



Enhancement of Gel Strength of Surimi from Japanese Threadfin Bream (*Nemipterus japonicus* Bloch, 1791) using Seaweed Extract

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Abstract

In the present investigation attempts were made to extract phenolic compounds from seaweed which is abundantly available along the west coast of India and to use it as cross-linker in Japanese threadfin bream surimi. Brown seaweed (*Sargassum tenerrimum*) was extracted using water and water seaweed extract (WSE) contained 16.24 mg tannin g⁻¹ of dry seaweed powder. Effect of WSE at different levels on Japanese threadfin bream (*Nemipterus japonicus*) surimi was investigated in comparison with surimi gel without seaweed extract (control). Gels added with 0.02% WSE showed 30% increase in gel strength, when compared with control. Lower expressible moisture content was observed in surimi gels incorporated with 0.02% WSE. Slight decreases in whiteness and insignificant increase in pH were observed with increasing seaweed extract concentration. However, significant difference was observed in the sensory properties of Japanese threadfin bream surimi gel added with 0.02% seaweed extract. Thus, the seaweed extract could be used as surimi gel enhancer without affecting its sensory properties.

Keywords: Gelation, seaweed, *Nemipterus japonicus*, surimi, phenolic compounds

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Introduction

In recent times, total utilization of fish landings, including underutilized fish species as human food, has been realized because of the diminishing marine

catch and increasing consumer interest in fish products. Surimi technology has been recognized as one of the most successful techniques for low cost fish utilization. The textural properties developed during surimi gelation are normally expressed in terms of gel strength, which is the basic parameter for determining the quality and price of surimi (Benjakul et al., 2004). To increase the gel strength of surimi, various food grade ingredients and protein additives have been used. However, the addition of these ingredients poses adverse effect on flavour and colour of surimi gel (Rawdkuen & Benjakul, 2008). Recently, interactions between phenolic compounds and proteins have been paid more attention in the processing of certain food products. There have been a few studies describing the cross linking ability of phenolic compounds with proteins (Rawel et al., 2002; Strauss & Gibson, 2004).

Brown seaweed (*Sargassum tenerrimum*) is very common along the west coast of India. Phenolic compounds make upto 20% of dry weight of seaweeds phenol level (Connan & Stengel, 2007). Tannins with phenolic character occur in marine algae in the phaeophytes of Phaeophyta, such as *Sargassum* species (Vimalabai et al., 2004). Pharmacologists, physiologists and chemists have been paying increasing attention to marine organisms particularly seaweeds for bioactive substances (Arunkumar et al., 2010). Phenolic compounds, mainly phlorotannins are found at high level in marine brown algae (Ragan & Glombitza, 1986). Preparation of seaweed extract containing phenolic compounds could increase the value of these seaweeds and the novel natural additives can be applied in food industry, especially surimi industry.

However, there is little information on the utilisation of seaweed extract as cross-linking agents in food proteins, particularly myofibrillar proteins. Therefore, the objectives of this research were to extract

phenolic compounds from seaweeds and to use the crude extract as gel enhancer in the surimi of Japanese threadfin bream.

Materials and Methods

Brown seaweed (*S. tenerrimum*) species were hand-picked from Ratnagiri coast washed with fresh water, sun dried for 14 days, ground (Kenstar, Senator, Japan) and then sieved with Test sieve (Jayant scientific, India) of diameter 0.07 mm. Seaweed extract was prepared according to the method described by Zahra et al. (2007) with slight modification *viz.*, prepared extract was evaporated directly on flame and final water seaweed extract (WSE) was collected in glass bottle.

Quantification of total phenolic compounds in seaweed extracts was carried out according to the Folin-Ciocalteu method of Kuda et al. (2005). Extract was measured in triplicate against a tannic acid standard curve, and the results were expressed as mg of Tannic acid equivalent (TA) g⁻¹ dry sample.

Japanese threadfin bream (*Nemipterus japonicus*) surimi was purchased from M. D. Naik, Pethkilla, Ratnagiri, which was prepared without any additives. Surimi gel was prepared according to the method described by Balange & Benjakul (2009a). While preparing surimi gel in a mincer, 3% salt and seaweed extract containing 16.24 mg tannin g⁻¹ of dry seaweed powder, at different concentrations *viz.*, 0.02, 0.04, 0.06 and 0.08% were added. Prepared surimi sol was stuffed in krehlon (UK) casing and subjected to setting at 40°C for 30 min, then sausages were chilled in ice for 20 min and stored in incubator (Metalab, Mumbai, India), overnight at 20°C prior to analysis. The control gels were prepared in similar way, without addition of seaweed extract.

Textural analysis of gels was performed using a texture analyser - RHEO TEX (Type: SD-700, Japan). Gels were tested at room temperature. Prepared surimi sausages were cut into five cylindrical shaped pieces of 2.5 cm in length. The breaking force (g) and deformation (cm) were measured by texture analyzer with spherical plunger (5 mm diameter; 60 mm min⁻¹ plunger speed). Gel strength for each surimi sausage was measured from respective breaking force and deformation.

Expressible moisture content was measured according to the method of Balange & Benjakul (2009b) by using the equation: Expressible moisture content (%) = 100 [(X - Y) / X].

Whiteness was measured by using whiteness meter (MINIOLTA, Chroma meter CR-400; Japan). The pH was recorded by using a pH meter (Sentex, California, USA).

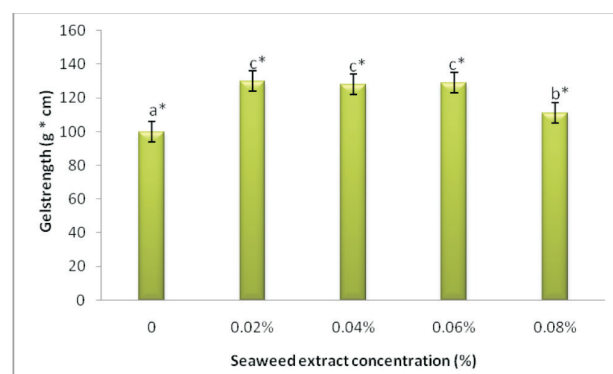
Japanese threadfin bream gels without and with seaweed extract were evaluated for appearance, colour, taste, texture, odour and overall liking by 10 trained panelists, in comparison with the control gel. A nine-point hedonic scale was used for evaluation (Meilgaard et al., 1990).

The experiments were run in triplicate. Data were subjected to analysis of variance (ANOVA). Comparison of means was carried out by Duncan's multiple-range tests. Analysis was performed using a SPSS package (SPSS 10.0 for Windows, SPSS Inc, Chicago, IL, USA).

Results and Discussion

It was observed that the extract contained 16.24 mg tannin g⁻¹ of dry seaweed powder. Hwang et al. (2010) reported that, freeze dried hot water extract from *Sargassum hemiphyllum* contained 0.240 mg phenolic compound ml⁻¹ of extract. Zahra et al. (2007) found total phenolic compounds in *Sargassum boveanum* water extract was about 17 ± 0.492 mg catechin equivalent g⁻¹ of dry sample.

Surimi gel with 0.02% WSE showed 30% increase in gel strength, than control (p < 0.05) (Fig. 1). Generally multidentate mechanism requires a much lower phenolic compound / protein molar ratio and thus a lower concentration of phenolic compound is needed (Haslam, 1989). In the present investigation, 0.02% concentration of WSE improved the gel

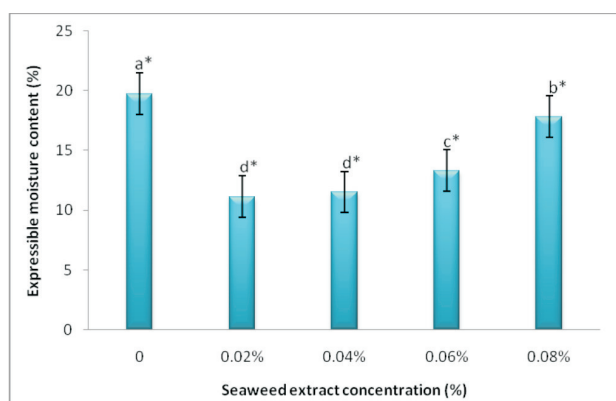


*Different letters indicate the significant difference (p < 0.05); ± Standard error of mean (n=3)

Fig. 1. Effect of seaweed extract on gel strength of *Nemipterus japonicus* surimi

strength and this might be attributed to the multidenate mechanism. However, with further increase in the concentration of WSE above 0.02%, decrease in gel strength was found. This decrease may be associated with self-aggregation of phenolic compounds, leading to the loss in capability of protein cross-linking.

The lowest expressible moisture content was found in surimi gel with optimum WSE of 0.02% while it was high in control gel and in surimi gels prepared with 0.08% WSE ($p < 0.05$), but, was lower than control values (Fig. 2). During setting, proteins underwent some denaturation and aligned themselves gradually to form the network, which can imbibe water (Benjakul & Visessanguan, 2003). The decrease in expressible moisture contents of surimi gel added with optimum WSE concentration was found in accordance with increased gel strength and indicate greater water holding capacity. Balange & Benjakul (2009a) reported the lowest expressible moisture content of mackerel surimi gel with optimum water kiam wood extract and the increase was found above optimum level. Balange & Benjakul (2009b) also reported lowest expressible moisture content in gels with addition of 0.50% oxidized tannic acid.

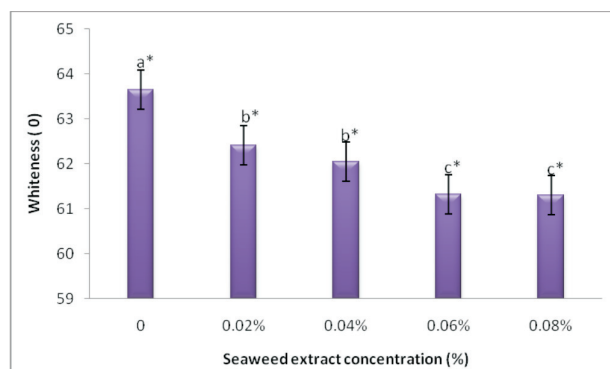


*Different letters indicate the significant difference ($p < 0.05$); $\pm$ Standard error of mean ($n=3$)

Fig. 2. Effect of seaweed extract on expressible moisture content of *Nemipterus japonicus* surimi

Progressive decrease in whiteness of Japanese threadfin bream surimi gels was observed as the levels of the WSE increased (Fig. 3) ($p < 0.05$), which may be attributed due to phenolic compounds. Phenolic compounds were responsible for discolouration in cheese products (O'Connell & Fox, 2001). Most of the phenolic compounds are stable

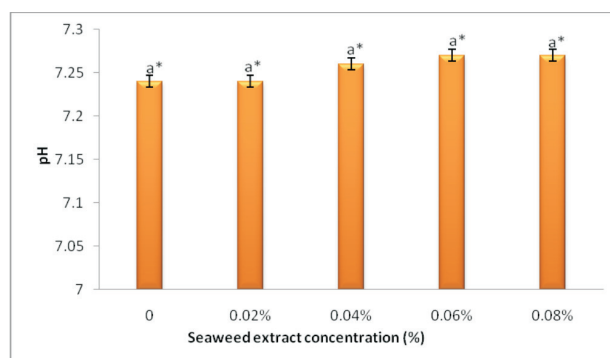
at neutral pH values and are suitable colourants (Asen et al., 1979).



*Different letters indicate the significant difference ($p < 0.05$); $\pm$ Standard error of mean ($n=3$)

Fig. 3. Effect of seaweed extract on whiteness of *Nemipterus japonicus* surimi

In the present study, addition of WSE showed insignificant increase in pH ($p > 0.05$) (Fig. 4), with increasing concentration in surimi. The WSE added in surimi contain higher amount of phenolic compounds *viz.*, polyphenols, possessing one or more aromatic rings bearing hydroxyl substituent (Parr & Bolwell, 2000), which resulted in increase of surimi pH. But the WSE quantity added in surimi was very less, hence insignificant increase in pH was found.

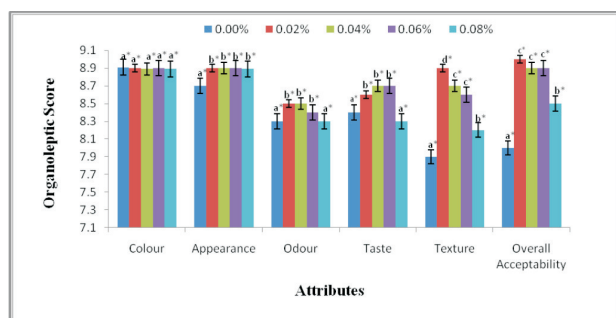


*Same letters indicate the insignificant difference ($p > 0.05$); $\pm$ Standard error of mean ($n=3$)

Fig. 4. Effect of seaweed extract on the pH *Nemipterus japonicus* surimi

The lowest overall acceptability for Japanese threadfin bream surimi was found in control surimi gel (Fig. 5). Decrease in overall acceptability was found in surimi gel prepared with WSE concentration above optimum level. Among the WSE, the extract added at 0.02% to surimi obtained highest overall

acceptability ($p < 0.05$). Balange & Benjakul (2009a) also reported the highest overall acceptability for surimi gel prepared with 0.15% ethanolic kiam wood extract, which exhibited highest surimi gel strength.



*Different letters indicate the significant difference ($p < 0.05$); $\pm$ Standard error of mean ($n=3$)

Fig. 5. Sensory score of *Nemipterus japonicus* surimi gels with and without seaweed extract

Water seaweed extract had a potential in strengthening the gel of Japanese threadfin bream surimi when the optimum level (0.02%) was introduced with no detrimental effect on sensory properties of surimi gel. Thus, the extract from seaweed can be used as a natural gel enhancer for fish surimi industry.

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References

- Asen, S., Stewart, R. N. and Norris, K. H. (1979) Stable foods and beverages containing the anthocyanin, peonidin, 3-(dicaffeoylsophoroside)-5- glucoside, US Patent 4172902
- Arunkumar, K., Sivakumar, S. and Rengasamy, R. (2010) Review of bioactive potential in seaweeds (Marine Macroalgae): A special emphasis on bioactivity of seaweeds against plant pathogens. *Asian J. Plant Sci.* 9: 227-240
- Balange, A. and Benjakul, S. (2009a) Effect of oxidized phenolic compounds on the gel property of mackerel (*Rastrelliger kanagurta*) surimi. *LWT- Food Sci Technol.* 42: 1059-1064
- Balange, A. and Benjakul, S. (2009b) Use of kiam wood extract as gel enhancer for mackerel (*Rastrelliger kanagurta*) surimi. *Int. J. Food Sci. Technol.* 44: 1661-1669
- Benjakul, S. and Visessanguan, W. (2003) Transglutaminase-mediated setting in bigeye snapper Surimi. *Food. Res. Int.* 36: 253-266
- Benjakul, S., Visessanguan, W. and Chantarasuwan, C. (2004) Effect of high temperature setting on gelling characteristics of surimi from some tropical fish. *Int. J. Food Sci. Technol.* 39: 671-680
- Connan, S. and Stengel, D.B. (2007) Environmental control of Brown Algal Phenol Production and Assessment of their Metal Binding Properties. 1st Environmental Change Institute Research Day, NUI Galway, 21st June 2007
- Haslam, E. (1989) Plant Polyphenols: Vegetable Tannins Revisited (Phillipson, J. D., Ayres, D. C. and Baxter, H., Eds), 230 p, Cambridge University Press Cambridge
- Hwang, P., Wu, C., Gau, S., Chien, S. and Hwang, D. (2010) Antioxidant and immune – stimulating activities of hot water extract from seaweed *Sargassum hemmiphylum*. *J. Mar. Sci. Technol.* 18: 41-46
- Kuda, T., Tsunekawa, M., Hishi, T. and Araki, Y. (2005) Antioxidant properties of dried 'kayamo-nori', a brown alga *Scytosiphon lomentaria* (Scytosiphonales, Phaeophyceae). *Food Chem.* 89: 617-622
- Meilgaard, M., Civille, G.V. and Carr, B.T. (1990) Sensory Evaluation Techniques. Boca Raton, Florida CRC Press
- O'connell, J. E. and Fox, P. F. (2001) Significance and applications of phenolic compounds in the production and quality of milk and dairy products. *Int. Dairy J.* 11: 103-120
- Parr, A. J. and Bolwell, G. P. (2000) Phenols in the plant and in man. The potential for possible nutritional enhancement of the diet by modifying the phenol content or profile. *J. Sci. Food Agric.* 80: 985-1012
- Ragan, M. A. and Glombitza, K. W. (1986) Phlorotannins, brown algal polyphenols. In: Progress in Phycological Research, IV, (Round, F. E. & Chapman, D. J., Eds), pp 129-241, Biopress, Bristol, UK
- Rawdkuen, S. and Benjakul, S. (2008) Whey protein concentrate: Autolysis inhibition and effects on the gel properties of surimi prepared from tropical fish. *Food Chem.* 106: 1077-1084
- Rawel, H. M., Czajka, D., Rohn, S. and Kroll, J. (2002) Interactions of different phenolic acids and flavonoids with soy proteins. *Int. J. Biol. Macromol.* 30: 137-150
- Strauss, G. and Gibson, S. M. (2004) Plant phenolics as cross-linkers of gelatin gels and gelatin-based coacervates for use as food ingredients. *Food Hydrocoll.* 18: 81-89
- Vimalabai, C., Prathiba, R. A. and Sumithra, P. (2004) Phenolic compounds in brown seaweeds from Tuticorin, southeast coast of India. *Seaweed Res. Util.* 26 (1-2): 93-98
- Zahra, R., Mehrnaz, M., Farzaneh, V. and Kohzad, S. (2007) Antioxidant activity of extract from a brown alga, *Sargassum bovenum*. *Afr. J. Biotechnol.* 6 (24): 2740-2745