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The Effects of Using Seaweed on the Rheological Properties of Asian Alkaline noodles

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Abstract : Seaweeds contain high levels of minerals, vitamins, essential amino acids, indigestible carbohydrates, and dietary fiber. The objective of this study was to use two type of seaweed such as Gracilaria and Ulva seaweed powder as an ingredient to make Alkaline noodle products of high nutritional quality with rich fiber content. The effect of wheat flour substitution with Gracilaria and Ulva seaweed powder was investigated in terms of the rheaological qualities of Asian Alkaline noodles. Five additional noodles were prepared by substituting wheat with 0, 1, 3, 5 and 7% Gracilaria and Ulva seaweed powder. The results shows that as the noodle containing 5% Gracilaria and Ulva seaweeds possessed the highest value of storage modulus G‟, it was possible to infer that 7% produced the least elastic cooked noodles, and 5% produced the most elastic cooked noodles. This indicate that further addition of seaweed also might have reinforced the seaweed was sufficient to bind of moisture but insufficient to fully exert the influence of seaweed over moisture..
Keywords : Seaweed, Gracilaria, Ulva, Alkaline noodle, Rheological properties.

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Introduction

Noodles are one of the favorite food products that are well accepted by many people of all ages. It has been a popular food item due to the convenience of preparation and reasonable price. (Afalla, 2010). Many varieties of noodles exist as a result of differences in formulation, processing, and quality characteristics. Seaweeds are macroscopic marine algae that form a part of the staple diet in some Asian countries such as Japan, Korea, and India (Sade et al., 2006). Ismail et al. (2002) reported that most Europeans and Americans use processed seaweeds as additives in their food preparation. Seaweeds are an excellent source of vitamins A, Bl, B12, C, D & E, riboflavin, niacin, pantothenic acid, and folic acid, as well as minerals such as Ca, P, Na, K. Their amino acid content is well balanced and contains all or most of the essential amino acids needed for life and health. They have more than 54 micro-elements required for the human body's physiological functions in quantities that greatly transcend vegetables and other land plants (Dhargalkar et al., 2004; Holdt et al., 2011; Norziah et al., 2000).

Red algae such as Gracilaria changgi mainly serve as a raw material from which agar or carrageenans are extracted out for use in the food industries or in the production of tissue culture media. Gracilaria showed contained a higher composition of unsaturated fatty acids (74%), mainly the omega fatty acids and 26% of saturated fatty acids (mainly palmitic acid), and also relatively high levels of calcium and iron (Chan et al., 2002).

Green macroalgae Ulva is considered valuable to human nutrition. its contained iron, protein, iodine, vitamins (A, B1, and C) and trace elements. Because of its antibacterial properties, it has been recommended to treat skin irritations typically, including burns (Apaydın et al., 2010).

Literature Review

The rheological properties of noodle dough can be used as quality indicators for the cooked noodle. Rheology is now well established as the science of the deformation and flow of matter. It is the study of the manner in which materials respond to applied stress or strain. All materials have rheological properties. These properties are described by rheometers. Many rheometers are used for the measurement of the dough rheological properties such as penetrometer, sensistometer, amylograph, farinograph, mixograph, extensigraph and alveograph described later (Mirsaeedghazi, 2008). Noodle dough is a viscoelastic and shear-thinning material combined with Hookean solid and non-Newtonian viscous liquid. The dough has non-linear rheological behavior, but in very low strains has linear behavior. The amount of low strain in which dough has linear behavior, depends on the type of dough, mixing, and testing method. Storage modulus (G') and loss modulus (G") can describe material’s rheological properties. The storage modulus can be used as a measure of the elastic component of the sample and similarly, the loss modulus can be used as a measure of the viscous component of the sample. An increase in protein in dough causes larger consistency. Increasing intermolecular cross-linkage causes higher G‟ and lower loss tangent in the dough. The interactions among protein molecules play important roles on the rheological properties. G' and G" decrease by increasing molecular weight and number of high molecular weight glutenin fractions, but increasing molecular weight causes increasing relaxation time. Thus, dough relaxation properties depend on the distribution of molecular weight in dough and particularly to glutenin subfraction. Strong flour dough has higher relaxation modulus and relaxation intensity over the whole relaxation time than those from weak flour. In gluten protein fractions, gliadin and soluble glutenin have one relaxation process, indicating no network structure (Yu, 2003).

The rheological properties of dough can be used as quality indicators for the final cereal products. A variety of instruments, empirical, fundamental, and dynamic rheometry had been used in the past few decades for rheological tests. Fundamental rheometry is capable of describing the physical properties of a material over a wide range of strains and strain rates. It allows direct comparison of results obtained by various testing instruments and researchers (Yu, 2003). Similarly, dynamic rheometers allow measurements without disturbing the inherent structure of materials. These instruments simultaneously measure the elastic as well the viscous components of dough and can give a better prediction to the quality of the final cereal products (Mirsaeedghazi, 2008).

Materıals and Methods

Samplıng of Seaweed

Gracilaria and Ulva Seaweeds were collected from Sabah, Malaysia. The seaweeds were cleaned and washed with distilled water to remove epiphytes and encrusting material and then freeze-dried. Dry seaweed powder samples were stored in plastic bags in desiccators at room temperature prior to extraction (Sasidharan et al., 2008). Some volume of fresh Gracilaria and Ulva seaweeds were used for making 1: 2 seaweed juices.

Materıals and Processıng

After prepared of Gracilaria and Ulva seaweed powder, Gracilaria and Ulva seaweed juice, all noodle ingredients: flour, water, kansui, salt were purchased from the local supermarket.

Table 1. Seaweed Noodle Formulation

	Component formulation				**Actual formulation**			
Formulation	**Seaweed : flour (%)**	**Water (%)**	**Kansui (%)**	**Salt (%)**	**Seaweed : flour (g)**	**Water (ml)**	**Kansui (g)**	**Salt (g)**
control	0 : 100	32	1	1	0 : 50	16	0.5	0.5
1% powder	1 : 99	32	1	1	0.5 : 49.5	16	0.5	0.5
3% powder	3 : 97	32	1	1	1.5 : 48.5	16	0.5	0.5
5% powder	5 : 95	32	1	1	2.5 : 47.5	16	0.5	0.5
7% powder	7 : 93	32	1	1	3.5 : 46.5	16	0.5	0.5
1% juice	1 : 99	32	1	1	1.5 : 49.5	15	0.5	0.5
3% juice	3 : 97	32	1	1	4.5 : 48.5	13	0.5	0.5
5% juice	5 : 95	32	1	1	7.5 : 47.5	11	0.5	0.5
7% juice	7 : 93	32	1	1	10.5:46.5	9	0.5	0.5

Table 1 shows the general formulation for alkaline noodles. Alkaline salt was dissolved in an appropriate amount of distilled water before adding to flour. The solution was stirred constantly using magnetic stirrers in 500 ml plastic screw cap containers until all salt (or alkali) was dissolved. 49.5g of flour sample and 0.5 g seaweed powder (for the second and third test will use 1.5g, 2.5, and 3.5g) was measured and placed in the mixer bowl of the mixer and mixed for 30 sec. Using a rubber spatula a well was made in the center of the bowl and all the alkaline salt solution was added. Total mixing time was 3 min and 30 sec after resting for 30 minutes (first resting).

The dough was compounded using the rolls of a Noodle Machine. The gap on the rollers was set at 4.0 mm and the dough crumble was compressed between them to form the first crude sheet. The dough was sheeted 3 more times, each time being folded once and traveling through the rollers in the same direction. The dough sheet was placed loosely, the dough sheet rested for another 30 minutes (second resting).

After the second rest, the dough was sheeted by passing it through the rollers 4 times with progressively reduced gaps of 3.5, 3.0, 2.0, and 1.5 mm. Dough thickness was measured using a Peacock thickness gauge. The roll gap was adjusted accordingly to give a final dough thickness of 1.2 ± 0.05 mm. All the noodle dough and strip samples were stored at room temperature for 24 hours before cooking.

For seaweed juice noodles, flour content was not changed but water content changed because seaweed juice was prepared with water and seaweed according to the 2:1 ratio. The noodle making process was similar to the steps mentioned earlier.

Noodle Cooking

50 ± 0.5 g of noodles were boiled in 750 ml of distilled water at high heat for 1 min, after 1 min, the temperature was lowered to medium, to stop the water from boiling over. Cooking then continued for another 1 minute until the uncooked core has disappeared. The total cooking time was 2 minutes. After cooking, the noodle sample was rinsed with distilled water at room temperature for 1 minute and drained.

Rheologıcal Test

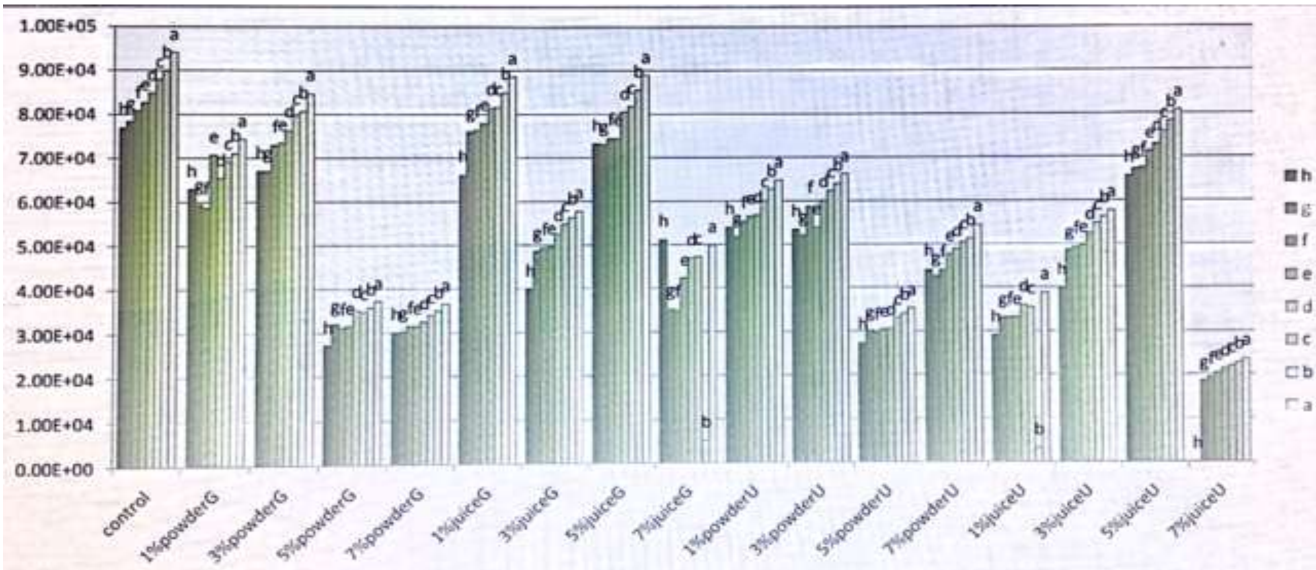
Rheological tests were conducted using a controlled rate rheometer operated with parallel plate geometry of 40 mm diameter. A preliminary test was made by performing a strain sweep (0.001 to 10%) at a frequency of 1 Hz, which showed a linear viscoelastic region of the noodle dough below the strain value of 1.0%. Therefore dynamic oscillatory measurements were made at a strain of 0.03% with a frequency sweep between 0.5 and 5 Hz. The data for the analysis were collected at a frequency of 1 Hz. The test was done immediately after the noodle disk (cutting from noodle sheet of dimension 2.5 mm thickness and 40 mm diameter) was brought out from the box, and lubricated with oil to avoid drying of the disk during the test. Relevant rheological parameters were obtained, including storage modulus (G'), loss modulus (G"), and phase angle (δ). These parameters were obtained by using the software analysis program of the rheometer. All the tests were carried out in three repetitions and the average values were calculated and used for further statistical analysis.

Statistical Analysis

The means and standard deviations were determined for rheological properties. The significant difference of mean values was assessed with one-way analysis of variance (ANOVA) followed by Duncan‟s test using SAS software at a significance level of ($P < 0.05$) (Ritthiruangdej et al., 2011).

Result and Discussion

Rheology of Seaweed Noodles



Frequency: h, g, f, e, d, c, b, a = 0.5Hz – 5Hz

Figure 1. Gracilaria and Ulva seaweed noodles storage modulus

Statistical analysis of data showed that Gracilaria and Ulva seaweed additions significantly ($p < 0.05$) affected storage modulus (G‟) for noodles. Figure 1 shows the storage modulus (G‟) versus deformation frequency of the seaweed noodles. Cooked noodle G‟ from all 17 samples was positively related to increased deformation frequency. Reungmaneepaitoon (2006) showed a higher frequency of dependency for G‟ in cooked noodles with decreased amylose content. However, Figure 1 showed that as increasing seaweed powder and juice addition level from 0 to 1, 3, 5, 7%, the storage modulus G‟ increased significantly. This indicated that increasing the addition level of seaweed to noodles might have reinforced the presence of seaweed in a proportion that was sufficient to bind a substantial quantity of moister, however, was insufficient to fully exert the influence of seaweed over moisture. This interacting development might have resulted in a significant decrease of storage modulus G‟, which was also a measure of the elastic property of noodle dough.

Table 2 shows the mean phase of angle (δ), storage modulus (G‟), and loss modulus (G”) of the Gracilaria and Ulva seaweed noodles. Mean values of three replicates with each of them with 2 repeated measures were reported. The values at a deformation frequency of 1 Hz (Figure 1) were used for comparison. There were significant differences between the varieties for all the rheological parameters measured ($p < 0.05$). Cooked noodle δ ranged from 2.5 – 6.8, the low δ values confirmed that the cooked noodle had primarily solidlike characteristics, as one would perceive from handling the products. The cooked noodle δ values observed in this study were within the range of reported values from Nitta (2005). As shown in table 2, there were no significant differences in elasticity between the Gracilaria and Ulva seaweed noodles. As the noodle containing 7% Gracilaria and Ulva seaweeds powder possessed the lowest value of storage modulus G‟‟, as the noodle contains 3% seaweed powder possessed the highest value of storage modulus G‟‟. It was possible to infer that noodles containing7% seaweed powder produced the least elastic cooked noodles, and noodles containing 3% seaweed powder produced the most elastic cooked noodles. 7% seaweed powder noodle’s lower G‟‟ value may be due to weaker dough mixing properties (Wang et al., 2011). At 3% Gracilaria and Ulva powders addition level, this implied that the interaction effects of seaweed and water addition were sufficient to fully exert the elastic characteristics of the noodle dough and hence caused increased storage modulus G‟‟ (Mirsaeedghazi et al., 2008). Nitta (2005) reported a positive correlation between G‟‟ of cooked noodle and starch amylose content.

Table 2. Mean value of dynamic viscoelasticity of cooked seaweed noodles

Sample	**δ (°)**	**G' (kPa)**	**G" (kPa)**
0%	1.3	9.41	1.62
1%G	1.29[d]	7.43[b]	8.93[b]
3%G	1.48[c]	8.47[a]	9.96[a]
5%G	2.11[a]	3.72[c]	7.56[c]
7%G	1.68[b]	3.66[d]	6.15[d]
1%GJ	1.23[d]	8.85[b]	9.37[c]
3%GJ	1.62[a]	5.77[c]	9.40[b]
5%GJ	1.33[c]	8.89[a]	9.76[a]
7%GJ	1.38[b]	5.14[d]	8.75[d]
1%U	1.80[c]	6.47[b]	9.98[a]
3%U	1.06[d]	6.62[a]	6.36[d]
5%U	1.87[b]	3.53[d]	6.62[c]
7%U	1.99[a]	5.44[c]	9.76[b]
1%UJ	1.62[b]	3.87[c]	6.27[c]
3%UJ	1.58[c]	5.77[b]	9.40[b]
5%UJ	1.44[d]	8.08[a]	9.51[a]
7%UJ	1.81[a]	2.35[d]	4.27[d]

δ - phase angle, G' - storage modulus, G" - loss modulus

a Values followed by the same letter in the same column are significantly different ($p < 0.05$).

Table 2 suggested that 3% seaweed noodles had a higher amylose content. However, G‟‟ was the lowest from this variety in contrast to the findings of Nitta (2005). This indicated that seaweed content and dough mixing properties may have been the dominant factors in influencing G‟‟ in 7% seaweed noodle. G” values were highest when noodle containing 3% seaweed and had the lowest value when noodle containing 7% seaweed, following the same trend as observed in G‟‟ (Table 2) and were consistent with the results showing in similar phase angle values (∝ G”/G‟‟) for all Gracilaria and Ulva seaweed powder noodles. G‟‟ values of Gracilaria and Ulva seaweed juice noodles were decreased with the increase of seaweed juice concentration from 1 to 3, 5 and 7%, this might be due to seaweed absorbing most water in the seaweed juice, as noodle doughs were inherently limited in moisture content, thus accentuating competition for available water. Table 2 also shows that as the noodle containing 5% Gracilaria and Ulva seaweed juice possessed the highest value of storage modulus G‟‟, it was possible to infer that 7% produced the least elastic cooked noodles, and 5% produced the most elastic cooked noodles. The above results indicate that seaweed as a hydrocolloid substance was able to exert a greater binding influence on water and form strong films which might have resulted in increased storage modulus at the lower moisture content (Yu, 2003). As the seaweed juice content was increased from 5% to 7%, this influence steadily diminished. This indicates that further addition of seaweed juice also might have reinforced the seaweed was sufficient to bind of moisture but insufficient to fully exert the influence of seaweed over moisture.

Conclusion

The results of the current study indicate that Noodles 3% added Gracilaria and Ulva seaweed powder and 5% added Gracilaria and Ulva seaweed juice was most elastic among all seaweed noodles, noodles made from 7% Gracilaria and Ulva seaweed powder and juice had the lowest elasticity among all seaweed noodles studied. The optimum addition level of Gracilaria and Ulva seaweed powder and juice into the noodles was 3%. Therefore, future research and progress were required to be focused on investigating the potential of using Gracilaria and Ulva seaweed in the food industry and the optimum amount for application in noodle manufacturing.

References:

1. Afalla, A. 2010. Nutria-enriched seaweed noodles. Aquatic Technology Competion and Marketplace.70-77.
2. Sade, A., Ali, I. & Ariff, M. R. M. 2006. the seaweed industry in sabah, east malaysia. The 7thAsian Fisheries Farm.
3. Ismail, A. & Hong, T.S. 2002. Antioxidant activity of selected commercial seaweeds. Mal J Nutr 8(2): 167-177.
4. Holdt, S. L. & Kraan, S. 2011. Bioactive compounds in seaweed: functional food applications and legislation. J Appl Phycol. 23: 543–597.
5. Dhargalkar, V.K. & Kavlekar, D. 2004. Seaweeds - a field manual. National Institute of Oceanography, Dona Paula, Goa - 403 004.
6. Norziah, M. H. & Ching, C. Y. 1999. Nutritional composition of edible seaweed racilaria changgi. Food Chemistry. 69-76.
7. Chan, C. X., Teo, S. S., Ho, C. L., Othman, R.Y. & Phang, S. M. 2002. Optimisation of RNA extraction from Gracilaria changii (Gracilariales, Rhodophyta). PASCApostgraduate fellowship from the Ministry of Science, Technology and the Environment, Malaysia, and Vote F (F0131/2002A) from University of Malaya, the IRPA grant no. 06-02-02-003.
8. Apaydın. G., Aylıkcı1. V., Cengiz. E., Saydam. M., Küp. N. & Tıraşoğlu. E. 2010. Analysis of metal contents of seaweed (Ulva lactuca) from istanbul. Turkish Journal of Fisheries and Aquatic Sciences 10: 215-220
9. Mirsaeedghazi. H., Emam-Djomeh. Z & Mousavi. S. M. A. 2008. Rheometric measurement of dough rheological characteristics and factors affecting it. International Journal of Agriculture & Biology
10. Sasidharan, S., Darah, I. & Noordin, M. K. 2008. Preliminary isolation and in vitro antiyeast activity of active fraction from crude extract of Gracilaria changii. Indian J Pharmacol, 40(5): 227-229.
11. Ritthiruangdej, P., Parnbankled, S., Donchedee, S. & Wongsagonsup, R. 2011. Physical, chemical, textural and sensory properties of dried wheat noodles supplemented with unripe banana flour. Kasetsart J. (Nat. Sci.) 45: 500 - 509.
12. Reungmaneepaitoon. S., Sikkhamondhol. C. & Tiangpook. C. 2006. Nutritive improvement of instant fried noodles with oat bran. Nutraceutical and Functional Food, Vol.28 (Suppl.1), 89-96
13. Nitta. Y & Nishinari. K. 2005. Gelation and gel properties of polysaccharides gellan gum and tamarind xyloglucan. J. Biol. Macromol., 5(3): 47-52
14. Wang.F., Huang.W., Kim. Y., Liu. R & Tilley. M. 2011. Effects of transglutaminase on therheological and noodle-making characteristics of oat dough containing vital wheat gluten or egg albumin. Journal of Cereal Science 53-59
15. Mirsaeedghazi. H., Emam-Djomeh. Z & Mousavi. S. M. A. 2008. Rheometric measurement of dough rheological characteristics and factors affecting it. International Journal of Agriculture & Biology
16. Yu. L. J. 2003. Noodle dough rheology and quality of instant fried noodles. Department of Bioresource Engineering Macdonald Campus, McGill University Montreal, Quebec.

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