ELEMENT COMPOSITION OF *SARGASSUM THUNBERGII**

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Abstract Results of neutron activation analysis (NAA) of *Sargassum thunbergii* samples collected from the Qingdao Taipingjiao coast on March 20, 1996 showed that (1) *Sargassum thunbergii* can to some extent accumulate potassium and calcium (the accumulation coefficient was 10); (2) it can accumulate almost all trace elements, especially iron, manganese and zinc; (3) it can accumulate strontium, aluminium thorium, and rare earth elements.

Key words: *Sargassum thunbergii*, neutron activation analysis, accumulation

INTRODUCTION

Sargassum is a large genera belonging to the class of Fucales, whose members are more than 250. *Sargassum thunbergii* is the most abundant wild species in the Yellow Sea coast, and is widely distributed along the entire China coast (Tseng, 1983). Although some studies on elements in seaweeds have been made by various authors (Fan et al., 1995; Fan et al., 1996; Yamamoto et al., 1983; Whyte & Englar, 1980) the elemental composition in seaweeds has rarely been studied in detail. Neutron Activation Analysis (NNA) is an ideal method for investigating the elemental composition in marine algae because of its convenience in sample preparation and simultaneous determination of multiple elements. The neutron activation analysis method was used to fractionate the water soluble part and insoluble part, then determine the elements content in each part to obtain the overall element composition in *Sargassum thunbergii*.

MATERIALS AND METHODS

Alga collection and treatment Attached plants of *Sargassum thunbergii* were collected from Taipingjiao (36 °02′N, 120 °20′E), on March, 26, 1996 (water temperature 7.5 ℃ ; seawater density 1.0260). After being freed of any foreign matter such as epiphytes and sands, the samples were washed with clean seawater, immediately put into a polyethylene plastic bag with a little hole to leak out seawater drops, transferred to the laboratory, and frozen (−15 ℃).

Sample preparation After thawing, the samples (25 g) were freed of any residual or strongly attached foreign matter, cut into small pieces, milled (at 1000 r/m) by plant miller, divided into 2 equal portions (one for determination of total element content the other was put into an Ehrenmeyer flask), extracted with 50 ml deionized water by electromagnetic stirrer, and after further filtration, the extraction for residue was repeated

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twice. The residue was used for element determination. All the extracts were combined for further iodine specification determination.

Neutron activation analysis The analysis procedure was described by Hou (1995). The prepared sample was sealed into a small polyethylene capsule, irradiated by a Chinese Atomic Research Institute miniature neutron source reactor equipped with an Hp Ge semiconductor detector connected with a PCA－Ⅱ －8000 multiple channel analyzer (Telenc/Nucleus, USA). Automatic analysis software based on the comparative method was used to determine element contents.

RESULTS AND DISCUSSIONS

The absorption capacity of *Sargassum thunbergii* for each element was investigated. The result showed that based on fresh weight, 1 gram of *Sargassum thunbergii* contained respectively 0.16 g and 0.1 g dried material before and after thorough extraction with water.

Macronutrients The concentrations of sodium, potassium, magnesium, calcium, chloride, and bromine, are respectively 10.77, 0.39, 1.29, 0.41, 19.35 and 0.067 g/L(Turekian, 1969) in natural seawater. Table 1 shows that alga can excrete excess sodium and chloride, and accumulate potassium and calcium to about 10 times its weight. This fact indicates that brown alga can bind divalent metal ions and is very beneficial for mineral absorption needed for human health. About 50% of magnesium and calcium are insoluble. Another astonishing fact is that *Sargassum thunbergii* can accumulate bromine to more than 80 times its weight. But only about 7% of bromine cannot be extracted by water, which implies that bromine accumulated in the alga is not assimilated but is turned into organic bromocompound.

Table 1 Content of Na, K, Mg, Ca, Cl, Br in *Sargassum thunbergii*

	Total content (g/kg fresh sample)	Content in residue (g/kg fresh sample)	Extract percentage by water (%)
Sodium	3.872	0.327	91.6
Potassium	3.232	0.45	86.1
Magnesium	0.7848	0.406	48.3
Calcium	5.68	2.93	48.4
Chloride	6.384	0.036	99.44
Bromine	4.464	0.307	93.12

Trace elements Seaweeds are known as natural elemental accumulators. From Table 2, it is evident that *Sargassum thunbergii* can accumulate all the trace metal ions. The order of content of trace metal is as follows: Fe>Mn>Zn>V>Cr>Co. According to the content of trace elements in seawater, the accumulation coefficient is 140000, 40000, 4800, 1300, 700, 800 for iron, manganese, chromium, zinc, vanadium and cobalt respectively. The extractability by water for divalent metals such as manganese, zinc, and cobalt are lower than that for trivalent metal elements such as iron and vanadium. This accords with the fact that the binding ability of divalent metal ions with alginate is stronger than that of trivalent metal ions.

Table 2 Content of Fe, Zn, Cr, Co, V in *Sargassum thunbergii*

	Total content (mg/kg fresh sample)	Content in residue (mg/kg fresh sample)	Extract percentage by water (%)
Iron	475.2	72	84.8
Zinc	6.624	3.87	41.6
Manganese	17.6	11.1	36.9
Chromium	0.968	0.168	82.6
Cobalt	0.3312	0.154	53.5
Vanadium	1.3424	0.398	70.4

Miscellaneous For other alkaline and alkaline earth elements, the insoluble part is almost undetectable after water extraction. Aluminum and arsenic are considered as health risk elements. One kilogram fresh alga contains 856 mg aluminium, of which only 20% is insoluble. Nagata et al.(1992) pointed out that aluminium is complexed by polyphenols in tea leaves. *Sargassum thunbergii* contains phlorotannins, which may similarly complex aluminium as in the case of tea leaves. The arsenic content in *Sargassum thunbergii* is below the detection limit. In our experiement, only one element belonging to the actinium series was determined, i.e. thorium, which accumulates to 0.16 mg/kg in fresh algal material, and about 15% is insoluble.

Table 3 Content of Rb, Cs, Sr, Ba in *Sargassum thunbergii*

	Total content (mg/kg fresh sample)	Content in residue (mg/kg fresh sample)	Extract percentage by water (%)
Rubidium	2.656	ND	–
Cesium	0.1488	ND	–
Strontium	27.2	ND	–
Barium	ND	ND	–
Aluminium	856	118	86.2
Arsenic	ND	ND	–
Thorium	0.1616	0.022	86.4

Rare earth elements Rare earth elements (REE) are beneficial to the growth of agricultural plants and the development of animals, and may increase wheat gross output by 10% and the gross weight of sheep by 15% (Xu & Ni, 1995). After the extensive use of rare earth fertilizer and feed, these elements will ultimately reach the ocean to affect the marine ecology. Because of the uncertainty of the effect of rare earth element on human health, knowledge of rare earth element content in alga is very necessary. Table 4 shows the total amount of eight species of rare earth elements such as lanthanum, samarium, cerium, europium, lutetium, neodymium, scandium, and ytterbium can reach 1.3 mg/kg fresh algal material, which means that 1 kilogram dried alga contains about 9 mg rare earth elements. This value is considered high.

Table 4 Content of rare earth elements in *Sargassum thunbergii*

	Total content (mg/kg fresh sample)	Content in residue (mg/kg fresh sample)	Extract percentage by water (%)
Lanthanum	ND	ND	–
Samarium	ND	ND	–
Cerium	1.1344	0.268	76.38
Europium	0.0112	0.006	46.43
Lutetium	ND	ND	–
Neodymium	ND	ND	–
Scandium	0.168	0.035	79.17
Ytterbium	0.0208	ND	–

CONCLUSION

NAA can be used readily with high sensitivity for elemental determination, especially for iodine. The elemental characteristics of *Sargassum thunbergii* are as follows:

1. *Sargassum thunbergii* can to some extent accumulate potassium and calcium (the accumulation coefficient is 10).

2. *Sargassum thunbergii* can accumulate almost all trace elements, especially iron, manganese, and zinc.

3. *Sargassum thunbergii* can accumulate strontium, aluminium, and thorium, and rare earth elements.

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