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Antioxidant Capacity and Polyphenol Content of Brown Seaweeds after Heat Processing

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Introduction

Seaweeds or marine macroalgae are renewable living resources used as food, feed and fertilizer in many parts of the world.

These produce a great variety of secondary metabolites characterized by a broad spectrum of biological behavior such as antibacterial and antioxidant capacities.

Over 500 different species of seaweed from Irish coast have been identified out of which 147 species belongs to brown algae.

The traditional role of antioxidants is to inhibit the development of oxidative rancidity in fat-based foods, because oxidation is a naturally occurring process within the human body, a balance with antioxidants must exist to maintain health.

It has long been perceived that thermally processed food, fruits and vegetables have altered nutritional value than fresh produce because of variation in some physiochemical characteristics.

Objective

The present study aims at evaluating the effect of heat processing on polyphenol content and radical scavenging capacity of three species of raw and hydrothermally treated (autoclaved) Irish brown seaweeds; namely *Himanthalia elongata*, *Laminaria saccharina* and *Laminaria digitata*.



Laminaria digitata



Laminaria saccharina



Himanthalia elongata

Materials and Methods

Irish seaweeds
(*H. elongata, L. saccharina, L. digitata*)

Heat treatment
Sample/water ratio: 1:5
Temperatures: 85, 95, 100, 110 and 121 °C
Time: 15 minutes

Extraction
- Seaweed samples were ground with liquid nitrogen and extracted with methanol (60%) under nitrogen atmosphere for 2 hours.
- The extraction was carried out at 40 °C at 100 rpm in a shaker incubator followed by centrifugation at 9468xg for 15 minutes.
- The resulting extracts were concentrated under vacuum on a rotary evaporator.

(Gupta *et al.* 2010)

Antioxidant analysis

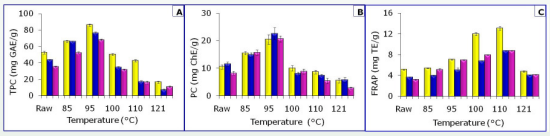
DPPH	FRAP
Sample (100 µl) in microtiter plate	Sample (50 µl) in microtiter plate
165 µM DPPH solution (100 µl)	Preheated 100 µl FRAP reagent (300 mM acetate buffer, pH 3.6; 10 mM TPTZ in 40 mM HCl and 20 mM $FeCl_3 \cdot 6H_2O$ in the ratio of 10:1:1)
Incubation at room temperature in dark for 30 min	
Read absorbance at 517 nm	Read absorbance at 593 nm after 10 min incubation.
Scavenging effect (%) $= \left[1 - \left(\frac{A_{sample} - A_{sample\ blank}}{A_{control}}\right)\right] \times 100$	

Phytochemical analysis

Total phenolic content (TPC)	Proanthocyanidin content (PC)
Sample (100 µl)	Sample (50 µl)
2% Sodium carbonate (2ml)	4% Vanillin solution (1.5 ml)
50% Folins reagent (100 µl)	Hydrochloric acid (750 µl)
Incubation at room temperature in dark for 30 min	Incubation at room temperature for 20 min
Read absorbance at 720 nm	Read absorbance at 500 nm

Results

Fig. 1: Total phenolic content (mg gallic acid equivalent/g), proanthocyanidin content (mg catechin equivalent/g) and FRAP value (mg trolox equivalent/g) of raw and heat processed Irish brown seaweeds (■: *H. elongata*, ■: *L. saccharina*, ■: *L. digitata*).

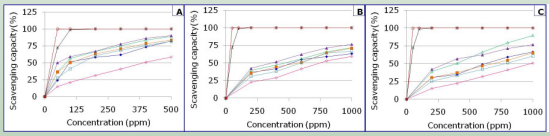


The TPC of brown seaweeds increased by thermal processing at 95 °C by 64, 75.6 and 69.8% as compared to raw *H. elongata, L. saccharina* and *L. digitata*, respectively.

The PC maximally increased by 94.3, 95.7 and 155.6% at 95 °C, as compared to raw *H. elongata, L. saccharina* and *L. digitata,* respectively.

The FRAP value increased maximum in *L. digitata* (2.8-fold) followed by *H. elongata* (2.6-fold) and *L. saccharina* (2.4-fold) at 110 °C.

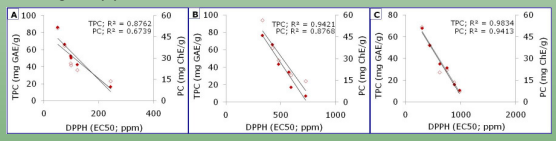
Fig. 2: DPPH radical scavenging capacity (%) of raw and heat processed *H. elongata* (A), *L. saccharina* (B) and *L. digitata* (C) seaweeds (◆) raw, (△) 85 °C, (▲) 95 °C, (■) 100 °C, (⊟) 110 °C, (◇)121 °C and (—◆—) ascorbic acid (AA), (○) BHT.



The highest DPPH• scavenging capacity was detected in raw *H. elongata* (EC_{50} 97.5 ± 1.90 ppm) followed by *L. saccharina* (EC_{50} 480.4 ± 5.71 ppm) and *L. digitata* (EC_{50} 619.5 ± 8.58 ppm).

The percentage reduction in EC_{50} values for all the seaweeds at 95 °C was 30.7 to 51.8%.

Fig. 3: Correlations analysis (r^2) between photochemical content and DPPH radical scavenging capacities (EC_{50}) of raw and heat treated *H. elongata* (A), *L. saccharina* (B) and *L. digitata* (C) seaweeds.



Conclusion

Present work revealed that Irish brown seaweeds are a good source of bioactive compounds. They have potent antioxidant capacity which was significantly increased by heating.

Heat processing not only enhanced the contents of biologically active compounds in seaweeds but also the biological activity associated with these compounds as compared to the unprocessed seaweeds.

These findings could provide new avenues for developing new nutraceutical foods based on seaweeds with particular considerations of processing conditions.

Literature Cited

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Yoshiki, M., Tsuge, K., Tsuruta, Y., Yoshimura, T., Koganemaru, K., Sumi, T., Matsui, T., & Matsumoto, K. (2009). Production of new antioxidant compound from mycosporine-like amino acid, porphyra-334 by heat treatment. *Food Chemistry*, 113, 1127–1132.

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"God made the world and seaweed made that field" - Bull Mc Cabe