World Journal of Dairy & Food Sciences 4 (1): 46-55, 2009
ISSN 1817-308X

Element Composition of Certain Seaweeds from Gulf of Mannar Marine Biosphere Reserve; Southeast Coast of India

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Abstract: The present study focus the element concentration of various seaweeds such as Chlorophyceae (*Codium tomentosum, Enteromorpha clathrata, Enteromorpha compressa*) Phaeophyceae (*Turbinaria conoides, Colpomenia sinuosa, Sargassum tenerimum, Sargassum wightii*) and Rhodophyceae (*Acanthophora spicifera*) were collected from Gulf of Mannar marine biosphere reserve; Southeast coast of India. The *S. wightii* showed the highest level of element composition such as chromium, copper, manganese, nickel, lead and zinc content than other seaweeds. *A. spicifera* recorded the lowest level of element content such as chromium, copper, lead and zinc.

Key Words: Different group seaweeds · Chlorophyceae · Phaeophyceae · Rhodophyceae and Element composition · Gulf of Mannar marine biosphere reserve

INTRODUCTION

Seaweeds are traditionally consumed in the orient as part of the daily diet. Currently, human consumption of green algae (5%), brown algae (66.5%) and red algae (33%) is high in Asia, mainly Japan, China and Korea [1]. However demand for seaweed as food has now also extended to North America, South America and Europe. The different species consumed present a great nutritional value as source of proteins, carbohydrates, minerals and vitamins.

Among the major edible seaweeds of the red algae types are *Porphyra*, *Palmaria*, *Gracilaria*, *Gelidium* and *Eucheuma* [2]. Red algae such as *Gracilaria* which mainly serve as a raw material from which agar or carrageenan are extracted out for use in the food industries or in the production of tissue culture media [3, 4]. Reports on certain edible seaweed showed that many contain significant amounts of protein [5-7]. Fresh and dried seaweeds are extensively consumed especially by people living in the coastal areas.

Depending on the type of species, seaweed is generally suitable for making cool, gelatinous dishes or concoctions. The nutrients composition of seaweed varies and is affected by species, geographic area, season of the year and temperature of water. These sea-vegetables are of nutritional interest as they are low caloric food, but rich in vitamins, minerals and dietary fibres [8]. Seaweed as a food in Malaysia is not as common as in countries like Japan and China. About 25% of all food consumed in Japan consists of seaweed prepared and served in many forms and has become the main source of income for the fishermen there. However, at present this seaweed is only consumed in certain coastal areas especially along the east coast of Peninsula Malaysia and in East Malaysia, where it is occasionally eaten as a salad dish.

Solimabi *et al*. [9] studied the seasonal changes in biochemical constitutions namely carbohydrate, protein and sulphate of *Hypnea musciformis* from Goa coast. Total lipid, sterol and chlorophyll contents of *Enteromorpha intestinalis*, *Caulerpa taxifolia*, *Gelidiella acerosa*, *Gracilaria corticata* and *Padina gymnospora* were estimated by Parekh *et al*. [10]. The vitamin and mineral contents of edible seaweeds make them nutritionally valuable [11, 12]. Biochemical investigation on protein, nucleic acids, distribution of amino acids, fats and lipids, carbohydrates, fatty acids, sterols, acrylic acid, crude fibre, pigments and carotenoids and inorganic elements of green alga, *Enteromorpha* from Okha have been reported by Parekh *et al*. [13]. Twenty-nine genera comprising forty-two species of red algae of Gujarat coast were analyzed for protein content by Dave *et al*. [14]. Much work has been done on algal fatty acids both micro algae as well as on the fatty acid composition of seaweeds [15-18].

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Seaweeds are potentially good sources of minerals, proteins, polysaccharides and fibre [19, 20]. Studies on the biochemical constituents such as protein, carbohydrate and lipid in green and brown marine algae have been carried out from different parts of Indian coast [21-32]. Selvaraj and Sivakumar [33] made an attempt on biochemical studies of protein, amino acids, carbohydrate and iodine on three species like *Sargassum ilicifolium, S. liniarifolium* and *S. polycystum*. Reeta Jayasankar [34] studied the seasonal variation in chemical constituents of *S. wightii* with reference to alginic acid content has been reported. Amino acids in free and combined state have been quantitatively estimated in three species of green algae viz., *Halimeda tuna*, *Spongomorpha indica* and *Udotea indica* collected from Okha Port by Dave and Parekh [35]. Some biochemical investigations on economically important species have been carried out [36-39].

Reports on certain edible seaweeds showed that many contain significant amount of protein, vitamins and minerals which are essential for human nutrition [5-7]. Fresh and dried seaweeds are extensively consumed especially by people living in the coastal areas. Studies on biochemical composition of seaweeds have been reported by Guerin and Bird [40] and Hurtado-Ponce and Umezaki [41].

The high vitamin and mineral contents of edible seaweeds make them nutritionally valuable [11, 12]. In addition to vitamins and mineral nutrients, seaweeds are also potentially good sources of proteins, polysaccharides and fiber [19, 20]. Although the chemical content of edible seaweeds from some regions of the world had been documented, research is long overdue on the nutritive value of Hawaiian seaweeds so commonly collected, bought, sold, cultivated and consumed in the Hawaiian Islands. Reed [42] reported the chemical composition (water, protein, fat, carbohydrates, ash and calories) of three genera of Hawaiian algae: *Ulva* and *Gracilaria*. Most studies on nutritional evaluation were carried out from naturally collected seaweeds from many parts of the world. The present investigation concentrated on trace element composition of different species of seaweeds from Mandapam regions (Gulf of Mannar marine biosphere reserve) along southeast coast of India.

MATERIALS AND METHODS

Collection and Processing of Seaweeds: The various group of marine macroalgae (or) seaweeds such as Chlorophyceae members (*Codium tomentosum, Enteromorpha clathrata, Enteromorpha compr*essa) Phaeophyceae members (*Turbinaria conoides, Colpomenia sinuosa, Sargassum tenerrimum, Sargassum wightii*) and Rhophyceae member (*Acanthophora spicifera*) collected from Mandapam coastal regions (Gulf of Mannar marine biosphere reserve) along southeast coast of India. The seaweeds were hand picked or collected with the help of scalpel and immediately cleaned with seawater to remove foreign particles, sand and epiphytes. Then the seaweed was kept in an ice box containing slush ice and immediately transported to the laboratory and cleaned thoroughly using tap water to remove the salt on the surface of the sample. Then it was spread on blotting paper to remove excess amount of water.

Iron, Copper and Phosphorus: Iron, Copper and Phosphorus were analysed by [43]. The tissue samples were stored in an precleaned polythene containers and aspirated in an Inductively Coupled Plasma spectrophotometer (ICP) (PERKIN ELMER, Optical Emission Spectrometer, Optima 2100 DV) after calibrating the instrument with appropriate blank and series of known standards for the minerals iron, copper and phosphorus.

Calcium, Potassium and Sodium: Calcium, Potassium and Sodium were estimated by [44]. To 5g of wet tissue samples, mixture of hydrochloric acid, nitric acid and perchloric acid (HCl, HNO_3, $HCLO_4$) at a ratio of 10:5:1 was added for digesstion at 300°C. The digests were filtered suitably and aspirated in digital flame photometer (Burner Unit 121, Digital Unit 125 and Compressor Unit 122). The obtained values were expressed in mg/100g.

RESULT

There are 8 species of seaweeds which includes 3 species (*Codium tomentosum*, *Enteromorpha clathrata, Enteromorpha compressa*) from Chlorophyceaean member; 4 species (*Turbinaria conoides*, *Colpomenia sinuosa, Sargassum tenerimum, Sargassum wightii* and) from Phaeophycean members and 1 species (*Acanthophora spicifera*) from Rhodophyceae collected from Mandapam coastal regions (Gulf of Mannar marine biosphere reserve) southeast coast of India for element analysis. In that cadmium showed the maximum level from brown alga *S. wightii* (0.082 ± 0.004 ppm) and the minimum level was attained the same brown alga *C. sinuosa* (0.0073 ± 0.001 ppm) Fig.1. Cobalt content was ranged from 0.007 ± 0.002 ppm to 0.28 ± 0.003 ppm;

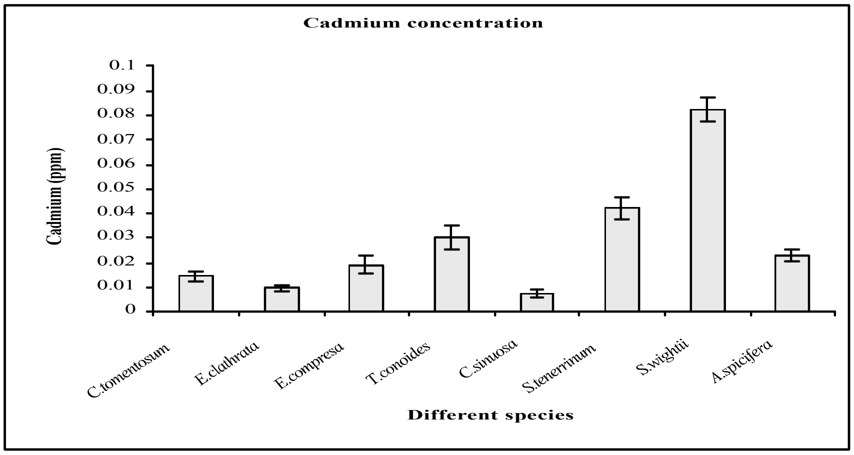

Fig. 1. Shows the Cadmium concentration of different seaweeds

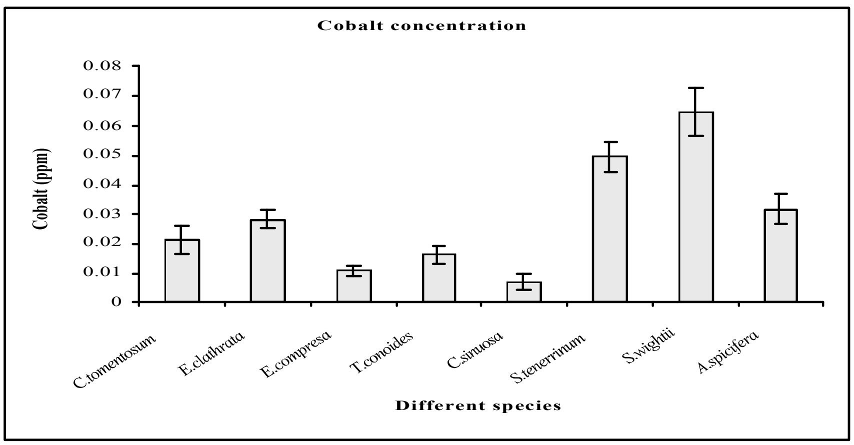

Fig. 2. Shows the Cobalt concentration of different seaweeds

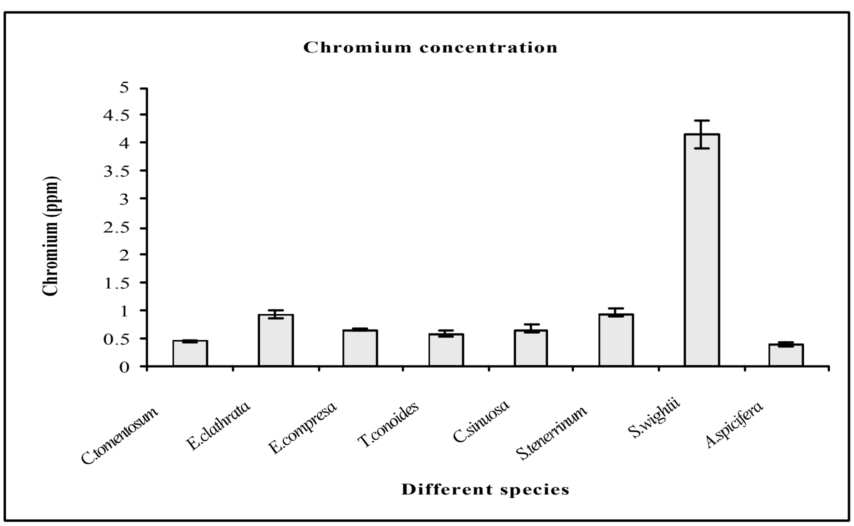

Fig. 3. Shows the Chromium concentration of different seaweeds

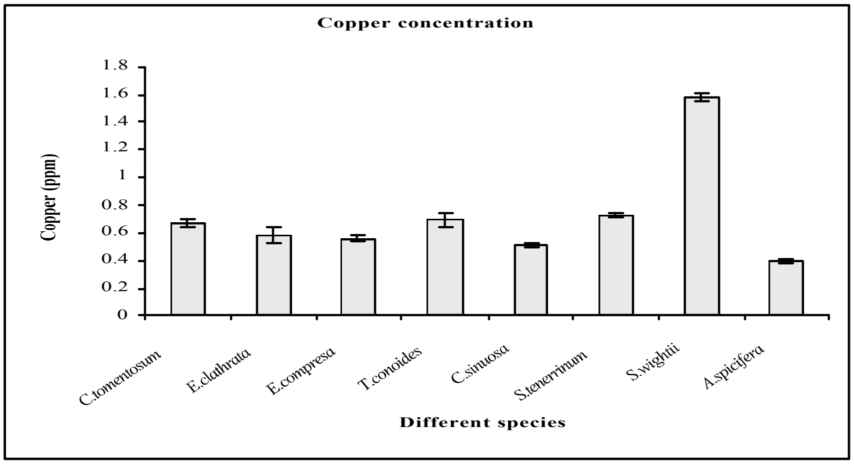

Fig. 4. Shows the Copper concentration of different seaweeds

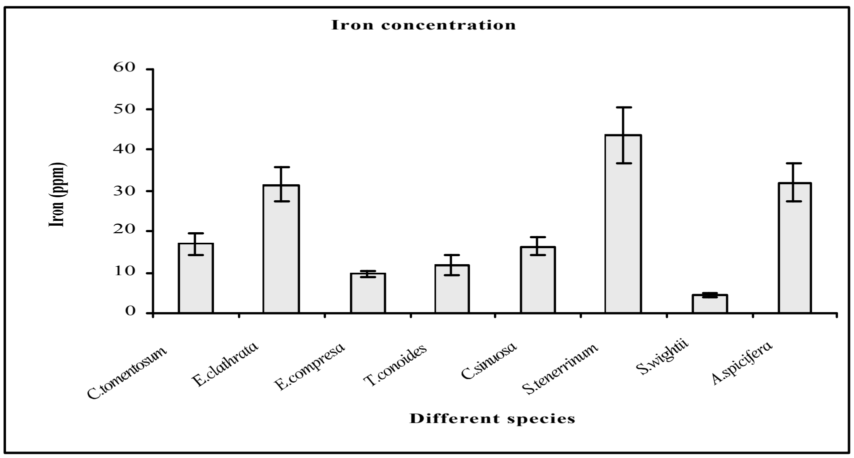

Fig. 5. Shows the Iron concentration of different seaweeds

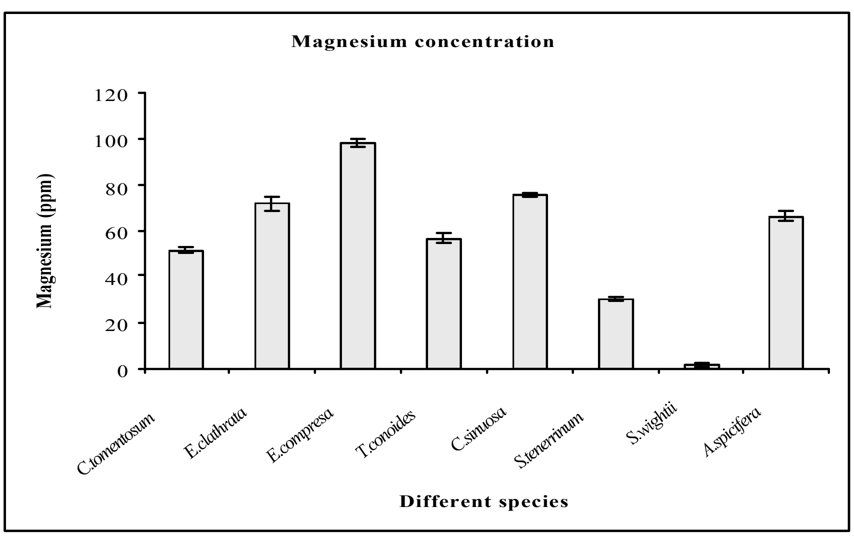

Fig. 6. Shows the Magnesium concentration of different seaweeds

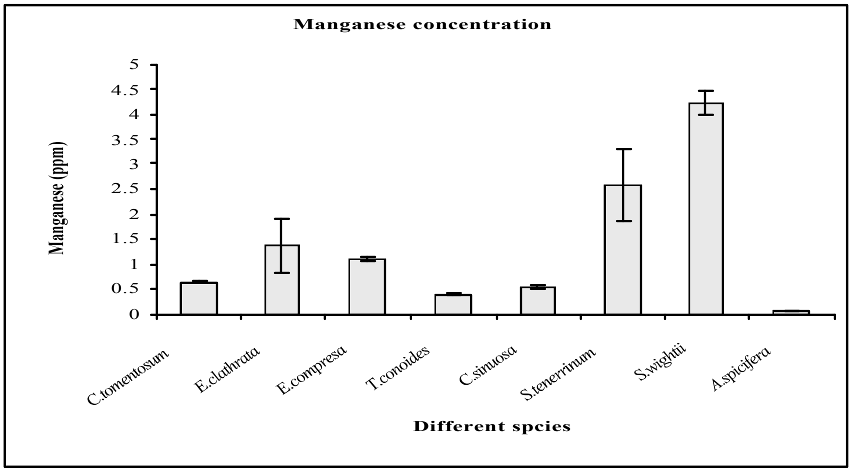

Fig. 7. Shows the Manganese concentration of different seaweeds

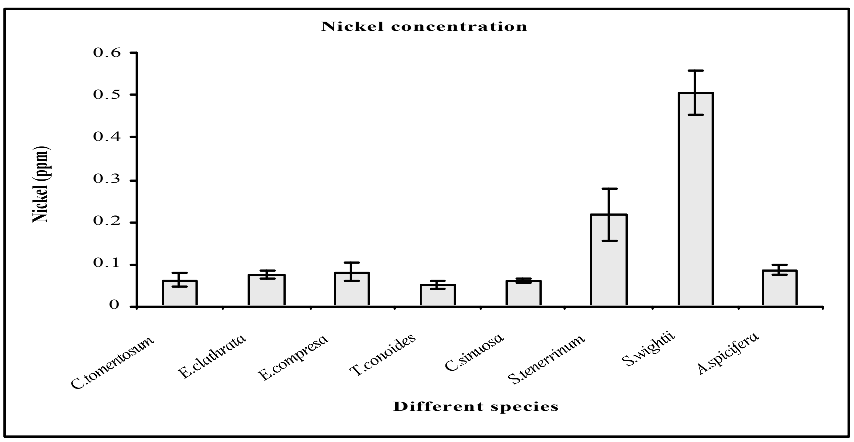

Fig. 8. Shows the Nickel concentration of different seaweeds

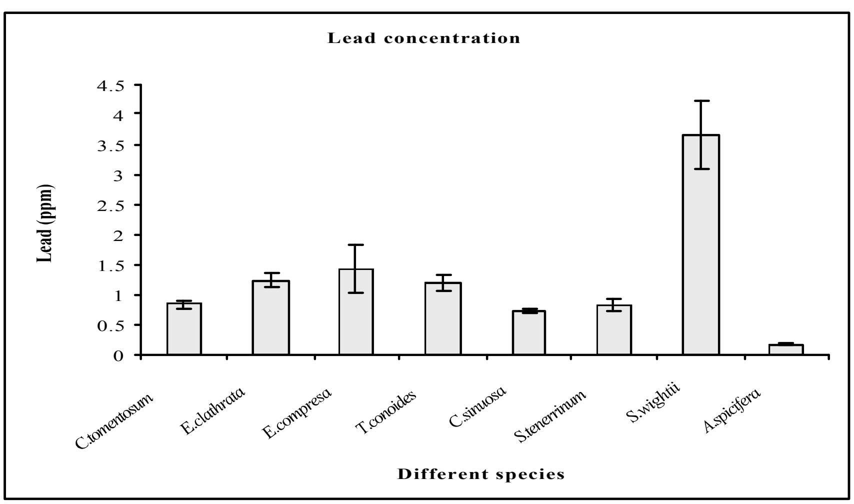

Fig. 9. Shows the Lead concentration of different seaweeds

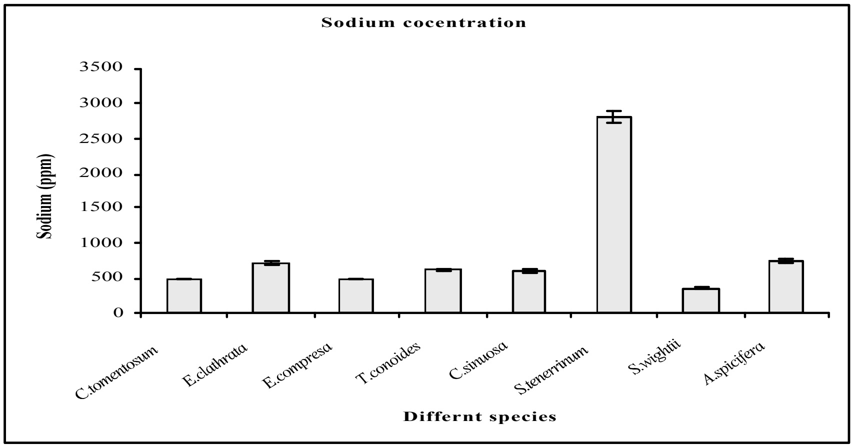

Fig. 10. Shows the Sodium concentration of different seaweeds

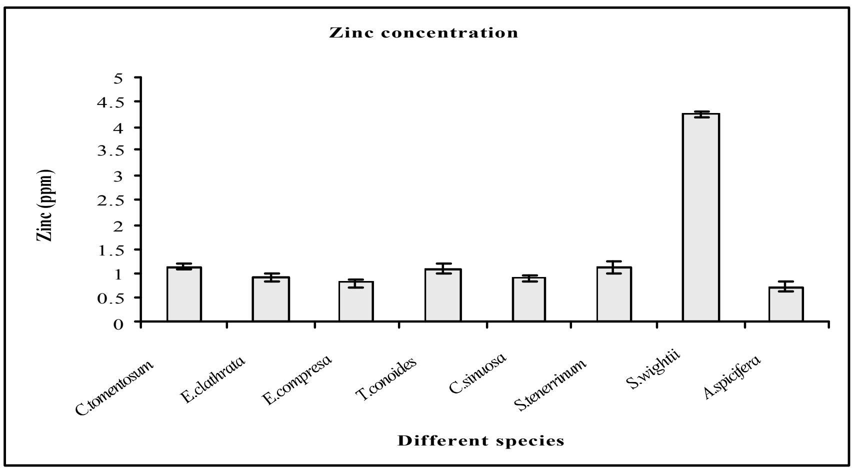

Fig. 11. Shows the Zinc concentration of different seaweeds

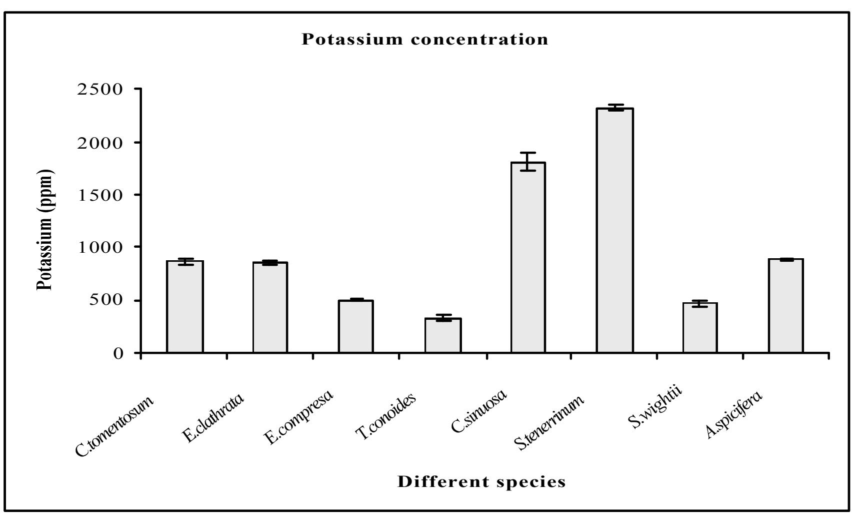

Fig. 12. Shows the Potassium concentration of different seaweeds

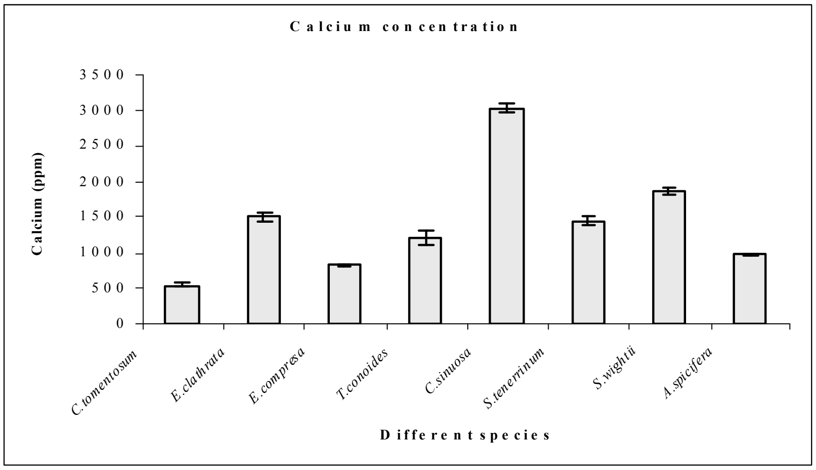

Fig. 13: Shows the Calcium concentration of different seaweeds

here the maximum content was recorded from Chlorophycean member *E. clathrata* and minimum level of element concentration obtained Phaeophycean member of *C. sinuosa* Fig.2.

The chromium content was varied from (0.38 ± 0.02; 4.16 ± 0.28 ppm); in that the higher level of concentration was obtained 4.16 ± 0.28 ppm from brown seaweed *S. wightii* and the lower content was attained from Rhodophycean member *A. spicifera* (0.38 ± 0.02 ppm) Fig.3. Copper level was attained maximum at brown seaweed *S. wightii* (1.51 ± 0.03 ppm) and the minimum level was observed from red alga *A. spicifera* (0.39 ± 0.01 ppm) Fig.4.

Iron content was observed the highest level from brown alga *S. tenerrimum* (43.86 ± 6.94 ppm) and the lowest level were obtained from the same brown algal species *S. wightii* (4.30 ± 0.36 ppm) Fig.5. The magnesium concentration was ranged from 1.43±0.47; 98.1±1.86 ppm; here the highest level of magnesium element concentration was observed from green alga *E. compressa* (98.1 ± 1.86 ppm) and minimum level was attained at brown seaweed *S. wightii* (1.43 ± 0.47 ppm) Fig.6.

Manganese level was varied from (0.40±0.09; 4.21±0.23 ppm); in that the maximum level was recorded (4.21±0.23 ppm) from Phaeophycean member *S. wightii* and the minimum level was observed at the same Phaeophycean member *T. conoides* (0.40±0.09 ppm) Fig.7. Nickel concentration was recorded maximum from brown seaweed *S. wightii* (0.503 ± 0.052 ppm) and the minimum level was observed at the same brown seaweed *T. conoides* (0.05 ± 0.008 ppm) Fig.8.

Lead content was varied from (0.15±0.02; 3.66±0.58 ppm); in that the maximum level was obtained (3.66±0.58 ppm) from Phaeophycean member of *S. wightii* and the minimum level of concentration was recorded from Rhodophycean member *A. spicifera* (0.159 ± 0.036 ppm) Fig.9. Zinc content was attained the maximum level from Phaeophycean member *S. wightii* (4.23 ± 0.05 ppm) and the lowest level was observed at brown from Rhodophycean member *A. spicifera* (0.74±0.09 ppm) Fig. 10.

The sodium content was varied from (360.6±22.3; 2813.3±102.63ppm); in that the highest level was obtained (2813.3±102.63ppm) from Phaeophycean member *S. tenerimum* and the lowest content was recorded from the same Phaeophycean member *S. wightii* (360.6±22.3 ppm) Fig. 11. Potassium was attained the maximum level from brown alga *S. tenerimum* (2330±30 ppm) and the lowest level were observed from the brown alga *S. wightii* (470±20 ppm) Fig. 12. The calcium content was ranged from (550±26.45; 3030±25.16 ppm); the maximum level of calcium was obtained from Phaeophycean member *C. sinuosa* (3030±25.16 ppm) and the lowest content was recorded from Chlorophycean member of *C. tomentosum* (550±26.45 ppm) Fig.13.

DISCUSSION

Seaweeds are known as an excellent source of vitamins and minerals, especially sodium and iodine, due to their high polysaccharide content which could also imply a high level of soluble and insoluble dietary fiber [19]. Marked changes in the chemical constituents were found to occur with change of seasons, environmental conditions as well as in the various phases of plants growth and fruiting cycle. Pillai [45-47] studied the seasonal variation in the major and minor constituents of green, brown and red algae. The present investigation only concentrate on element composition of seaweeds in species level and it is entirely different from earlier studies.

Parekh *et al*. [48] studied the chemical composition of 27 species of green seaweeds of Saurashtra coast. The biochemical contents of *Ulva lactuca, Sargassum swartzii* and *Gelidiella acerosa* from Port Okha were studied in relation to ecological factors by Murthy and Radia [49] presented the month-wise protein, fat, carbohydrate, crude-fibre, sodium, potassium, calcium and phosphorous contents of these species. Dhargalkar [50] estimated the major metabolites such as proteins, carbohydrates and lipids. Seasonal variations in biochemical composition of some seaweed from Goa coast was followed by Sumitra Vijayaragavan *et al*. [23]. Dhargalkar *et al*. [51] estimated protein, carbohydrate and organic carbon in 43 marine algal species from different stations along the Maharashtra coast Muthuraman and Ranganathan [52] selected six species of marine macro algae viz., *Caulerpa scalpelliformis, Cladophora vagabunda, Enteromorpha compressa, Halimeda macroloba, Ulva fasciata* and *Chaetomorpha antennina* to investigate protein, aminoacids, total sugars and lipid contents. Venkatesalu *et al*. [53] investigated fatty acid composition in *Ulva lactuca, Caulerpa chemnitzia, Padina tetrastromatica, Sargassum longifolium, Acanthophora spicifera* and *Gelidium micropterum* collected from Rameswaram coast; here the present study investigate element composition of seaweeds from Gulf of Mannar marine biosphere reserve.

Elizabete Barbarino and Sergio Lourenco [54] made different protocol for extraction of protein from macroalgae (*Aglaothamnion uruguayense, Caulerpa fastigiata, Chnoospora minima, Codium decorticatum, Dictyota menstrualis, Padina gymnospora* and *Pterocladiella capillacea*) from Rasa beach. These findings revealed that biochemical constituents of algae varied independently of one another. The previous study was supportive to our present study; here the element composition of seaweeds varied one another.

Pillai [55] during the course of chemical studies on marine algae carried out in Central Marine Fisheries Research Institute, observed that in *Gracilaria lichenodes* there were 60-90 % of minerals and a good amount of sulphur, nitrogenous matter and carbohydrate occurring in water soluble from and these compounds, which come as impurities while extracting agar, could be removed by pulverising, soaking and washing the seaweed.

Mineral content are shown to vary according to species, wave exposure, seasonal, annual, environmental and physiological factors and the type of processing and method of mineralization [56-60]. Sulphate seems to be a typical component of marine algal polysaccharides, related to high salt concentration in the environment and to specific aspects of ionic regulation. Sulphate is derived from fucans in brown algae or from galactans in red ones. Such sulphated mucilages are not found in land plants [61]. Based on the results obtained in the present study element composition was varied with genus and species level. Although the results of element composition analysis had demonstrated that can be potentially good; more study is necessary to evaluate the nutritional value of this seaweed as food ingredients.

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