Seaweeds: A Promising Functional Food Ingredient

Jesmi Debbarma, Viji P. and B. Madhusudana Rao

Introduction

Seaweeds are a group of aquatic plants (algae) that live either in marine or brackish water environments and grow in the rocky intertidal as well as in the sub-tidal regions up to a certain depth where very little sun light is reachable. Seaweeds are classified under three classes: Red algae, Brown algae and Green algae based on the nature of pigment present. They are available in different colours and composition, shapes, sizes, and occupy various habitats, such as, some species remain attached to coral reefs, rocks and sea bed while some others float on the water surface. Seaweed is a source of biologically active phytochemicals, which include carotenoids, phycobilins, fatty acids, polysaccharides, vitamins, sterols, tocopherol, phycocyanins among others. Seaweed as a source of bioactive compounds is helpful as, antioxidant activity - carotenoids, antibacterial and antiviral activities of dietary polysaccharides - carrageenan, platelet aggregation, antitumor activity, hyperoxaluria and hyaluronidase inhibition.

Seaweeds have been consumed as food in Asia since ancient times. Seaweeds are usually cultivated for foods in Asia while they are harvested from the wild resources in Europe. The main species cultivated for food in larger scale are Pyropia and Porphyra (nori), *Undaria pinnatifida* (wakame), *Euchema* sp., *Saccharina japonica* (Japanese kelp), *Gracilaria* sp., and species like *Sargassum fusiforme* and *Caulerpa* spp. are farmed in small quantities (FAO, 2012).

Distribution in India

The potential areas in India for abundant growth of several species of red, brown and green seaweeds are the southeast coast of Tamil Nadu from Mandapam to Kanyakumari covering 21 islands in the Gulf of Mannar, Gujarat coast, Lakshadweep and Andaman & Nicobar Islands. Mumbai, Karwar, Ratnagiri, Goa, Varkaja, Vizhinjam, Pulicat and Chilka are other places in the east and west coast where rich seaweed beds occur.

Nutritional value

Seaweeds have a highly variable nutritional composition and considered as low caloric food but rich in protein, vitamins (A, B1, B12, C, D and E, riboflavin, niacin, pantothanic acid and folic acid), minerals as well as important bioactive compounds. The majority of those lipids in seaweeds are long chain polyunsaturated ω-3 and ω-6 fatty acids. Brown seaweeds are richer in soluble fibre and iodine, while, red and green seaweeds are richer in carbohydrate content. The highest iodine content is found in brown seaweed with dry Laminaria having 1500 to 8000 ppm and Fucus having 500 to 1000 ppm (Dharmananda, 2002). Seaweeds are also a good source of bioactive compounds, which are characterized by

having broad spectrum of biological activities.

Seaweed as food

Seaweeds have been commonly utilized as a part of Oriental diet, especially in China, Japan, and Korea since ancient times because of their beneficial nutrients. In Japan, seaweeds have been used for preparation of jam, cheese, wine, tea, soup and noodles. In Japan, the red seaweed nori (Pyropia and Porphyra), is used as a traditional wrapping for sushi and is consumed in soups. Seaweeds provide several ingredients to the food or pharmaceutical industries such as agar-agar, alginates, carrageenan, vitamins, pigments, chelated micro-minerals (selenium, chromium, nickel, arsenic) and prebiotic substances in the form of complex carbohydrates (alginates, fucose-containing polymers, mannitol and laminarin) and phlorotannins. ontinents. Red and brown seaweeds are also used to produce hydrocolloids (alginate, agar and carrageenan), which are used as thickening and gelling agents.

In India, there has been little exploitation of seaweeds species for edible purpose. Their utilization is mostly restricted to phycocolloids extraction, as fertilizer for agriculture and animal feeds in India. ICAR-CIFT has developed the following seaweed products.

Seaweed dietary fibre fortified fish sausage

Generally, fish sausage available in the market are deficient in dietary fibre. Dietary fibres have received increasing attention from researchers and industry due to its beneficial effects in reducing coronary heart-related diseases, diabetes incidence, gut neoplasia and prevention of constipation as well as reduce the risk of colon cancer. Hence, incorporation of seaweed dietary fibre to fish sausage can enrich the product with dietary fibre and improve the quality and textural properties.

Washed fish mince is mixed with seaweed dietary fibre, salt, sugar, poly phosphate, guar gum, corn starch and sunflower oil using a bowl chopper for 10min under low temperature (<10°C). Then the emulsion is stuffed in a polyamide material sausage casing using a sausage stuffer and cooked in a closed water bath at 85-90°C for 30 minutes. After cooking, sausages are immediately cooled in ice-cold water for 5 minutes. Each sausage sample weighing approximately 150-200g are packed in flexible low-density polyethylene pouches and the sausage are acceptable up to 9 weeks at 2 ±0.5°C.

Table. Formulation of Dietary fibre fortified sausage

Ingredients	Ingredients (%)
Washed mince	69
salt	2.5
sugar	1.5
poly phosphate	0.2
guar gum	0.1
corn starch	9
sunflower oil	6.7
Crushed ice	10
Carragenaan	-
Dietary fibre from *G. edulis, S. wightii, U. lactuca*	1

Fig. Sausage fortified with seaweed dietary fibre

Seaweed and fish enriched noodle

Seaweed and fish enriched noodles are seaweed and fish meat based fast food items. Noodles available in the market generally have low nutritional value in terms of dietary fibre, protein, vitamins and minerals. Addition of seaweed and fish meat can enhance the nutritional value of the noodles.

Noodles is prepared using wheat flour, corn flour, tapioca starch, salt, edible green seaweed (Ulva reticulate) puree and fish (Pangasianodon hypophthalmus) mince. All the ingredients are mixed to make dough. Then, dough was sheeted, rolled and passed through cutting blades of noodle making machine to obtain noodles strands of desired width. Steam cooked and dried noodles are packed in polyethylene cover and the product is acceptable up to 6 months at ambient temperature.

Fig. Seaweed and fish enrich noodles

Table. Formulation of noodles enriched with seaweed and fish

Ingredients (%)	Formulation of noodles	
	Seaweed noodles	**Seaweed & fish noodles**
Refined wheat flour	62	62
Corn flour	5	5
Tapioca starch	10	10
Salt	3	3
Cooked Pangasius fish meat	-	10
Green-seaweed *(Ulva reticulata)* puree	20	10
Water (ml/100g flour basis)	30	30