SEMINAR

ON

SEAWEED PRODUCTS AND THEIR APPLICATIONS

Chairman

Dr.S.BALASUNDARI. M.F.Sc, Ph.D

K.VIJAY

ID.NO. MFT15060(FPT)

Department of Fish Processing Technology

Fisheries College and Research Institute

Tamil Nadu Fisheries University

Thoothukudi-628 008

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INTRODUCTION:

Seaweeds are marine algae and primitive type of plants, growing abundantly in the shallow waters of sea, estuaries and backwaters of area up to certain depth where 0.1 % photosynthetic light is available (up to 118 m). We can find them attached to rocks in the intertidal zone, washed up on the beach and floating on the ocean`s surface. They can be very tiny or large quiet, growing up to 30 meters long. Presently, there are 42 countries in the world with reports of commercially exploitation of seaweeds. Among them, China holds first rank, followed by North Korea, South Korea, Japan, Philippines, Chile, Norway, Indonesia, USA and India. These top ten contributes up to 95 % of world`s commercial seaweed utilization (Khan et al., 2003). Human consumption of green algae (5 %), brown algae (66.5 %) and red algae (33 %) is higher in Asia, mainly in Japan, China and Korea. In Asian countries, seaweeds are often consumed as marine vegetables (Marinho Soriano et al., 2006). China and Japan are the two major seaweed harvesting countries, where more than 70 species of seaweeds are consumed as human food (Kumari, 2010). A total of about 400,000 tonnes of seaweed such as Porphyra (for Nori), Laminaria (for Kombu), Undaria (for Wakame) are harvested annually throughout the world (Braune et al., 2011).

DIVERSITY:

Worldwide:

More than 20,000 seaweeds are distributed throughout the world, of which only 221 (1.1 %) are commercially utilized, which includes 145 species for food and 110 species for phycocolloid production (Sahoo, 2000, Chennubhotla et al., 2013).

India:

Coastline of India is about 8118 km long. 844 seaweed species comprised of 68 families and 271 genera, which includes 217 Chlorphyta, 191 Phaeophyta and 434 Rhodophyta species (Oza et al., 2000).

- Seaweeds grow abundantly along the Indian coastline particularly in rocky shore regions rich seaweed beds occurs along Visakhapatnam in the eastern coast; Mahabalipuram, Gulf of Mannar, Tiruchendur, Tuticorin and Kerala in the southern coast; Veraval and Gulf of Kutch in the western coast; Andaman and Nicobar islands and Lakshadweep (Umamaheswara Rao, 1967; Silva et al., 1996; Sahoo, 2001)

Tamil Nadu:

Tamil Nadu having 302 species of seaweeds

India presently harvests only 22,000 tonnes of macro-algae annually compared to a potential harvest of 870,000 tonnes, a mere 2.5 per cent (NAAS, 2003).

AGAR:

A Japanese innkeeper discovered agar in the mid seventeenth century. Agar is a marine colloidal carbohydrate present in cell walls

of algae of the class Rhodophyta. Agar is defined as a gel forming substance soluble in hot water and requiring one percent solution to set as a gel on cooling (Humm. 1951) and (Yaphe., 1959). In 1882, Koch was first to use agar in microbiology. Agar produced by modern industrial freezing technique was initiated in 1921 in California, U.S.A by a Japanese person named Matsuoka. Two genera, *Gelidium* and *Gracilaria*, account for most of the raw materials used for the extraction of agar. Important and commonly occurring agarophytes of India are *Gelidiella acerosa, Gracilaria lichenoides, Gracilaria crassa, Gracilaria verrucosa, Gracilaria corticata and Gracilaria folifera* (Umamaheswara., 1970). Seaweed collection are mainly centered along southeastern coast of India from Rameswaram to Kanyakumari. There appeared to be 13 seaweed landing centers on the southeastern coast. The seaweed collections for agarophytes (*G. acerosa, G. edulis, G. crassa, G. foliifera and G. verrucosa*) from 240 to 1518 tons (dry weight). *Gracilaria* species were once considered unsuitable for agar production because the quality of the agar was poor (gel strength too low).

Applications:

- Used predominantly for its stabilizing and gelling characteristics
- It is mainly employed as a stabilizer in pie fillings, piping gels, icings, cookies, cream shells etc.
- Agar is useful in low-calorie breads or biscuits since they are non-nutritive, because it acts as bulking agent.
- They have low gel strength, high gelling temperature, high metal ion concentration and high sulphate contents

Bacteriological agar: Bacteriological grad agar is used in clinical applications, auxotrophic studies, bacterial and yeast formation studies, bacterial molecular genetics applications as well as in mammalian and plant tissue cultures.

Recent works: One of the recent developments is the use of alginates in restructured meat products like shrimp or crab meat products and also for making structured fruit products (Chandini et al., 2008).

Recent new applications of agar harness and its viscosity enhancing property and hydrophilicity in micro fluidic and visible image receiving devices.

ALGINATES:

Alginic acid is a polyuronide found in the cell walls of brown marine algae (Kappanna et al., 1962; Stella, 2003). Indian small scale industries utilize 30 – 35 % of seaweeds for producing about 360 to 540 metric tonnes of alginates (Vinod., 2014). The various salts of alginic acid are termed ‘alginates’ (for example. Sodium alginate, calcium alginate etc.). Alginic acid and its salts with divalent and trivalent metal ions are generally insoluble in water, while alkali metal salts are water soluble.

Applications:

Food technology:

- Alginates improve the baking properties and they are constituent of baking emulsions.

- Alginates are used to make sugar glazings, egg, fruit and other cream fillings and in confectionery for making imitation fruits. Jelly products are made with water, insoluble alginates (calcium alginates).
- Alginates are suggested as a gelating agent in marmalades and jams (Thivy., 1958)

Dairy products:

- Cheese, creams, milk shake mixed in chocolates, puddings, cold prepared pudding powder, soft cheese and custards.
- Stabilizer in milk mixes

Textiles:

- Sodium alginate and other salts are used in manufacture of synthetic fiber for certain textiles.

Medicine:

- Alginate gauze is used as a blood stopping creams
- In dental technology, alginates are used for making denture moldings as well as denture fixative

Pharmaceutical:

- Used as emulsifiers in watery emulsions with fats, oils and waxes, as fillers in the manufacture of tablets, pills and as base of any ointments.

CARRAGEENAN

It differs from agar mainly in its higher sulpahted fraction and higher ash content. The backbone of the carrageenan polymer consists of 1,3 and 1,4 linked D- galactopyranose units which vary in the degree and location of sulpahted esterification. Carrageenan is a sulphated galactan polymer obtained from various red seaweeds belonging to the families Gigartinaceae, Solieriaceae and Hypneaceae. The food sector accounts for nearly 70 % of world market for carrageenan.

Food:

- In food industry, carrageenan finds its use in bakery, confectionery and for culinary purposes especially in the preparation of condiment products, syrups, whipped creams, ice disserts, cheese etc.
- Carrageenan is used for clarification of beer, fruit juices and other beverages.
- Carrageenan improves the quality of wheat flour in spaghetti and parotta making.

Pharmaceutical:

- Used in emulsifiers in cod liver oil and emulsions as granulation and binding agents to tablets, elixirs, cough syrups etc.
- Used in ulcer therapy and for diseases of blood vessels.

Cosmetics:

- In cosmetics, carrageenan is applied as stabilizer and thickening agents in tooth paste, skin ointments and solid air fresheners.

Textile industry:

- In textile industry, hot water extracts of carrageenan is used in printing designs with dye and acts as finishing and sizing agents.

Paint:

- Used sometimes in paint manufacturing as stabilizer for pigments.
- They are also good as film-forming agents.

FERTILIZERS

Seaweed liquid fertilizer (SLF) contained macro nutrient, trace elements, organic substances like amino acids and plant growth regulators such as auxin, cytokinin and gibberellins. SLF enhanced the water retention capacity of soil. Increase crop yield, improves growth and induces resistance to frost, fungal and insect attack and increases nutrient uptake from soil. Seaweeds were increasingly used in the industrial, scientific, chemical plant fertilizer and as live stock feed supplements (Druehl, 2000). The use of seaweeds as manure in farming practice is very ancient and was prevalent among the Romans and seaweed extracts are also practiced in Britain, France, Spain, Japan and China. *Sargassum* was use in coastal Kerala for coconut plantation. They contain high amount of water soluble potash and other minerals which are readily absorbed by plants. More than

15 million tones of seaweed products are used annually as nutrient supplements and bio-stimulants in agriculture and horticultural crop production (FAO, 2006).

Preparation of SLF:

- One kg of seaweed was cut into small pieces and autoclaved for 1hour and the hot extracts were filtered through a double-layered cheese cloth and allowed to cool at room temperature
- The filtrate was then centrifuged at 10,000 rpm for 30 minutes at 4^0 C and the resulting supernatant was taken as 100 % seaweed extract and was stored in refrigerator for further studies

FEED

Because of the presence of vitamins, minerals and trace elements in significant amounts, health of the domestic animals is improved when seaweed meal is added to the daily rations. Washed and dried weeds of *Gracilaria, Hypnea, Sargassum* and *Turbinaria* are useful for the preparation of seaweed meal. The residue obtained from agar preparation can be used as feed for cattle and poultry.

FUEL GAS

A mixture of about six micro-organisms mostly derived from marine environments can be used as digesters. Addition of indole acetic acid stimulated anaerobic digesters. Salinity of the liquid above 20 % was stated to be detrimental to production of fuel gas (Chennubhotla et al., 1987).

MEDICINE

Several seaweed species have economic importance as food for humans, as industrial material and as ingredient in traditional medicine (Hong et al., 2007). More than 600 secondary metabolites belonging to the categories of terpenes, alkaloids, fatty acids and nitrogenous compounds have been isolated from marine algae. Many of these compounds are therapeutically active and have been exclusively studied using laboratory and pharmacological assays. Species of *Sargassum* were used for cooling and blood cleaning effect. They contain sargalin, a blood sugar reducing agent. *Hypnea musciformis* is employed as vermifuge and *Centroceras clauulatum* as cathartic agent. Seaweeds rich in iodine such as *Asparagopsis taxiformis* and *Sarconema furcellatum* can be used to check goiter disease. Several red algae including *Gracilaria* and *Gelidium* have been used to treat various stomach and intestinal disorders. The stripes of *Laminaria cloustoni* have been used to aid in child birth by distending the uterus during labour.

FOOD PRODUCTS

The most important food species in Japan are nori, kombu and wakame. The mean intake of seaweed in Japanese diet has been reported to be approximately 7 g/person/day (CFSAN, 2003). 100,000 tonnes of seaweeds are eaten annually in Japan in the name of nori, kombu (konbu) and wakame. Seaweeds are rich in proteins, vitamins, amino acids, growth hormones, minerals and other trace elements.

Nori:

- Nori is prepared by harvesting *Porphyra,* pounded washed with water, drained, chopped and finally mixed with freshwater before being spread on bamboo mats for drying.
- When dried thin sheets of nori are obtained, these are pressed flat, stored, bundled and packed for marketing.
- Nori is used as a flavouring agent in soup, sauces and broths or even soaked in soybean sauce and eaten with boiled rice.

Kombu:

- After harvesting and drying, *Laminaria* is separated from the stripe and holdfast for quality and sent to kombu factories
- Kombu processing involves boiling the kelp in a green aniline dye solution, air drying, compressing in frames and then cutting into blocks which are shredded.
- Kombu is used as soup stock, boiled vegetables, snack or seasoning for rice dishes (as curry leaves are used in India).

Wakame:

- Wakame has become more popular in recent times
- *Undaria* is processed as wakame by washing, desalting and drying.
- Desalting is achieved by boiling with water.
- Wakame is popularly known in the forms of roasted or sugar candied products.

Salad:

- The following seaweeds are used for making salads either singly or in combination of two or three seaweeds.

- Fresh seaweeds are cleaned of sand, debris, attached stones etc. and then washed in freshwater. Chopped tomatoes, carrot, onion, chilli and ginger are added and mixed. Salt is added to taste.
- *Caulerpa racemosa, C. sertularioides, Codium spp, Gracilaria verrucosa, G. eucheumoides, Hydroclathrus clathratus, Laurencia papilosa* and *Porphyra spp.*

Seaweed masala:

- Cut onion and green seaweed (*Ulva lactuca*) into pieces and garnish them in low fire with oil, mustard and cuny leaves. When about to turn grey, add chilli powder, coriander powder, turmeric powder, salt, ginger and tomato pieces and mix well. It can be eaten with rice and chapattis.

Seaweed pickle:

- Take cleaned fresh seaweed (*Gracilaria edulis*) and remove moisture with cloth.
- Cut into small pieces.
- Soak in vinegar for 2 days.
- Remove from vinegar; add gingelly oil, chilli powder, mustard and fenugreek powder.
- Season with asafetida.
- Add peeled garlic.
- Mix thoroughly and bottle.

Seaweed wafer:

- Boil cleaned dried seaweed (*Gracilaria edulis*) in water.

- Filter through organdy cloth.
- Add rice paste, chilli paste and asafetida powder.
- Add gingelly seed and cumin seed and mix well.
- Cook together.
- Dry the paste in open sun in small lumps on cloth.
- Stored in air tight jar before serving fried in oil.

Seaweed porridge:

- Boil dried cleaned seaweed (*Gracilaria edulis*) in water for 20 minutes.
- Grind it into a fine paste.
- Boil the paste in water.
- Add sugar and milk and mix thoroughly.
- Add cashew nut raisins and cardomon.
- Serve hot.

Seaweed jelly:

- Boil cleaned and dried seaweed (*Gracilaria edulis)* in water for 45 minutes.
- Stir frequently.
- Filter through organdy cloth into vessel.
- Add sugar, lime juice, food essence and food colour to taste in hot condition.
- Mix thoroughly.
- Pour in an enamel or stainless steel tray.
- Allow to set.
- Refrigerate for a minimum of 30 minutes.
- Cut into pieces and serve.

Seaweed jam:

- Prepare sugar syrup.
- Add seaweed powder *(Ulva lactuca)* and boil for 15 minutes with stirring.
- Add edible colour and essence.
- Ready to serve.

Applications:

- Seaweed contains virtually all the nutrients found in the ocean and very same minerals are found in human body.
- Seaweed diet (up to 20 calorie per serving and no fats) is a good food to take when you want to take control of your weight.
- Seaweed are also a good source of amino acids. That's why they are very special and important food stuff for vegetarians.
- Seaweeds are also high in fibers than food grains and cereals which make a person feel full when eating a meal. This will prevent over eating.
- Seaweed have a high salty flavour which could be used in processing food and also snacks instead of salt. This will be very advantageous because it helps to reduce heart attacks and even stoke.
- The soluble fibers found in seaweeds are good for digestion. Fibers prevent constipation and facilitates in effective bowels movement.
- Fucoidan present in brown seaweeds lowers inflammation and may prevent infections. They also contains antioxidants which can stop the formation of disease causing free radicals.

- Seaweeds also help to prevent birth defects as the infants would get all the nutrients needed for healthy growth.
- Seaweed eating countries have shown fewer instances of obesity, diabetes, Alzheimer's disease and other degenerative diseases.
- Seaweed has high level of folic acid which is very essential in the breakdown of a chemical that poses great risk called homocysteine.
- Seaweeds are also a very good stress reliever as they are high in magnesium, vitamins and pantothenic acid which are important parts of adrenal gland.
- Research suggests that seaweeds could help reduce the risk of many chronic conditions such as high blood pressure, diabetes type 2 etc.
- Seaweeds contain significant amount of lignans which are plant compounds with cancer protective properties.
- In the present day world, everybody is continually exposed to radiation, metal poisoning, gaseous emission, radioactive substances, pollution etc. in order to reduce their negative health impact, it is necessary to eat seaweed diets that will continually detoxify our body.

BROWN ALGAE SEAWEED SIDE EFFECTS

- Bladder wrack consumption is always considered unsafe because of its potential contamination with many heavy metals.
- High iodine content in bladder wrack may be toxic if taken in large doses. It may lead to abnormal thyroid conditions, acne-

type skin lesions, increased salivation, stomach irritation and brassy taste.

- Bladder wrack may lower blood sugar levels and have blood thinning effects. Thus it should be used with caution for patient with diabetes, hyperglycemia, bleeding disorders, or taking medications for these conditions.
- Due to high level of arsenic kidney and liver toxicity have been reported in some individuals.
- Bladder wrack not be advisable for children and during pregnancy and lactation due to its high iodine, heavy metal and other contamination.

RED ALGAE SEAWEED SIDE EFFECTS

- Being a proper food, there are no side effects with red marine algae and there have been no noted side effects with red marine algae pus consumers.

GREEEN ALGAE SIDE EFFECTS

- Few side effects have been reported from the ingestion of green algae.
- However, as green algae can accumulate heavy metals from contaminated water, consuming green algae could increase the body's load of lead, mercury and cadmium though non contaminated green algae have been identified.

REFERENCES

- Chennubhotla, V. S. K., Kaliaperumal, N. and Kalimuthu, S. 1987. Economically important seaweeds. CMFRI bulletin 41.
- Chennubhotla, V. S. K., Kaliaperuma, N., Kalimuthu, S. and Nair, P.V.R. 1987. Biology Of The Economically Important Indian Seaweeds – A Review. *Seaweed Res. Utiln,* 10 (1): 21 – 32
- Coppen, J. J. W. 1991. Agar and Alginate Production from Seaweed in India. *Bay of Bengal Programme.*
- Kaladharan, P., Kaliyaperumal, N. Ramalingam, J.R. 1998. Seaweeds - Products, Processing and Utilization. *Marine fisheries information service,* 157.
- Kaliyaperumal, N. 2003. Products from seaweeds. *SDMRI Research Publication,* 3: 33 – 42.
- Kaliyaperumal, N., Kalimuthu, S. and Ramalingam, J.R. 2004. Present Scenario of Seaweed Exploitation and Industry in India. *Seaweed res. Utiln,* 26 (1&2): 47-53.
- Lei, L., Michael, H., Stephen, M., Symon, A. and Dworjanyn, C. 2012. Towards a better understanding of medicinal uses of the brown seaweed sargassum in Traditional Chinese Medicine: A phytochemical and pharmacological review. *Journal of Ethnopharmacology*, 142: 591 – 619.
- McHugh, D.J. 2003. A guide to the seaweed industry. *FAO Fisheries Technial Paper,* 441.
- Mitali, P.P., Satyabrata, D.S., Lakshman, N. and Chita, R.P. 2016. Uses of Seaweed and Its Application to Human Welfare: A Review. *International Journal of Pharmacy and Pharmaceutical Sciences,* 8(10): 12 – 20.
- Paul, M., Christopher, I.R., Gill Mariel, B., Ross, C. and Ian, R.R. 2007. Nutritional Value of Edible Seaweeds. *Nutrition Reviews,* 65(12): 535 – 543.
- Ramani, G., Siva, T.M. and Aruna, B.V. 2013. Seaweeds: A Novel Biomaterial. *International Journal of Pharmacy and Pharmaceutical Sciences,* 5(2): 40 – 44.
- Rameshkumar, S., Ramakritinan, C.M. and Yokeshbabu, M. 2013. Proximate composition of some selected seaweeds from

Palk bay and Gulf of Mannar, Tamilnadu, India. *Asian journal of biomedical and pharmaceutical sciences.*

- Silas, E.G., Chennubhotla, V.S.K. and Kaliyaperumal, N. 1986. Seaweed Resources, Products and Utilization. *Seaweed Res. Utiln,* 9(1): 50 – 56.
- Thirumaran, G., Arumugam, M., Arumugam, R. and Anantharaman, P. 2009. Effects of seaweed Liquid Fertilizer on Growth and Pigment Concentration of *Cyamopsis tetrogonolaba* (L) Taub. *American-Eurasian Journal of Agronomy,* 2(2): 50 – 56.
- Umamaheswara, R.M. 1970. The Economic Seaweed of India. *Bulletin Of The Central Marine Fisheries Research Institute,* 20.
- Vinod, K.D. 2014. Uses of seaweeds in the Indian Diet for sustenance and Well-being. *Science and Culture* 80(7-8): 192 – 202.
- Yadav, S.K., Palanisamy, M. and Murthy, G.V.S. 2015. Economically Important Seaweeds of Kerala Coast, India – A Review. *Elixir Bioscience,* 82: 32147 – 32153.
- Yedukondala, R. P., Rukmini, S. I. and Sudha R. D. 2015. Distribution of Seaweeds along the Coastal Waters of Visakhapatnam, East Coast of India. *Journal of International Academic Research for Multidisciplinary,* 3(5): 154 – 162.
- Yedukondala, R. P., Rukmini, S.I. and Sudha, R.D. 2015. Distribution of Seaweeds along the Coastal Waters of Visakhapatnam, East coast of India. *Journal of International Academic Research for Multidisciplinary,* 3(5): 154 – 162.