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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(4): 119-123

www.thepharmajournal.com
Received: 18-01-2023
Accepted: 21-02-2023

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Formulation of Instant Tea from Seaweeds: *Sargassum wightii* and *Ulva lactuca*

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Abstract
Seaweeds have gained popularity as neutraceuticals, or functional foods, in the last three decades, since they provide nutritional advantages beyond their macronutrient composition. A study was undertaken to formulate tea using seaweeds in order to enrich the nutrient content of tea as normal tea lacks nutrients. The study's objectives are to formulate tea products using underutilized seaweeds, conduct sensory evaluation and compute nutritive value of the formulated tea products. The tea products formulated were dip tea powder and instant premix tea powder. The sensory evaluation was conducted using 5- point hedonic-rating scale and the nutritive values of the products were computed using Indian Food Composition Table, 2017. The formulated tea products are more in carbohydrates and calcium content and have high amounts of micronutrients like vitamins and minerals from a nutritional standpoint when compared to a standard. Seaweeds, when used in tiny doses, are nutritional powerhouses. Indians are yet to discover the nutritional advantages of seaweeds and seaweeds are yet to be used in Indian diets.

Keywords: Product formulation, tea, seaweeds, *Sargassum wightii*, *Ulva lactuca*

Introduction
A crucial motivation in food production to feed the increasing population of the world is a critical incentive in the search for innovative food components. (Bikker *et al*. 2020; Amoriello *et al*. 2021) [1, 2]. Marine natural resources are currently being underutilised(Afonso*et al*. 2019; Hayes *et al.* 2020) [3, 4]. The term “seaweeds" is colloquial and has no official definition. Seaweeds are photosynthetic algae which are abundant in every ocean. They are primordial plants with no root system, stalks or leaves, and no conductive tissues like terrestrial plants. (Jayaprakash *et al.* 2017) [5]. In coastal settings, they usually dwell adhering to rock or other hard substrates. They can be found up to 180 metres underneath the sea bed, typically in solid substrates at depths of 30–40 metres. (Baweja *et al.* 2016) [6].
Marine seaweeds like *Ulva lactuca*, *Ulva reticulata*, *Enteromorphagutis*, *Acanthophora Cayfera*, *Gracilaria edulis*, *Padina tetrastomatica and Sargassum wightii* have indeed been recorded to be plentiful along the coastal region of Mannar Bay from Rameswaram to Kanniyakumari in Tamil Nadu. They are accessible throughout the year and can be conserved in a dry condition for a long period. In the coastal belts of Tamil Nadu, Gujarat, Lakshadweep, Andaman and Nicobar Islands, seaweeds are abundant.
Sargassum wightii and *Ulva lactuca* seaweeds were chosen for the current study. *Sargassum wightii*, is a brown seaweed that includes a variety of beneficial chemicals, including fucoidan and fucoxanthin, as well as significant amounts of polyphenols and flavonoids.
Ulva sp. (green algae) has been recognised for a variety of natural bioactive constituents that may have promising use in biomaterial science, nutraceuticals, functional foods, and agriculture. *Ulva lactuca*, sometimes known as “green laver” or “sea lettuce” is a rich bioactive nutrition source (Imen *et al*., 2022) [7].
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 and their use as food is very limited (Thinakaran, 2012) [8]. 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.
Seaweeds are good options for functional food due to their high nutritional density. Seaweeds have piqued the food industry's interest. By incorporating them into bread, milk products, fish,.

meat, or vegetable-based products, novel functional food items may be created with improved nutritional content, quality, and health benefits (Roohinejad *et al*. 2017) [9].

Although much research has been done on the nutritional benefits of freshwater algae such as spirulina, seaweeds have yet to be popularized and promoted. Seaweeds, when used sparingly, are nutritional powerhouses. Using natural food resources to avoid the increased incidence of lifestyle and nutritional diseases is a simple and quick approach. Seaweeds are a potential natural resource in terms of availability and nutrient density in today's demanding and unhealthy lifestyle.

Keeping these facts in mind, the present study was conducted to formulate nutrient-rich innovative tea products using unexploited seaweed species, to conduct sensory evaluation and computation of nutritive value of the formulated products.

Materials and Methods

The present study had started after the approval by the Institutional Human Ethics Committee.

The selected sample of seaweeds (*Sargassum wightii* and *Ulva lactuca*) was collected from Mandapam coastal area, Tamil Nadu, India. The selected seaweeds samples were washed properly in running water to get rid of any foreign particles. The washed seaweeds were let to dry in the open air for 4 days. The dried samples were ground into powder and sieved well and stored for further use.

A. Incorporation of seaweeds powder in tea products at different proportions

Inclusion of seaweeds in tea may provide a significant quantity of nutrients, establishing this beverage as a nutritious one rather than a normal beverage. Normal tea lacks macronutrients like carbohydrates and micronutrients like calcium and iodine therefore seaweeds were incorporated in tea to boost the nutrient content of tea. As a result, the present study sought to develop and standardize tea products with good nutritional properties. Dip tea powder and instant premix tea powder were developed with the incorporation of seaweeds powder (*Sargassum wightii* and *Ulva lactuca*) at different proportions in order to enrich their nutrient contents.

I. Dip tea powder

The formulated dip tea powder was standardized with 3g of Nilgris orthodox tea leaves and 2g of dried ginger powder. Three variations were prepared from each varieties of seaweeds powder (*Sargassum wightii* and *Ulva lactuca*). The first variation of dip tea powder was made by incorporating 1g of dry seaweeds powder (*Sargassum wightii* and *Ulva lactuca*)while 2g of seaweeds powder(*Sargassum wightii* and *Ulva lactuca*) was incorporated in second variation and 3g of (*Sargassum wightii* and *Ulva lactuca*)seaweeds powder in the third variation.

II. Instant premix tea powder

The instant tea premix powder which comprised of 100g tea leaves powder, 50g milk powder, 50g sugar and 15g ginger as the flavour was formulated as the standard. Along with added seaweeds powder (*Sargassum wightii* and *Ulva lactuca*), the instant premix tea powder (1g, 2g and 3g) was prepared at varying proportions in variations I, II and III respectively

B. Organoleptic evaluation of formulated innovative products

Organoleptic evaluation or sensory evaluation is the analysis of a product by inspecting it by the sense, sight, taste, smell and taste for various quality attributes like appearance, flavour, aroma, texture and sound.

The evaluation was carried out with 15 semi trained panel members of age 20-27 years from Avinashilingam University, Coimbatore. The formulated product samples (dip tea powder and instant tea premix powder) with seaweeds (*Sargassum wightii* and *Ulva lactuca*) 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.

Fig 1: Organoleptic Evaluation

C. Shelf life analysis

The shelf-life of seaweeds (*Sargassum wightii and Ulva lactuca*) incorporated products (dip tea powder and instant premix tea powder) 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 15 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 tea products namely dip tea powder and instant premix tea powder 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

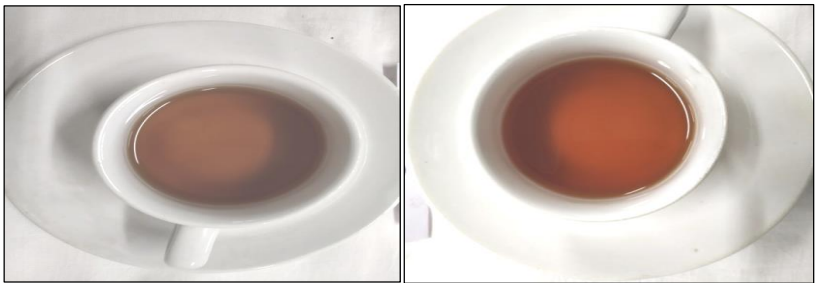
A. Development of products using seaweeds

The tea products 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 1g, 2g and 3g in dip tea powder and in the case of formulation of instant premix tea powder 1g, 2g and 3gof seaweeds were incorporated.

Table 1: Formulation of dip tea powder using selected seaweeds powder

Ingredients (g)	Standard	Variation I	Variation II	Variation III
Tea leaves (g)	3	3	3	3
Dried ginger(g)	2	1	2	2
Dry seaweed powder (g)				
(*Sargassum wightii*)	-	1	2	3
(*Ulva lactuca*)	-	1	2	3

The prepared dip tea powder was packed in tea bags and can be taken by just dipping the bags in a cup of 120 ml of hot water. The yield for one variation of the tea was 120ml.



Tea (*Sargassum wightii*) Tea (*Ulva lactuca*)

Fig 2: Formulated tea from *Sargassum wightii* and *Ulva lactuca* powder

Table 2: Formulation of instant premix tea powder using seaweeds powder

Ingredients (g)	Standard	Variation I	Variation II	Variation III
Tea leaves powder	100	100	100	100
Milk powder	50	50	50	50
Sugar	50	50	50	50
Dried ginger powder	15	15	15	15
Dry seaweed powder (g)				
(*Sargassum wightii*)	-	1	2	3
(*Ulva lactuca*)	-	1	2	3

The instant tea was prepared by just mixing 2 tbsp of the premix tea powder in 120 ml of hot water. It was stirred well and strained to remove residues. The yield of the instant tea for one serving was 120ml.

Instant tea (*Sargassum wightii*) Instant tea (*Ulva lactuca*)

Fig 3: Formulated instant tea from *Sargassum wightii* and *Ulva lactuca* powder

B. Acceptability of the formulated products 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 aged 20-27 years. The acceptability attributes scores were calculated using mean and standard variation.

Table 3: Acceptability scores for the formulated dip tea powder

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±0.65	4.7±0.45	4±0.92	3.9±0.7	4.8±0.35	4.4±0.63
Colour	3.8±0.86	4.8±0.35	4.07±0.91	4.6±0.63	4.6±0.48	4.5±0.51
Consistency	4.06±0.79	4.8±0.41	4.3±0.81	4.2±0.59	4.8±0.41	4.7±0.45
Flavour	3.8±0.77	4.6±0.48	3.9±1.03	4.06±0.88	4.8±0.35	4.06±0.59
Taste	3.6±0.89	4.8±0.35	4.2±0.88	4±0.75	4.8±0.35	4.4±0.51
Overall Acceptability	19.3±3.17	23.9±0.79	20.3±3.35	20.8±1.68	24.06±1.95	22.2±0.96

Table 3 depicts the overall acceptability score of the formulated dip tea powder using selected seaweeds powder where the average score was calculated. The highest overall acceptability scorewas recorded in variation II from sample B (*Ulva lactuca* powder), (24.06 ±1.95). Variation I from sample A (*Sargassum wightii* powder) obtained the least mean score (19.3±3.17). Hence, dip tea powder with variation II containing 2g of dry seaweeds powder (*Ulva lactuca*) was most accepted by the panel members than the other variations. Variation I containing 1g of seaweeds powder (*Sargassum wightii*) had least acceptability. While for colour attribute, variation II prepared from sample B (*Sargassum wightii*) had the highest mean score (4.8±0.35) while the lowest mean (3.8±0.86) was obtained by variation I of sample A.

Table 4: Acceptability scores for the formulated instant tea premix powder

Attributes	Sample A (*Sargassum wightii* powder)			Sample B (*Ulva lactuca* powder)		
	Variation I	Variation II	Variation III	Variation I	Variation II	Variation III
Appearance	4.7±0.45	4.7±0.45	4.7±0.45	4.8±0.35	4.7±0.45	4.6±0.5
Colour	4.3±0.51	4.5±0.51	4.4±0.51	4.6±0.48	4.6±0.5	4.6±0.5
Consistency	4.6±0.48	4.6±0.48	4.8±0.41	4.8±0.41	5±0	4.8±0.35
Flavour	3.8±0.56	3.8±0.63	3.4±0.73	4.7±0.45	4.8±0.41	3.5±0.63
Taste	3.4±0.63	3.6±0.61	3.1±0.74	4.6±0.49	4.9±0.25	3.6±0.91
Overall Acceptability	20.8±1.74	22.4±3.39	20.5±1.8	23.4±1.68	24.06±1.03	21.2±1.74

Sensory evaluation of the formulated instant tea premix powder given in table 4 reveals that variation II incorporated with 2g of *Ulva lactuca* powder from sample A gained the maximum scoring (24.06±1.03) when compared tovariation III prepared with 3g of *Sargassum wightii* powder (sample A)which had the minimum scoring (20.5±1.8) for overall acceptability. The variation with the maximum mean score (4.6±0.48) for colour was variation I of sample B (*Ulva lactuca*) while the variation with the least score (4.3±0.51) was variation I of sample A (*Sargassum wightii* powder). Hence out of all the variations, based on their overall acceptability variation II was chosen as the most acceptable one.

C. Shelf-life study of the formulated products

The shelf- life of seaweeds incorporated tea products (dip tea powder and instant premix tea powder) were analyzed by storing them in the sterilized pouches under normal condition with regular monitoring for appearance, colour, flavour and smell. Even after storing the formulated products for more than 15 days under normal conditions there was no presence of microbial growth.

D. Computation of nutritive value obtained for formulated products

The nutritive values of the formulated tea products from seaweeds (*Sargassumwightii and Ulva lactuca*) were computed with the help of the Indian Food Composition Table (IFCT, 2017). The nutritive value of the products is given in the following tables.

Table 5: Nutrient composition of seaweeds incorporated dip tea powder (per 100 g)

Nutrients	Standard	*S. Wightii*	*U. Lactuca*	*S. Wightii*	*U. Lactuca*	*S. Wightii*	*U. Lactuca*
		V1	V1	V2	V2	V3	V3
Energy (kCal)	2	3	2	6	5	8	7
Carbohydrate (g)	1.1	0.63	0.57	1.27	1.15	1.82	1.63
Protein(g)	0.18	0.07	0.06	0.14	0.13	0.19	0.18
Fat(g)	0.04	0.0121	0.0127	0.02	0.025	0.02	0.02
Fibre(g)	0.11	0.29	0.326	0.51	0.66	0.83	0.93
Calcium(mg)	0.38	0.51	8.97	1.03	17.94	1.35	26.72
Iodine(mcg)	-	0.06	0.06	0.12	0.122	0.18	0.18
Iron(mg)	0.04	0.027	0.041	0.05	0.08	0.06	0.1

Table 5 demonstrates that the standard dip tea powder formulated has 2 kCal of energy and 1.1g carbohydrate and very less amount of nutrients like protein, fat, fibre, calcium, iodine and iron. Dip tea powder prepared with variation I of

Sargassum wightii has 3 kCal of energy while variation II and III has 6 kCal and 8 kCal respectively. The calcium content which is increased with the incorporation of *Sargassum wightii* in variation I, variation II and III is 0.51 mg, 1.03 mg and 1.35 mg when compared to the standard (0.38 mg).

While in the case of dip tea powder prepared from *Ulva lactuca*, variation I, II and III has 2 kCal, 5 kCal and 7kCal of energy respectively. Similarly, the calcium content of the dip tea powder incorporated with *Ulva lactuca* is increased, variation I contains 8.97 mg, variation II has 17.94 mg and 26.72 mg of calcium is present in variation III.

Table 6: Nutrient composition of seaweeds incorporated instant premix tea powder (per 100 g)

Nutrients	Standard	*S. wightii* V1	*U. lactuca* V1	*S. wightii* V2	*U. lactuca* V2	*S. wightii* V3	*U. lactuca* V3
Energy (kCal)	385	387.46	387.19	389.92	389.39	392.38	391.597
Carbohydrate (g)	76.55	77.09	77.03	77.64	77.52	78.19	78.00
Protein(g)	19.38	19.43	19.42	19.48	19.47	19.53	19.52
Fat(g)	0.13	0.132	0.132	0.134	0.135	0.136	0.138
Fibre(g)	0.8	1.041	1.076	1.282	1.352	1.523	1.628
Calcium(mg)	693.83	694.15	702.61	694.48	711.39	694.80	720.17
Iodine(mcg)	0	0.06	0.02	0.122	0.059	0.18	0.08
Iron(mg)	1.07	1.077	1.091	0.085	1.112	1.09	1.13

Table 6 gives the nutritive value of instant premix tea powder prepared with *Sargassum wightii* and *Ulva lactuca.* Variation III of instant premix tea powder formulated with *Sargassum wightii* has more energy (392.38 kCal), carbohydrate (78.19 g), protein (19.53 g) and iodine (0.18 mg) content as it contained more amount of seaweeds powder (3g). Whereas, the instant tea prepared from *Ulva lactuca in* variation III has the most amount of calcium content (720.17 mg).

Conclusion

Seaweeds have grown in popularity in recent years as a more adaptable culinary item that may be used directly or indirectly in the creation of dishes and drinks. Because of their composition and nutritional qualities, seaweeds are considered a healthy food. 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.

Tea is a popular beverage that is drunk by the majority of people globally. While tea normally lacks macronutrients like carbohydrates and micronutrients like vitamins and vitamins, incorporation of seaweeds will help in the enrichment of those nutrients in tea. Thus, seaweeds inclusion in diet may also help to alleviate health issues caused by protein, mineral, and carbohydrate shortages.

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