



Research Article

MINERAL NUTRITIVE STATUS OF *ENTEROMORPHA INTERMEDIA* BLIDING: A FRESH WATER GREEN ALGAE

S. S. Sagar

Department of Botany, Yashvanrao Chavan Institute of Science, Satara (MS) India. 415001.

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Corresponding Author's email: sssbotany.2013@gmail.com

Abstract: Fresh water green algae *Enteromorpha intermedia* collected from Godavari river at kopergaon, (M.S) was screened for its mineral contents, Major elements viz. N, P, K, Ca, Mg, and Minor elements Fe, Zn, Cu, Mn, B were estimated. Results of the present study indicated higher concentration of Fe, Ca, Zn, Cu and B, moderate range of N, P, K while Mn values were fluctuating. The potential use of these algae for human consumption or alternative human use is discussed.

Keywords: Godavari River, *Enteromorpha intermedia*, mineral contents.

INTRODUCTION

Algae, a large and diverse group of autotrophic organisms; have been the subject of applied research over the years. Algae can be applied to solve the food, feed and fertilizer scarcity problems¹. Out of the total estimated 3,40,000 algal species on the earth², human beings, utilize only 221 species of algae, 145 species as food and 101 species for other use³. For the production of unconventional food algal studies are gaining momentum. The reports on use of seaweeds (marine algae) have been cited as early as 2500 years ago in Chinese literature⁴. In earlier periods, coastal people used algae as food during famine ward off starvation⁵. The fresh water micro algae are also rich in protein, carbohydrates amino acids, trace elements and vitamins⁶. My earlier studies on Godavari River at Kopergaon, revealed presence of abundant *Enteromorpha* algae in the water except during some monsoon months. This alga was found to be growing in clean as well as in polluted water of the river studied. Published accounts on the *Enteromorpha* for marine environment⁷ indicated its possible use as food, feed and for antibiotic production. There is large number of publications dealing with chemical studies on mineral and biochemical constituents of Indian sea weeds^{8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22 and 23}. However, not much is known about the application of freshwater green algae as food, feed and manure from any part of the world to date.

MATERIALS AND METHODS

Study area

The present study deals with mineral uptake potential in fresh water algae, *Enteromorpha intermedia*, collected from Godavari River at Kopergaon during 2008 to 2010. The collection site, as indicated on the map (Plate I.) is located to the extreme south west of the town, a point where the river entered the town ship. Here there was a flow of water for most of the year.

About the alga- *Enteromorpha intermedia*

The fresh water alga *Enteromorpha intermedia* start to appear in the river from October onwards and attains a peak growth in the month of January-February. The thallus of the alga (Plate II) is filamentous, 6-18cm in length, dark green, sparingly branched up to the second order, tertiary branches uniseriate, cells mostly rectangular in surface view with long axis parallel to the axis of the frond, arranged usually in linear series tending to become irregular at the base of the primary axis cell in surface view 16-25 µm long, 10-14µm broad. Chloroplast completely filling the cell as in surface view with 1-3 pyrenoids which are 2-4 µm in diameter.

Preparation of algal powder

Enteromorpha intermedia was collected in large quantity from the collection sites. Collected algal material was washed in water to remove epiphytes, impurities, soil particles etc. and carefully screened under binocular (Olympus) to remove filaments of other algae if present. Washed algal material was dried under shade in the laboratory. Completely dried material was ground in a grinder to obtain fine powder. Fine powder of the alga was stored in airtight plastic containers for further use.

Estimation of some major and minor elements

Major and minor elements were estimated according to Tandon²⁴. Total nitrogen was estimated by Kjeldahl distillation method, phosphorus was estimated by using molybdate vanadate reagent. The acid digested extract of the alga was used for the estimation of potassium by flame photometric method and also used to estimate iron, zinc, copper, manganese, calcium and magnesium by atomic absorption spectrophotometer. Boron estimation is carried out by the formation of colored rosacyanin, absorbance of an alcoholic solution of rosocyanin is proportional to that of boron concentration determined by spectrophotometer.

RESULTS AND DISCUSSION

Green plants have comparatively simple nutrient requirements and that these are classified as macronutrients (N, P, K, Ca, Mg, S, and Na) and micronutrients (Fe, Mn, Cu, Zn, Mo, B and Cl). The mineral nutrition is an important aspect of plant growth that governs the productivity of all plants. It was thought that the status of these mineral nutrients may give an idea about adaptability and luxuriant growth of any plants. An estimation of biochemical contents

of algae gives basic information about their nutritive potential²⁵ which is essential for their proper utilization as food, feed, fodder and fertilizer. An idea regarding the status of mineral elements in *Enteromorpha intermedia* is given in Table 1 and Fig 1. Increase in element uptake like Potassium, Magnesium, Ferrous and Manganese since 2008 to 2009 indicates increase in water pollution of Godavari River. Increased Zn content indicates that *Enteromorpha intermedia* can adapt for any environmental stress.

Table 1. Mineral uptake potential of algae *Enteromorpha intermedia*

Sr no.	Elements	Year 2008	Year 2009
		%	%
1	Nirogen	3.08	1.40
2	Phosphrous	0.05	0.07
3	Potassium	0.55	0.82
4	Calcium	30.16	30.16
5	Magnesium	5.00	6.18
		ppm	ppm
6	Ferrous	524.62	942.95
7	Zinc	31.24	111.19
8	Copper	116.72	115.67
9	Manganese	199.93	678.98
10	Boron	172.48	149.6

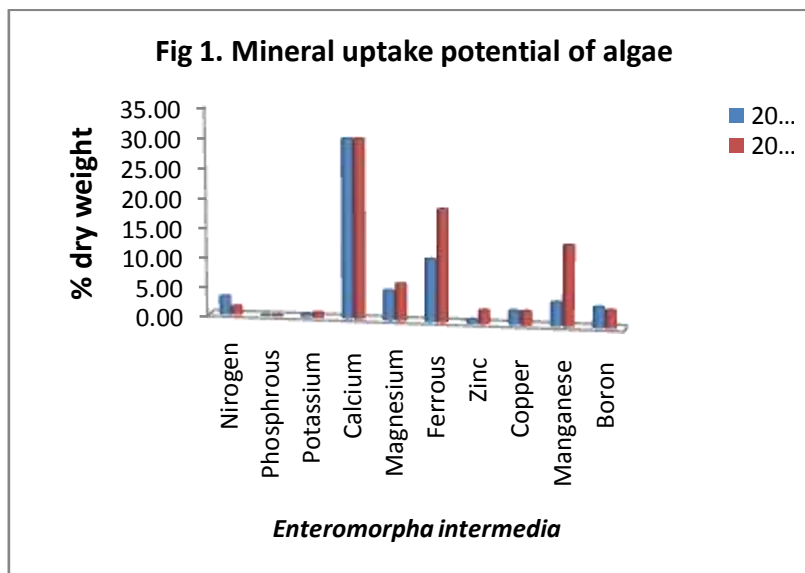


Fig-1: Mineral Uptake potential of Algae

Among all elements, nitrogen play vital role in the growth of plant. It is very essential for synthesis of many organic compounds. The total nitrogen values estimated during the year 2008 and 2009 were 3.08 and 1.40% respectively. The values show marked fluctuation in nitrogen content. However the mean average value of nitrogen content is in the same range of nitrogen content

estimated by Dhargalkar *et al.* ^[18] and Rao and Indusekar¹⁹ from some marine seaweed.

High phosphorus contents in plant species signifies the high metabolic activities associated within these species. The total phosphorus content in the algal samples collected during the year 2008 and 2009 were recorded as 0.05 and 0.07% respectively. Rao²⁰ reported a range of 0.003% to 0.62% phosphorus with an average of 0.16% in the Indian

marine algae. The estimated phosphorus content of *E. intermedia* fall within the range but is lower than the average value proposed by him. Potassium is indispensable for plant growth. Plants require 1% potassium for their optimal growth²⁶. It is evidence from result that *E. intermedia* have 0.55 to 0.82% (dry wt.) Potassium. Rao²⁰ proposed a range of potassium in Indian marine algae from 0.15% to 6.45% with an average value of 3.51%. Potassium content of *E. intermedia* studied is within the range of those reported but found to be lower than the average value.

Calcium is also a non-toxic mineral nutrient, even in high concentration it is very effective in detoxifying high concentrations of other mineral elements in plants. The major role carried out by calcium in plants is to bind with proteins, nucleic acids and lipids to affect cell adhesion, membrane chromatin organization and enzyme conformation²⁷. Calcium content in *E. intermedia* was found similar (30.16%) in both the years which is relatively higher than that of angiospermic plants. It shows high ion exchange affinity of *E. intermedia* for divalent cations. Arasaki and Arasaki²⁸ reported values 1.1 to 3% for Ca in some edible seaweed. Rao²⁰ reported Ca in the range of 0.2 to 1.9% in the Indian marine algae, with an average of 0.9%. The Ca content in *E. intermedia* is comparatively much higher than the values reported earlier by all authors for marine algae.

Magnesium is a small, mobile and strongly electropositive divalent cation in the plants, found both in bound as well as free form²⁹. Most well known role of Mg is its contribution to the center of the chlorophyll molecule. In the plants, 2% Mg on dry weight basis has been regarded as critical value by Epstein²⁶. It is evidence from result that magnesium content in the alga *E. intermedia* under investigation was 5.0% in the year 2008 and slightly higher values of magnesium, 6.18% was obtained in the year 2009. Comparatively lower Mg content, 0.73% and 2.57% were reported earlier by Parekh *et al.*¹⁴ and Khemnar and Chaugule^[30] respectively from *Sargassum tennerimum*. The estimated values of Mg in *E. intermedia* are quite high than the marine seaweeds.

Iron in living cells, is required to catalyse a number of enzymatic reactions. It is an immobile element. The adequate value of iron for optimal growth of plants is 100 ppm (0.01%)^{26, 31}. The analysis of *E. intermedia* exhibited 524.62 ppm iron content in the year 2008 and 942.95 ppm in the year 2009. There is no available information about iron content in fresh water algae so far. Rao^[20] reported an average of 1.33% iron in the Indian seaweeds. The high amount of iron in *E. intermedia* indicates its usefulness for edible purpose.

According to Epstein^[26] the level of zinc for optimal growth of plant is 0.002 g/100g (dry wt.). Zinc contents in *E. intermedia* were 31.4 ppm and 111.19 ppm in the year 2008 and 2009 respectively. Zingde and Singbal^[32]

reported 20.4 ppm zinc content in *S. tennerimum*. Khemnar and Chaugule^[30] reported 14 ppm of zinc in the same species. Higher level, of zinc in *E. intermedia* indicates its tolerance capacity for any kind of environmental stress and also indicates that this species may act as antioxidant.

Copper as a cupric ion is an essential trace element for algae and higher plants^{33, 34}. The critical deficiency level of copper in vegetative parts is generally in the range of 3 to 5 $\mu\text{g g}^{-1}$ dry wt. and this range can be larger³⁵. Fairly constant values of copper content were obtained in *E. intermedia*. It was 116.72 ppm in the year 2008 and 115.67 ppm in the year 2009. Similarly from marine algae *S. tennerimum* by Zingde and Singbal³², Rao^[19], Khemnar and Chaugule³⁰ reported 7.3, 11.2 and 10 ppm Copper content. Compared to marine algae, Cu content is more in fresh water alga *E. intermedia*.

Manganese is associated with photosynthesis, respiration, oxidation of carbohydrates and IAA and activation of enzymes of nitrogen metabolism. According to Marschner³⁶, it is directly involved as a component of the biotin enzyme in the biosynthesis of fatty acids. In the present study manganese content in the year 2008 was 119.93 ppm and 678.98 ppm in the year 2009. Like iron and zinc, manganese content was also fluctuating. There are reports of Mn content from marine algae *S. tennerimum*. Zingde and Singbal³² estimated 223 ppm, Khemnar and Chaugule³⁰ reported 200 ppm Mn in the aforesaid species. The analysis of *E. intermedia* for Mn content shows that, Mn content is more than that obtained from marine algae.

Boron is essential for the growth of higher plants. The primary function of the element is to provide structural integrity to the cell wall in plants. Boron requirements vary among crop plants, the optimum boron content of the leaves for most crops is 20-100 ppm³⁷. It is evident from result that the boron content of *E. intermedia* was 172.48 ppm in the year 2008 and 149.60 ppm in the year 2009. However, Rao²⁰ reported an average of 90 ppm of boron content in Indian seaweeds. Results of the present study indicate high values of boron in *E. intermedia*. It is higher than optimum requirement but plant does not show any kind of toxicity.

CONCLUSION:

It can be concluded from result that *E. intermedia* alga has having powerful mineral uptake potential. Higher level, of zinc in *E. intermedia* indicates its tolerance capacity for any kind of environmental stress and also indicates that this species may act as antioxidant therefore this alga may have high medicinal potential properties against many pathogens. While the high amount of iron and calcium content in *E. intermedia* indicates its usefulness for edible purpose and for preparation of iron and calcium tablets.



Plate I. Collection Site near the entrance of the river in the township



Plate II. *E. intermedia* algal colony and its Filamentous thallus

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