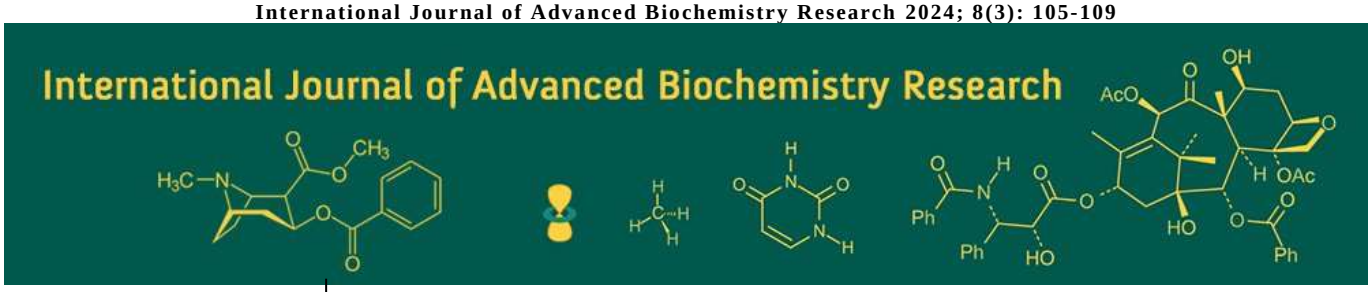

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Formulation of instant soup mix from seaweeds

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Abstract
In an era where health consciousness is on the rise, the spotlight is gradually shifting towards natural food sources that offer not only sustenance but also vitality. Simple dietary adjustments have been shown to significantly reduce the global burden of non-communicable illnesses. Amidst the vast expanse of the ocean, teeming with life forms, lies a treasure trove of nutritional wonders, among which seaweeds stand out as a manifold and intriguing group of organisms. The overarching goal of this study is to harness the potential of underutilized seaweeds in formulating innovative food products, particularly instant soup mixes. Through meticulous sensory evaluation, shelf life analysis, and comprehensive nutritional assessment, we aim to shed light on the nutritive value and sensory appeal of these formulations. Our study focuses on two varieties of seaweeds: *Sargassum wightii* and *Ulva lactuca*. These seaweeds, often overlooked, boast a rich nutritional profile, brimming with essential micro and macronutrients vital for human health. The sensory evaluation of the instant soup mixes was conducted using a 5-point hedonic rating scale, providing valuable insights into the overall acceptability and palatability of the formulations. Additionally, the nutritive values of the products were meticulously calculated, drawing upon the Indian Food Composition Table of 2017 for reference. Our findings reveal that the formulated instant soup mixes exhibit superior energy content, carbohydrates, and calcium levels compared to standard formulations. Furthermore, they boast significant amounts of micronutrients, including vitamins and minerals, thus positioning them as formidable contenders in the realm of nutritionally dense food options. Despite their immense potential, seaweeds remain relatively unexplored in the Indian culinary landscape. Their myriad health benefits and nutrient density are yet to be fully realized and capitalized upon by Indian consumers. By harnessing the availability and nutrient richness of seaweeds, we have the opportunity to revolutionize dietary habits and promote healthier lifestyles amidst the demands of modern living, seaweeds emerge as a potent natural resource, offering a plethora of health advantages in today's fast-paced and often unhealthy lifestyle. As we delve deeper into the realm of nutritional science, embracing the bounty of the ocean may pave the way for a healthier, more sustainable future for generations to come.

Keywords: Formulation, instant soup mix, seaweeds

Introduction
Seaweeds are basic plants that grow in shallow seawater and use sun energy to make carbohydrates from carbon dioxide, water, and dissolved minerals. Seaweeds do not have the same excellent root system and conducting tissues as terrestrial plants. Seaweeds sustain the entire living system and provide the foundation of the food chain in the water, together with floating tiny plants.

The composition of seaweeds is highly variable, as it depends on many factors: species, time of collection, growth conditions or habitat, among others. From a nutritional point of view, seaweeds are characterized by a high content of carbohydrates (<60 percent) and proteins (17-44 percent), a low percentage of lipids (<4.5 percent) and a high presence of other micronutrients, such as vitamins, pigments and minerals (Sudhakar *et al.* 2018) [1].

Besides high-quality protein, seaweeds contain a huge spectrum of bioactive compounds, notably essential fatty acids, dietary fibres, carotenoids, phenolic compounds, and water- and liposoluble vitamins (Nunes *et al.* 2017) [2]. Brown seaweeds are high protein level of 5 to 15 percent containing all essential amino acids as per the proportions recommended according to the FAO (Fauziee *et al.* 2020) [3].

Polyphenols, polysaccharides and sterols, along with other bioactive molecules, are essentially responsible for the healthy properties of seaweeds. The antioxidant, anti inflammatory, anti cancer and anti diabetic properties are associated to these compounds.

They have a higher proportion of essential fatty acids as eicosapentaenoic (EPA) and docosahexaenoic (DHA) fatty acids when compared to terrestrial plants (Penalver *et al*. 2020) [4].

In many coastal nations, brown seaweed, *Sargassum* spp., is cooked and eaten directly.It is used in salads, soups, rice dishes, and as a savoury cuisine element in India, Japan, and Korea (Kumar *et al.*, 2015) [5]. *Ulva lactuca*, sometimes known as "green laver" or "sea lettuce" is a rich bioactive nutrition source (Imen *et al*., 2022) [6]. Some important amino acids like histidine are present in amounts equivalent to those found in legumes and eggs in *Ulva* (Lordan *et al.*, 2012) [7]. The use of seaweeds extracts in the food industry is one of the most interesting applications to improve nutritional properties (Ghannam *et al*. 2018) [8]. *A. nodosum* and *F. vesiculosus* Linnaeus extracts have been incorporated as components of yoghurts and milk, evidencing antioxidant functionality without compromising their shelf-life characteristics and quality parameters (Roohinejad *et al*. 2017; Michalak *et al*. 2018 [9-10].

It is interesting to note that only a few species of seaweeds have been studied for their application in food industry. Incorporating seaweeds or their extracts into foods to improve nutritional properties is a recent practice, prompted by improved understanding of dietary sciences and the nutrient dense nature of algae.

The use of seaweeds extracts in the food industry is one of the most interesting applications to improve nutritional properties (Ghannam *et al*. 2018) [8]. It is interesting to note that only a few species of seaweeds have been studied for their application in food industry.

Several studies have successfully incorporated seaweed and their extracts into cereal-based products. Kumoro *et al*. (2016) [11] improved the fibre, protein, lipid and mineral profile of wheat flour noodles with the addition of dried, milled *Eucheuma cottonii*.

Indonesians, Japanese, and Koreans eat a lot of seaweeds because they are well aware of their nutritious value. Despite its rich availability, seaweeds consumption is less common in India's coastal areas. *Gracilaria* and *Acanthophora* species are consumed in porridge form in India, primarily in the coastal states of Kerala and Tamil Nadu. The treasured health benefits of seaweeds have not been realized by the Indians and seaweeds are yet to be exploited by Indians (Sumayaa and Kavitha, 2015) [12].

Materials and Methods

The seaweeds varieties chosen for the research (*Sargassum wightii* and *Ulva lactuca*) were collected from Mandapam coastal area, Tamil Nadu, India. The selected seaweeds samples were washed thoroughly with water to eliminate any contaminants and impurities. Sun drying method was adopted to dry the seaweeds. The washed seaweeds were spread on a clean white paper placed on trays and laid out in the open air in direct sunlight for 4 days. The dried samples were ground into powder using a mixer grinder and sieved well. The powdered sieved samples were then packed in zip lock pouches at room temperature for further use.

Formulation of instant soup mix with seaweeds powder

The word "instant food" refers to food that is simple, uncomplicated, and quick to make (Sowjanya and Manjula, 2016). Instant soup is nearly ready to eat and cooks in short time. Instant soup helps to meet everyone's nutritional needs quickly in a shorter time".

Vegetables contain nearly all of the needed elements for human metabolism and, when taken as directed, promote excellent health.

The vegetables (carrot, benas, peas and sweet corn)were sundried for 2 days with the average temperatures being 33 °C-35 °C and humidity between 53-55 percent. The standard soup mix for one serving was prepared with 10 g dried vegetables powder and other ingredients like corn flour (5 g) and salt for taste. The soup mix was then incorporated with seaweeds powder in three variations. The first variation was prepared with 10 g dried vegetables powder, 1.5 g seaweeds powder and 3 g corn flour, whereas second variation was made with 10 g dried vegetables powder, 3 g seaweeds powder and 3 g corn flour. Then, 10 g dried vegetables powder, 3 g seaweeds powder and 3 g corn flour was incorporated into the third variation. In the case of fourth variation it was formulated with 10 g dried vegetables powder, 4.5 g seaweeds powder and 3 g corn flour. 2.5 g of garlic powder and 3 g of onion powder were used in all variations as flavouring agents.

Plate 1: Sundried vegetables

Plate 2: Dried vegetables powder

Plate 3: Ingredients for the formulation of instant soup mix using sample A (*Sargassum wightii*)

Plate 4: Ingredients for the formulation of instant soup mix using sample B (*Ulva lactuca*)

Organoleptic evaluation of formulated instant soup mix

Organoleptic evaluation or sensory evaluation refers to the sensory analysis of food using human senses like taste, smell, sight and touch. This method is crucial in assessing the quality, flavor, texture, appearance and overall acceptability of the products. The evaluation was carried out with 15 semi trained panel members of age 20-27 years .The formulated seaweeds incorporated soup mix powders were properly coded with three digits and given for sensory evaluation in order to check the acceptability of the formulated products. The sensory assessments of the items were conducted in the laboratory in the morning and afternoon, and the acceptability of the products was assessed using a 5-point hedonic scale (1 - dislike very much, 2 - dislike slightly, 3 - neither like nor dislike 4 - like slightly, 5 - like very much). According to a numerical scoring methodology with values ranging from 1 to 5, samples were assessed for appearance, taste, colour, flavour, consistency, and overall acceptability.

Plate 5: Organoleptic Evaluation

C. Shelf life analysis

The shelf- life of seaweeds (*Sargassum wightii and Ulva lactuca*) incorporated instant soup mix were analyzed by direct method that consists of storing each product in the sterilized pouches under normal condition with regular monitoring for appearance, colour and smell for 30 days.

D. Computation of nutritive value

The nutrient analysis of seaweeds (*Sargassum wightii* and *Ulva lactuca*) was done by standard procedures of Association of Official Analytical Chemists (AOAC), 2016. The nutritional composition of formulated soup mix powders were computed with the Indian Food Composition Table (IFCT, 2017).The macronutrients like energy, carbohydrates, fibre, protein and fats and micronutrients like calcium, iodine and iron were computed for the nutritive value of the products.

Results and Discussion

A. Development of instant soup mix using seaweeds

The instant soup mixes were formulated with seaweeds in three variations with a standard. Dry seaweeds powder of *Sargassum wightii* and *Ulva lactuca* was incorporated at the variations of 1 g, 2 g and 3 g.

Table I: Formulation of instant soup mix with seaweeds powder

Ingredients (g)	Standard	Variation I	Variation II	Variation III
Dehydrated vegetables	10	10	10	10
Corn flour	5	3	3	3
Dry seaweed powder				
(*Sargassam wightii*)	-	1.5	3	4.5
(*Ulva lactuca*)	-	1.5	3	4.5

The standard soup mix comprised 10 g dehydrated vegetables and 5 g of corn flour. 1.5 g of seaweeds powder (*Sargassum wightii* and Ulva *lactuca*) were incorporated in variation I. Variation II was formulated with 3 g of seaweeds powder (*Sargassum wightii* and *Ulva lactuca*) whereas variation III of the soup mix was incorporated with 4.5 g of seaweeds powder(*Sargassum wightii* and *Ulva lactuca*).

Formulated soup was prepared with the instant soup mix by boiling 500 ml of water. Salt, pepper and butter were added to enhance the taste and reduce the flavour of the seaweeds. The yield of the soup for one variation was 250 ml.

Soup (*Sargassum wightii*) Soup (*Ulva lactuca*)

Plate 5: Formulated soup from *Sargassum wightii* and *Ulva lactuca* powder

Acceptability of the formulated instant soup mix from seaweeds

The acceptability of the formulated products was carried out through organoleptic evaluation by 15 semi trained panel members (n=15) of adult female adult aged 20-27 years.

Table 2: Acceptability scores for the formulated instant soup mix

Attributes	Sample A (*Sargassum wightii* powder)			Sample B (*Ulva lactuca* powder)		
	Variation I	Variation II	Variation III	Variation I	Variation II	Variation III
Appearance	4.4±1.08	4.7±0.42	3.8±0.63	4.4±0.51	4.6±0.5	4.8±0.36
Colour	4.1±1.15	4.6±0.49	3.7±0.59	4.2±0.46	4.5±0.51	4.7±0.46
Consistency	4.7±1.26	4.7±0.46	4.8±0.35	4.1±0.66	5±0	4.7±0.42
Flavour	3.5±0.89	4.4±0.51	3.5±0.51	3.6±0.49	4.6±0.5	4.6±0.49
Taste	3.2±0.99	4.2±0.46	3.6±0.5	4±0.67	4.8±0.37	4.9±0.26
Overall Acceptability	20.1±4.95	22.8±1.02	19.6±1.45	20.5±1.45	23.6±0.86	23.9±0.82

The overall acceptability score obtained for soup mix prepared from varying proportions of dry seaweeds powder is shown in the above table. Variation III from sample B (*Ulva lactuca*) had the maximum score (23.9±0.82) whereas the variation III from sample A (*Sargassum wightii*) had the with the minimum score (19.6±1.45) was Therefore 4.5 g of *Ulva lactuca* powder incorporated in variation III of sample B (*Ulva lactuca*) was selected the best quality attribute and acceptability by the panel members.

Computation of nutritive value obtained for formulated products

The nutritive value of the formulated instant soup mix powders from selected seaweeds (*Sargassum wightii and Ulva lactuca*) were computed with the help of the Indian Food Composition Table (IFCT, 2017). The nutritive value of the formulated instant soup mix is given in the following tables:

Table 3: Nutrient composition of instant soup mix using *Sargassum wightii* (per 100 g)

Nutrients	Standard	Variation I	Variation II	Variation III
Energy (kCal)	3	7	10	14
Carbohydrate (g)	0.56	1.38	2.2	3.03
Protein (g)	0.23	0.306	0.38	0.46
Fat (g)	0.01	0.014	0.01	0.02
Fibre (g)	0.31	0.67	1.033	1.39
Calcium (mg)	2.98	3.46	3.95	4.44
Iodine (mcg)	-	0.09	0.18	0.27
Iron (mg)	0.09	0.101	0.11	3.43

Table 3 shows that the standard soup mix contained 3 kCal energy. Variation I, II and III prepared with *Sargassum wightii* powder had 7, 10 and 14 kCal of energy; 1.38, 2.2 and 3.03 g of carbohydrate; 3.46, 3.95 and 4.44 mg calcium respectively. The iron content of variation III was 3.43 mg.

Table 4: Nutrient composition of instant soup mix using *Ulva lactuca* (per 100 g)

Nutrients	Standard	Variation I	Variation II	Variation III
Energy (kCal)	3.5	6	10	3
Carbohydrate (g)	0.56	1.28	2.01	2.74
Protein(g)	0.23	0.3	0.37	0.45
Fat(g)	0.01	0.015	0.019	0.023
Fibre(g)	0.31	0.72	1.138	1.55
Calcium(mg)	2.98	16.15	29.32	42.49
Iodine(mcg)	-	0.04	0.08	0.13
Iron(mg)	0.09	0.12	0.15	0.18

According to table 4, the standard soup had 3.kCal energy. The energy content of variation I, II and III were 6, 10 and 3 kCal; carbohydrate content was 1.28, 2.01, and 2.74 g respectively. The calcium levels were more in the soup mix powder prepared using *Ulva lactuca* powder *than Sargassum wightii* powder.

Shelf-life study of the formulated product

The shelf- life of seaweeds (*Sargassum wightii and Ulva lactuca*) incorporated instant soup mixes were analyzed by direct method that consists of storing each product in the sterilized pouches under normal condition with regular

monitoring for appearance, colour, flavour and texture for 30 days. Even after storing the formulated products for 30 days under normal conditions there was no presence of microbial growth.

Conclusion

The formulated instant soup mixes are more in energy, carbohydrates and calcium content and have high amounts of micronutrients like vitamins and minerals from a nutritional standpoint when compared to a standard. Instant soup mixes incorporated with 4.5 g of *Ulva lactuca* powder in variation III was selected the best quality attribute and acceptability by the panel members. Seaweed inclusion in diet may help to alleviate health issues caused by protein, mineral, and carbohydrate shortages.

Seaweeds are vital marine plants that make up the flora of our coastal environments. When compared to terrestrial plants, however, knowledge on its diversity is yet in its infancy. Seaweeds have been used as a meal by many cultures throughout history, and these marine plants have lately been promoted as a diet for the future. While India contains a large variety of seaweeds, neither the degree of its diversity nor the effectiveness of its resources has been reported. Seaweeds are employed in a variety of sectors, including cosmetics, nutraceuticals, and medicines, in addition to culinary usage.

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