Characterization and Utilization of Seaweed in Noodle Making

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Abstract

This research was based on the application of seaweed in the preparation of food products. Seaweed is good for health and it contains a wealth of nutrients that will improve overall health. A phytochemical investigation of seaweed was conducted. The nutritional value and chemical composition of seaweed were also determined. The study reports on the preparation of noodles consisting of wheat, potato flour, and seaweed. And then the effects of seaweed and wheat flour on the physicochemical and sensory properties of instant noodles were also determined. Potato flour was incorporated into wheat flour at flour replacement levels of 0, 10, 20, and 30%. In the preparation of seaweed noodles, different amounts of seaweed were also used, and the physicochemical properties of raw seaweed and instant noodles were also determined.

Key words: seaweed, phytochemicals, wheat flour, potato starch

Introduction

Seaweeds are the source of chemical compounds like agar-agar, carrageenan, and alginates. These chemical compounds and also known as phytochemicals and are mainly used for human consumption, animal feed, etc. These phytochemicals are also extensively used in food, textiles, dairy, the paper industry, and confectionary. Seaweeds extracts are also a very important component of mast of biostimulate product found in market nowadays and it is best known for their richness in polysaccharide, minerals and certain vitamin (BBS. 2008). Noodles are long, thin pieces of food made from a mixture of flour, water, and eggs usually cooked in soup or boiling water. The instant noodle is a food item made from unleavened dough that is made from different types of ingredients. Instant noodles are dried or precooked noodles fused with oil and sold with a packet of flavoring and are consumed among people of all socioeconomic levels, both in urban and rural areas of the country (Yasui, A. 2006). Noodles are made from unleavened dough which is rolled flat and cut, or extruded, into one of a variety of shapes. Noodle shapes include long, thin strips (or waves), helices, tubes, strings, shells, or other shapes. Noodles can be refrigerated for short-term storage or dried and stored for future use. Noodles are usually cooked in boiling water, sometimes with cooking oil or salt added. They are also often pan-fried or deep-fried. Noodle dishes can include a sauce or noodles can be put into soup. The material composition and geocultural origin are specific to each type of a wide variety of noodles (Wada, S. 2007). The objective of this project was to produce good quality seaweed noodles and lead to more effective and more nutrient-dense food products.

Materials and Methods

Raw Materials

Seaweed was purchased from Aung San Bazzar, Insein Township, Yangon Region. Wheat flour, potato flour, and sodium bicarbonate were purchased from City- Mark supermarket.

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Preparation of Seaweed Powder

The selected sample of Hypnea-spinella is a known species of red seaweed. It was washed with tap water to remove the adhered sediments and impurities. Then, it was washed successively with distilled water to remove all the salt on the surface. The water was drained off and the seaweed was spread on blotting paper to remove excess water. The clean seaweed was dried at room temperature for 24 hours. The dried seaweed material was ground and screened with a 200 mesh screen.

Figure (1) Washing the Seaweed

Figure (2) Drying the Seaweed

Figure (3) Grinding the Seaweed

Figure (4) Screening the Seaweed

Analysis of seaweed

Phytochemical Investigation

The phytochemical examination of a plant is one of the important experiments because it provides a classification of phytochemical constituents present in it. The preliminary phytochemical examinations by the test tube method indicate the chemical constituents of seaweed. The detailed methods were done according to the following procedures. All parameters were determined at the Myanmar Pharmaceutical Research Department, Ministry of Industry, Insein Township, Yangon Region.

The results of a phytochemical investigation of seaweed are shown in Tables (1).

Determination of Moisture Content

The moisture content of seaweed samples was measured by a moisture analyzer (MOC 63u). The results are tabulated in Table (2)

Determination of Ash Content

A seaweed sample of 5g was weighed in a clean, dry, tare porcelain crucible and dried in a muffle furnace at about 600°C for 2 hours. It was then cooled in a desiccator for 30 minutes and then weighed. The ash was almost white in color. The ash content was calculated as follows:

$$\text{Ash Content (\%w/w)} = \frac{\text{Weight of Ash}}{\text{Weight of Sample}} \times 100$$

And the results are represented in Table (2). [AOAC method 2000 (942.05)]

Determination of Protein Content

1 g of the prepared sample was taken in 500 mL Kjeldahl digestion flask. 10 g of anhydrous potassium sulfate, 0.5 g of copper sulfate, and 20 mL of sulphuric acid were added. It was digested by placing the flask in an inclined position. It was heated gently at first and then strongly until the solution was clear. It continued for further one to two hours. Then, it was cooled and 200 mL of distilled water was slowly added and mixed. The content was transferred into a one-liter distillation flask and washed with additional 100 mL of distilled water. It was made alkaline by pouring 70 mL of sodium hydroxide (1:1) by the side of the flask without disturbing the liquid. A pinch of zinc dust was immediately added to prevent bumping and the head of the condenser was connected to the distillation flask. The tip of the condenser trap must be dipped into 50 mL of 0.1N sulphuric acid containing 1 mL of methyl red indicator in a conical flask immersed in ice water. The tip of the trap from the acid was removed and distillation was continued for further 5 minutes. The tip was rinsed with water into the receiver and the residual acid left was titrated with a 0.1 N hydroxide solution. A blank determination was carried out in a similar manner using the same reagents [AOAC method 2000 (942.152)].

$$\text{Nitrogen}\left(\%\frac{w}{w}\right) = \frac{(T-B)\times N\times 14.007}{\text{Weight of sample}}\times 100$$

$$\text{Protein}\left(\%\frac{w}{w}\right) = \text{Nitrogen}\,\%\times 100$$

Where, N = exact normality of 0.1 N standard HCl solution

T = titrant volume for sample (mL)

B = titrant volume for sample (mL)

The results are shown in Table (3).

Determination of Crude Fibre Content

The samples were treated with sulphuric acid (1.25 %, v/v) and a sodium hydroxide solution. The digested matter was then filtered, washed with hot water, and ignited. Crude fibre content was determined by calculating the loss in weight after ignition [AOAC-2000 (978.10) Fibre Cap Method]. The results are shown in Table (3).

Determination of Crude Fat Content

Crude fat present in the sample was extracted by n-hexane. Fat was dissolved in the solvent. After the extraction, the solvent was evaporated and the fat content was determined [AOAC-BuchiSoxhlet Method]. The results are shown in Tables (3 and 7).

Determination of Carbohydrate Content

The carbohydrate content of the sample was calculated as follows

Carbohydrate = 100 - (Moisture+ Ash+ Protein+ Fiber +Fat)

The results are shown in Table (3).

Determination of Sugar Content

20 ml of Fehling’s solution was pipetted into a 500 ml conical flask. About 15 ml of water was added and 39 ml of 0.25% standard invert sugar solution was run from a burette.

Some anti-bumping granules were added, and the flask was placed over a hot flame. The flask was allowed to come to boil at a moderate rate without moving the flask or altering the flame for exactly 2 minutes. About 3- 4 drops of methylene blue solution were added five seconds before the completion of the boiling solution. Standard invert sugar solution was added from the burette until blue color lessens. Then the solution was dropped wise until the final disappearance of blue color leaving the red coloration due to cuprous oxide. The titration should be completed in 3 minutes from the commencement of boiling and the volume of titration (V_o) should be between 39 and 41 ml with a final volume of 75 ml in the boiling flask.

An aqueous extract of the sample was prepared by using clearing agents as necessary, containing 20-400 mg of reducing sugar per 100 ml. The titration was repeated with the sample solution in the burette as before, using 20 ml of Fehling's solution, 15 ml water and 25 ml of sample solution. The titration was carried out rapidly in order to find the approximate titre. The final accurate titration (V_1) was carried out after adding from the burette, less 1ml of sample solution was used in the first titration and sufficient water to give a final volume of 75 ml.

% reducing sugar as invert sugar in the sample = $(V_o \times 25 \times f) / (C \times V_1)$

Where f is a correction factor,

Sucrose content (g in V_1)	0	0.5	1	2	3	4	5
Correction factor (f)	1.0	0.982	0.971	0.954	0.939	0.926	0.915

Other standard reducing sugar solutions may be used to calibrate Fehling's solution. If the mixed Fehling's solution was standardized by adjustment so that (20 ml + 15 ml) of water was reduced by 40 ml of standard 0.25 % invert sugar solution and the sample solution contained a m percent m/v sample, then (AOAC, 2000)

% invert sugar in the sample = $(1000) / (\text{titration} \times m)$

% sucrose = % invert sugar $\times$ 0.95

The results are shown in Tables (3 and 7).

Determination of Mineral Content

The mineral content of seaweed was analyzed by using EDXRF (Energy Dispersive X-ray Fluorescence Spectroscopy). These parameters were determined by EDXRF, at the Physics Department, Taungoo University and the results are represented in Table (3).

Preparation of Seaweed Noodles

All the ingredients, such as wheat flour, potato flour, $NaHCO_3$ and seaweed, were weighed and mixed with warm water and kneaded for 10 minutes to prepare the dough. The dough was transferred to a vertical noodle making machine, and longer types of noodles were made. The prepared raw noodles were then steamed at 100°C for 3 minutes. The noodles were then dried in a cabinet dryer at 70°C for 2 hours. The cooled and dried instant noodles were packed in polythene bags of 100g each.

Preparation of Seaweed Noodles with Different Compositions

Seaweed noodles were prepared by using different amounts of wheat flour, potato flour and seaweed flour (100:0: 0) g, (80:10:10) g, (70: 20:10) g and (60:30: 10) g. The characteristics of the resulting noodles were also determined. The results are shown in Table (5).

The Effect of Seaweed Content on the Color of Noodle

Seaweed noodles were prepared by using different amounts of seaweed (0, 5,10,15) g. The characteristics of resulting noodles were also determined. The results are shown in Table (6).

Determination of the Nutritional Characteristics of Seaweed Noodle

The nutritional values of noodles were determined by using the same procedure as mentioned in the analysis of seaweed. The results are shown in Table (7).

Determination of Energy Value

Energy values of the samples were determined by using the following formula.

$$\text{Energy value} = 4\ (\text{ protein} + \text{carbohydrate }) + 9\ (\text{fat})$$

Rehydration Test for Dried Noodle

Dehydration is the replacement of water in dehydrated foods. Through the process of rehydration, a large percentage of the original water present is assimilated. Not all products can be reconstituted to 100 % of their original state because of inherent differences in their chemical compositions. The following tests were used to find out the quality of the product.

(i) Quick Method

Cold water, ten times the weight of the dry product, was added to the dried product. The container was covered, brought to a boil, and simmered gently until the product was tender. The cooking time may be 15 to 45 minutes after the boiling point has been reached.

(ii) Slow Method

This gives better results than the quick method. Cold water was added to the dried product and was left to soak for 1 to 2 hours before cooking. The product was then cooked in the same water in which it was soaked. The actual cooking time would probably be shorter than that for the quick method (Berghofer, L.K. ,2004).

Calculation can be made to express the term of "rehydration ratio".

$$\text{Rehydration ratio} = \frac{W_R}{W_D}$$

Where W_R = Weight of rehydrated sample (g)

W_D = Weight of dried sample (g)

The results are shown in Table (7).

Figure (5) Gathering and Rolling

Figure (6) Molding

Figure (7) Seaweed Noodle

Results and Discussions

For the preparation good quality of seaweed products, the raw materials and final product should be of good quality specifications. The results of the phytochemical investigation of seaweed powder are shown in Table (1). According to these results, seaweed contains carbohydrate, glycoside, phenol, α-amino acid, saponin, flavonoid, and reducing sugar. The results of the nutritional values and mineral content of seaweed are illustrated in Tables (2) and (3).

Table (4) shows the yield percent of seaweed powder. From this table, after washing, drying, and grinding the seaweed, the yield percent of seaweed powder is 31.74%.

Table (5) shows the effect of composition on the texture of seaweed noodles, and it was found that the composition of 70 % wheat flour, 20 % potato flour, and 10 % seaweed was the most suitable for making seaweed noodles. It gives noodles that are light brown and soft in boiling.

The effect of seaweed content on crude fiber and color of noodle is shown in Table (6) and it was found that the most suitable amount of seaweed was 10 g and the higher the seaweed content, the darker the color of the noodle.

The characteristics of seaweed noodles are shown in Table (7) and it was found that the protein, carbohydrate, and sugar contents are higher than the commercial noodle and literature value. The energy value was a little higher, and the rehydration ratio was 2.62.

Table (1) Nutritional Characteristics of Raw Seaweed

Sr. No.	Characteristics	Raw Seaweed	Literature*
1.	***Protein (% w/w)	43.2	12
2.	***Fat (% w/w)	N.D	0
3.	***Crude Fiber (% w/w)	6.71	32
4.	***Carbohydrate (% w/w)	34.90	27
5.	**Ash (% w/w)	3.5	3.39
6.	**Water (% w/w)	7.6	8.58

* Patel, H.Jhala, Y..(2019)

N.D = not detected

Table (2) Phytochemical Investigation of Seaweed Powder

Sr. No.	Types of Compound	Extract	Reagent used	Observation	Results
1.	Alkaloid	1% HCL	Mayer's reagent	No ppt	-
			Wagner's reagent	No ppt	
			Dragendorff's reagent	No ppt	
			Hager's reagent	No ppt	
2.	Carbohydrate	H_2O	10% α –naphthol & H_2SO_4	Red ring	+
3.	Glycoside	H_2O	10% lead acetate solution	White ppt	trace
4.	Phenol	H_2O	5% $FeCL_3$ solution	Greenish yellow color	+
5.	α Amino Acid	H_2O	Ninhydrin reagent	Light purple	trace
6.	Saponin	H_2O	H_2O	Persistent foam	+
7.	Tannin	H_2O	1% gelatin & 10% NaCl solution	No ppt	-
8.	Flavonoid	70% EtOH	Mg ribbon & Conc: HCL	Pink color	trace
9.	Steroid	Petroleum ether	Acetic Anhydrite & Conc: H_2SO_4	-	-
10.	Terpenoid	Petroleum ether	Acetic Anhydrite & Conc: H_2SO_4	-	-
11.	Reducing Sugar	H_2O	Fehling solution	Brick red ppt	trace
12.	Starch	H_2O	Iodine solution	Brown color	-
13.	Cyanogenic glycosides	powder	H_2O, Conc:H_2SO_4, sodium picrate paper	No color change	-

Table (3) Elemental Analysis of Seaweed Powder

Sr. No.	Element	(% w/w)
1.	S	1.383
2.	Si	1.165
3.	Ca	0.830
4.	Fe	0.221
5.	K	0.182
6.	Br	0.034
7.	Mn	0.014
8.	Ti	0.009
9.	Er	0.006
10.	Sr	0.006
11.	Cr	0.004
12.	Cu	0.002
13.	Ni	0.002
14.	Zn	0.001
15.	V	0.001
16.	CH	96.142

Table (4) Yield Percent of Seaweed Powder

Sr. No.	Weight of Seaweed (raw) (g)	Weight of Seaweed (after washing) (g)	Weight of Seaweed (after drying) (g)	Weight of Seaweed Powder (g)	Yield (%w/w)
1.	37.4	32.8	12.07	11.87	31.74

Table (5) Effect of Composition on Texture of Seaweed Noodle

Sr. No.	Samples	Ingredients (g)				Texture
		Wheat Flour	Potato Flour	Seaweed	Sodium Bicarbonate	
1.	I	100	-	-	1.0	Cream color and very hard noodle on boiling
2.	II	80	10	10	1.0	Cream color and little hard noodle on boiling
3.	III*	70	20	10	1.0	Light brown and soft noodle on boiling
4.	IV	60	30	10	1.0	Brown and soft noodle on boiling

* the most suitable formulation of seaweed noodle

Table (6) Effect of Seaweed Contents on Color and Crude Fiber Content of Seaweed Noodle

Wheat Flour = 70 g

Potato Flour = 20 g

Baking Soda = 1.0 g

Sr. No.	Sample	Amount of Seaweed (g)	Color of Seaweed Noodle	Crude Fiber	Literature**
1.	I	0	White	0.28	1.69
2.	II	5	Pale Yellow	0.57	
3.	III*	10	Light Brown	1.45	
4.	IV	15	Brown	2.5	

* the most suitable amount of seaweed

** Berghofer, L.K. 2004.

Table (7) Characteristics of Seaweed Noodle

Sr. No.	Characteristics	Prepared Noodle	Lucky Noodle (from market)	Literature*
1.	Protein (% w/w)	10.26	7.14	13.4
2.	Fat (% w/w)	N. D	0.0	1.22
3.	Crude Fiber (% w/w)	1.45	0.28	1.69
4.	Carbohydrate (% w/w)	59.82	61.0	64.2
5.	Sugar (% w/w)	3.48	-	-
6.	Moisture (% w/w) **	6.68	11.34	10.0
7.	Ash (% w/w) **	0.96	2.12	0.89
8.	Energy Value **	280.32	272.56	-
8.	Rehydrating Ratio **	2.62	2.62	-
9.	Shelf Life (Months)	6	6	

N.D = not detected * Berghofer, L.K. 2004.

Conclusion

In this research work, the purified raw materials were used to produce the seaweed product. In the preparation of seaweed noodles, different formulations of wheat flour, potato starch and seaweed were used. It was found that the noodles with more wheat flour content gave hard and had more rehydration time. It was also found that the more seaweed content would lead the noodles into darker in color. The most suitable formulation was (70: 20:10) of wheat flour, potato starch, and seaweed.

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