between the two thallus portions (Barriero *et al*., 1993). The reason for the differences in the upper and lower parts may be due to slow accumulation rates, greater number of binding sites in the older tissues, high particulate contamination or great accumulation of epiphytes in the basal part of the thallus. The thalli of brown seaweeds are generally rich in K, Na, Ca, Mg, P, Fe and Zn (Mahran, 1991).

Table 3. Elemental composition in ppm of three brown seaweeds.

Thallus parts	Ca	Cd	Co	Cr	Cu	Fe	K	Mg	Na	Pb	Zn	Average
Stoechospermum polypodioides												
T	14570.00	5.45	11.00	7.25	12.30	1514.00	28455.00	6730.00	31200.00	139.25	52.55	7517.89
M	17530.00	9.65	3.50	15.70	61.60	1542.00	31575.00	6985.00	33000.00	90.05	53.10	8260.50
B	17255.00	9.85	9.85	16.10	127.60	1661.00	28225.00	8970.00	27500.00	93.40	57.80	7632.23
Average	**16451.66**	**8.31**	**8.11**	**13.01**	**67.16**	**1572.33**	**29418.33**	**7561.66**	**30566.66**	**61.15**	**54.48**	
Jolyna laminarioides												
T	7885	19.25	5.35	11.20	81.60	117.00	236.00	9575.00	41050	9.45	70.60	5369.13
M	7760	21.30	8.30	3.20	104.05	91.00	264.85	10630.00	42900	76.60	60.95	5629.11
B	15510	27.45	7.60	4.70	32.80	180.00	271.55	9215.00	40550	15.55	74.40	5989.91
Average	**10385**	**22.66**	**7.08**	**6.36**	**72.80**	**129.33**	**257.46**	**9806.66**	**41500**	**33.86**	**68.65**	
Sargassum tenerrimum												
T	9005.00	8.60	4.05	6.30	59.50	430.50	23400.00	9345.00	36350.00	60.75	26.70	7154.21
M	8745.00	12.30	6.25	4.15	61.00	423.50	269100.00	10460.00	37550.00	91.00	21.20	29679.49
B	17360.00	4.75	9.05	4.60	21.25	1014.00	23150.00	9390.00	33900.00	66.60	24.95	7722.29
Average	**11703.33**	**8.55**	**6.45**	**5.01**	**47.08**	**622.66**	**105216.66**	**9731.66**	**35933.33**	**72.78**	**24.28**	

Avg. = Average, **T** = Terminal part, **M** = Middle portion, **B** = Basal part with holdfast.

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