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 (Dawes, 1998). However demand for seaweed as food has now also extended to North America, South Africa and Europe. (MuHugh, 2003). The different species consumed at present have a great nutritional value as source of proteins, carbohydrates, minerals and vitamins.

The natural products of seaweed and other marine organisms represent one of the new frontiers in the exploration for bioactive compounds. India is sitting on a gold mine of well-recorded and well-practiced knowledge of traditional herbal medicine. India is one of the 12 leading bio-diversity centers with the presence of over 45,000 different plant species. From this flora 15,000 to 20,000 have good medicinal values (Kamboj, 2000). Amongst all of these herbal alternatives, algae, especially marine algae, are least explored for their medicinal properties. The identification of bioactive compounds present in marine algae is a new potential area (Rizvi et al., 2013). Seaweeds or macroalgae belong to the lower plants, meaning that they do not have roots, stems and leaves. Instead they are composed of a thallus (leaf-like) and sometimes a stem and a foot. Some species have gas-filled structures to provide buoyancy. They are subdivided in three groups, the red, green and brown macroalgae (Luning and Pang, 2003).

Manivannan (Thivy, 1960) reported the mineral composition of different group seaweeds such as chlorophyceae (Ulvalactuca, Enteromorpha intestinalis) phaeophyceae (Turbinaria ornate, padina gymnospora) Rhodophyceae (Hypnae valentiae, Gracilaria folifera) from mandapam coastal regions, and they found that padina gymnospora showed the maximum content of mineral composition such as copper, chromium, iron lead sulphur and calcium content and potassium than other seaweeds. Minerals are very important for the biochemical reaction in the body as a cofactor of enzymes. For examples, ca, p and mg build and maintain balance of water, acids and bases in fluids outside cells an involve in acid base balance and transfer of nutrients in and out of individual cells, respectively (Ensminger et al., 1995).

Defects in mineral are capable of producing severe impairment of health. For instance, Ca malnutrition causes abnormal bone formation, namely osteoporosis and anaemia caused from Fe deficiency. Deficiency in Mg can
result in a variety of metabolic abnormalities, such as K depletion and clinical presentations (Reinhold, 1998).

Seaweeds are known as an excellent sources 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 fibre (Lahaye, 1991). Mineral content is generally high (8-10%) and the essential minerals and trace elements needed for human nutrition are present in seaweed (Mabeau and Fleurence, 1999, Fleurence, 1999 and Ruperz et. al., 2001). This wide range in mineral content, not found in edible land plants, its related to factors such as seaweed phylum, geographical origin and seasonal, and environmental and physiological variations. Seaweeds mineral content is higher than that of land and animal products. In most land vegetables, ash content ranges from 5 to 10g/100g dry wt (USDA, 2001). Sweet corn has a low content (2.6%) while spinach an exceptionally high mineral content (20.4%) for a land plant. Thus edible seaweeds may be an important source of minerals, since some of these trace elements are lacking of very minor inland vegetables.

Eating patterns of people all over the world have recently undergone marked changes, due to the globalization of markets along with innovation in food technology. The macrobiotic diet, which came to Europe from Japan, contributed to the introduction of sea vegetables in their staple diet. Fresh seaweeds have been used directly as food stuff in the Asian countries for centuries and are considered under-exploited resources (Chapman and Chapman, 1980). About 221 seaweeds are utilized commercially world-wide of which 65% are used for human food (Zemke White-and Ohno, 1999). Most recently seaweeds have been utilized in Japan as raw materials in the manufacture of many seaweed food products, such as jam, cheese, wine, tea, soup and noodles (Nisizawa et.al., 1987) and in Western countries, mainly as a source of polysaccharides (agar, alginates, carrageenans) for the food and pharmaceutical industries (Indegrarrd and Ostgarrd, 1991). Seaweeds are a rich source of minerals, especially macro and micronutrients necessary for human nutrition; however, the nutritional properties of seaweeds are usually determined from their biochemical composition alone viz., proteins, carbohydrates, vitamins, amino acids, etc., (Darcy –vrrillon, 1993; Mabeau and Fleurence, 1993). The mineral fraction of some seaweed even accounts for up to 40% of dry matter (Ortega- Calvo et al., 1993), however, in some cases the mineral content of the seaweeds is recorded even higher than that of land plants and animals products (Ito and Hori, 1989). Consumption of seaweeds can increase the intake of dietary fiber an lower the occurrence of some chronic diseases (diabetes, obesity, heart diseases, cancers, etc.) which are associated with low fiber diets of the Western countries (Southgate, 1990).

**MATERIALS AND METHODS**

**COLLECTION AND IDENTIFICATION OF SEAWEED**

Red seaweed such as Acanthophora deliei, Scinaia furcellata, Porphyra tenera, Gracilaria verrucosa and Hypnea species were collected from the Pamban, Mandapam coastal region of India were belonged to red (Rhodophyceae). Further, it was washed thoroughly, kept for overnight to remove dirt and unnecessary material. Then it was subjected for shade drying then prepared into samples to preserve its phytochemical properties. Since, this particular seaweed type is very common in Mandapam coastal area; the collected seaweed sample was authenticated by a local commercial seaweed based organization.

**SAMPLING**

The seaweeds’ samples were picked with hand and immediately washed with seawater to remove the foreign particles, sand particles and epiphytes. Then it was kept in an ice box and immediately transported to the laboratory and washed thoroughly with tap water to remove the salt on the surface of the sample. After that, the samples were identified by species (Riedel 1970; Aleem 1993). They were spread on blotting paper to remove excess water. The dry air samples were placed in an oven at 50°C and water content was calculated. Pulverized in the grinder and sieved through a screen with an aperture of 0.5 mm. Then, the powdered material was kept in airtight plastic bottles at room temperature until analysis.

**MINERAL AND HEAVY METAL ANALYSIS IN RED SEAWEEDS**

Calcium was determined by titration method after digestion with acid Maiti (2003) whereas potassium and sodium was measured by flame photometer. Chloride and sulphur were determined by silver nitrate and barium chloride method respectively (APHA 1998). Total Phosphorus, magnesium, Manganese, Iron, copper, zinc, boron, iodine were determined by colorimetric or spectrophotometer. Leads, nickel, cobalt, chromium, aluminium, cadmium were analyzed by of Atomic Absorption of photometer method. All determinations were performed in triplicate and data represented on dry weight basis on mean values.

**STATISTICAL ANALYSIS**

All determinations were performed at least in triplicate. Statistical analysis was carried out by using the SPSS 10.0 version software for Windows. The analyzed data were expressed as mean with standard deviation (SD).

**RESULT AND DISCUSSION MINERALS COMPOSITION**

The macromolecules such Sodium (Na), Calcium (Ca), Potassium (K) and Magnesium (Mg) are among the minerals which are present in significant amounts in marine algae (Nisizawa, 2006). The mineral and trace element composition of the selected five seaweeds are given in the following table .1. Manivannan et al. (2009) reported the mineral composition of different group of seaweeds such as Chlorophyceae (ulva lactuca, Enteromorpha intitaliens) Phaeophyceae (Turbinaria ornate, Padina gymnospora) and Rhodophyceae (Hypnea valentiae,Gracilaria foliftera)from mandapam coastal regions, and they found that Padina gymnospora showed the maximum content of mineral composition such as copper, chromium, iron, lead sulphur and calcium content and potassium than other seaweeds.

Among the selected five seaweeds, Porphyra tenera contains high sodium (5.52g) than gacilaria verrucosa. Potassium content was high in gacilaria
verrucosa (6.36g). The Na/K ratio in the studied species ranged between 0.78 and 2.4, which is a favorable value and also agreed with the previous reports (Rupee`rez, 2002; Matanjun et al., 2009). Na, Cl, and K are responsible for the maintenance of body fluid balance, and the consumption of foods with a high Na level may relate to the risk of hypertension. Calcium content was ranged from 0.53 to 0.31g in all five seaweeds. Mac Artain et al. (2007) showed in his study that calcium was the most important element, and accumulated in seaweeds at much higher levels than in terrestrial foodstuffs. Mineral contents are shown to vary according to species, wave exposure, seasons, environmental factors, and physiological factors, type of processing and method of mineralization (Mabeau and Fleurence, 1993).

The result of five seaweeds shows that, magnesium, chloride and sulphate content was more in gracilaria verrucosa (0.93g, 4.21g and 2.57g). Regarding the results of trace elements present in five seaweeds, porphyra tenera contains high amount of iron content (62.5g) than scinaia farcellata (58.42g). The maximum Cu value was present in the Gracilaria verrucosa. Copper is an essential nutrient that plays an important role in the production of hemoglobin, myelin, collagen and melanin (Cobanoglu et al., 2010). According to PSSICA (2009) the dietary intake of copper should not exceed 12,000 mg/100 g for males and 10,000 mg/100 g for females. The levels of the detected elements fit within the ranges observed in previous reports on seaweeds (Mabeau and Fleurence, 1993; Rupee`rez, 2002). The levels of the detected elements fit within the ranges observed in previous reports on seaweeds (Mabeau and Fleurence, 1993; Rupee`rez, 2002).

More amount of Manganese was found in Acanthophora deliei (54.24) than Porphyra tenera (41.86). Porphyra tenera shows more amount of boron (3.35mg) than Scinaia farcellata (2.07mg) seaweed. Kannez et al. (2001) stated that magnesium in plant lowers the cholesterol level. Magnesium plays an important role in regulating muscular activity of heart rhythm and also magnesium is important cofactor of converting blood glucose into energy (Serfor et al., 2002). According to Zayed (2009) and Perry (1972), the presence of Cr and Mn in plants may be correlated with therapeutic properties against diabetic and cardiovascular diseases.

**COMPOSITION OF HEAVY METALS**

Many studies have been conducted to determine the toxic levels of heavy metals for certain plants, especially those metals considered as public health threats (Honkanen, 2005 and Plaza et al., 2008). At the low concentrations some of the heavy metals excite some biological processes, but at threshold concentration these become toxic. Being non-biodegradable, these metals accumulate at various tropic levels through food chain and can cause human health problems (Bocanegra et al., 2009).

During present research, Pb concentration in different red seaweed species decreased as following order: Scinaia farcellata > Acanthophora deliei > Porphyra sp.> Gracilaria verrucosa > Hypnea species. Among all species, Pb concentrations varied from 0.174 to 0.528 µg g dry wt. The concentrations of Pb found in hypnea species in this study showed higher compared to other species (Table 2). High levels of Pb in alga of study area could be attributed to combustion of fossil fuels and oil pollution.

All algal species showed approximately similar pattern of nickel levels: Gracilaria verrucosa > Scinaia farcellata > Hypnea species > Porphyra tenera > Acanthophora deliei.
low concentration can cause the physiological disturbance like protein, carbohydrate and pigment concentration. Copper is an essential micronutrient but when the concentration of copper will increase it will affect the photosynthesis and lead to depigmentation as well as it could be depressing the growth of algae. In the present study copper accumulation is very high among eight seaweeds and two seagrasses species. Rashida qari (2010) has reported that the red seaweed has more ability to uptake these metals (Fe, Mn, Cu, Ni, Zn, Cr & Pb) when compared to brown and green seaweeds. Seaweeds have regulated the uptake of these metals and hence it does not accumulate them to such a great extent.

CONCLUSION

According to the recent researches that always discover and explore seaweeds benefits this study concerned with the validity of different seaweeds species collected from south coastal region showed that the consumption of seaweed is sporadically seen near the coastal areas but was still underexploited. Seaweed products were used commercially but as a natural food the goodness of seaweeds have to be utilized. The research points out that seaweed contains substantial amount of essential minerals iron, calcium, phosphorus, zinc sodium, magnesium, manganese, potassium, boron, copper, iodine, chlorides and sulphate and less amount of heavy metal accumulations. As nature’s wealth seaweeds have to promote health.

REFERENCES

24. S.K.Maiti, Handbook of methods in Environmental studies Vol2: Air, Noise, Soil and overburden


Source of support: Nil; Conflict of interest: None declared