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Antioxidant and antimicrobial activity from six species of edible Irish seaweeds

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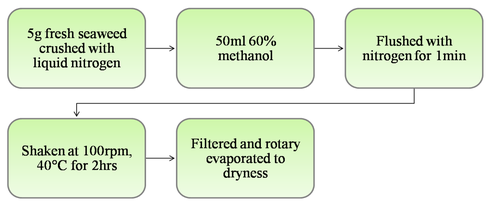
Introduction

- Seaweeds are macroalgae which are macroscopic plants of marine benthoses. Based on nutrient and chemical composition seaweeds are classified as Rhodophyta (red algae), Phaeophyta (brown algae) and Chlorophyta (green algae)
- Ireland harvests 32,000 tonnes of seaweed per year with an annual turnover of €15 million
- Seaweeds are a known source of bioactive compounds such as antiviral, antifungal, antimicrobial and antioxidants as they contain secondary metabolites characterized by a broad spectrum of biological activities
- Seaweeds are exposed to light and high oxygen concentrations which result in free radicals and other strong oxidizing agents being formed, however seaweeds seldom suffer any serious photodynamic damage which implies that their cells have protective mechanisms and compounds
- Seaweeds are a relatively unexploited resource in Ireland thus investigation into this plentiful resource could provide a promising alternative and natural source of bioactive compounds, neutraceuticals and functional foods

⇒ The main objective of this work was to investigate and evaluate the antioxidant and antimicrobial activity of six species of edible Irish seaweeds

Materials and Methods

Three species of Phaeophyta, two Rhodophyta and one Chlorophyta were used in this study.



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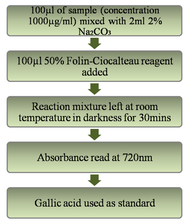
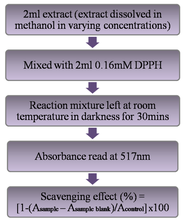
Antioxidant Analysis

Folin-Ciocalteau Method



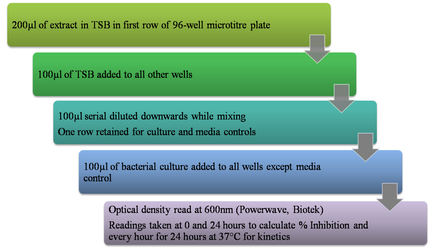
DPPH Method



Antimicrobial Analysis

Common food spoilage and food pathogenic bacteria used*	Type of bacteria
Listeria monocytogenes	Gram+ Food pathogenic bacteria
Salmonella enterica	Gram- Food pathogenic bacteria
Enterococcus faecalis	Gram+ Food spoilage bacteria
Pseudomonas aeruginosa	Gram- Food spoilage bacteria

*All grown overnight prior to analysis. Adjusted to 0.5 OD using McFarland Standards to prepare cultures at $1x10^6$ for microtitre analysis.



Results and Discussion

Extracts from six species of edible Irish seaweeds were screened for antioxidant and antimicrobial activity.

Antioxidant Analysis

- All six species of seaweeds exhibited antioxidant content using the Folin-Ciocalteau method for determination phenolic content (Fig. 1)
- *Himenthalia elongata* showed the highest content of phenolics (155.3 gallic acid units)

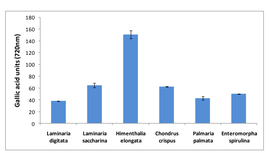
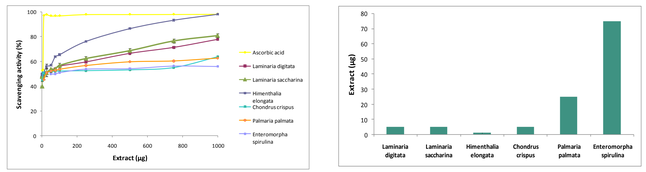


Fig. 1. Total phenolic content of seaweed extracts (Each data point is an average of 6 values)

- All species of seaweeds exhibited a concentration-dependent DPPH radical scavenging activity. DPPH assay is based on the concentration of sample required to reduce the DPPH radicals by 50% (EC_{50})
- All three species of brown seaweed and *Chondrus crispus* showed better scavenging capacity than *Palmaria palmata* and *Enteromorpha spirulina* (Fig. 2)
- *Himenthalia elongata* showed highest antioxidant activity giving 50% reduction of DPPH radical at 1µg/ml and gave 100% inhibition at 1000µg/ml
- Followed by *Laminaria digitata, Laminaria saccharina* and *Chondrus crispus* (all 5µg/ml)
- *Palmaria palmata* had an EC_{50} of 25µg/ml and *Enteromorpha spirulina* gave the lowest level (75µg/ml)



(a) **(b)**

Fig. 2. (a) DPPH free radical scavenging activity of seaweed extracts and (b) EC_{50} level of each seaweed extract (Each data point is an average of 6 values)

Antimicrobial Analysis

- Antimicrobial properties of seaweed extracts against two species of gram+ and gram- food pathogenic and food spoilage bacteria are displayed in Fig. 3
- Brown seaweeds had the highest antimicrobial activity
- *Himenthalia elongata* gave 100% inhibition of all bacteria at 12.8mg
- All extracts inhibited growth of bacteria except *Chondrus crispus* which increased the growth of the studied bacteria
- This may have been due to high levels of polysaccharides in the extract which supported bacterial growth
- All effective extracts had highest impact at inhibiting *Listeria monocytogenes*

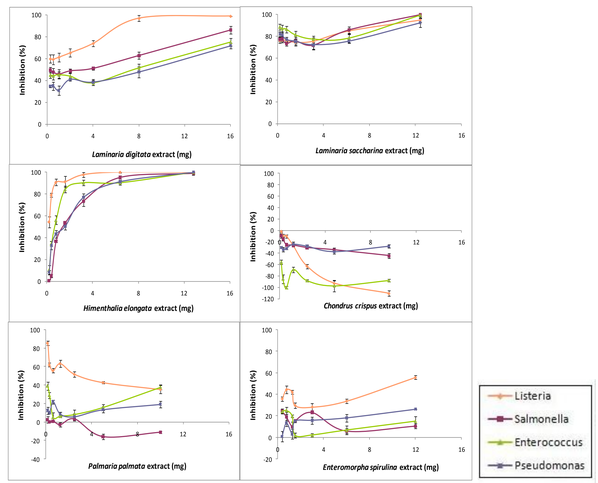


Fig. 3. Percentage Inhibition of seaweed extracts against food spoilage and food pathogenic bacteria (Each data point is an average of 6 values)

- The most effective concentration of seaweed extracts were analysed kinetically over 24 hours (Fig. 4)
- *Himenthalia elongata* was most effective against all bacteria inhibiting bacteria from the first hour, followed by *Laminaria saccharina* and *Laminaria digitata*
- *Palmaria palmata* and *Enteromorpha spirulina* increased the lag phase (average 2 and 4 hours respectively) after which growth increased
- *Chondrus crispus* increased the overall growth of the bacteria higher than the control

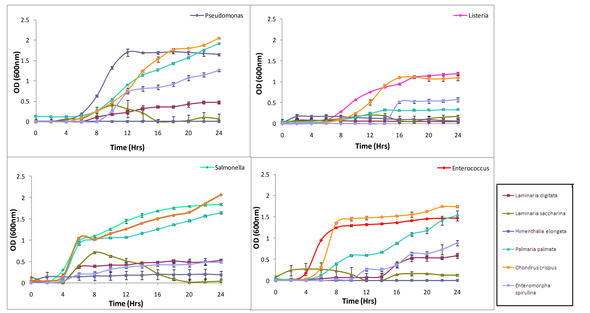


Fig. 4. Kinetic analysis of highest concentration of seaweed extract against common food spoilage and food pathogenic bacteria (Each data point is an average of 6 values)

Conclusion

- The results of the present work indicated that extracts of Irish seaweeds successfully displayed antioxidant activity
- *Himenthalia elongata* was most effective (phenolic content 155.3 gallic acid units; DPPH EC_{50} 1µg/ml extract)
- All seaweed extracts except *Chondrus crispus* had some antimicrobial activity
- *Himenthalia elongata* was most successful at inhibiting bacteria (100% inhibition at 12.8mg extract concentration) followed by the other two Phaeophyta *Laminaria saccharina* and *Laminaria digitata*
- *Chondrus crispus* increased the growth of all bacteria
- The present findings appear useful in leading to further experiments to test the potential of the extracts to increase the shelf life of food products. The ability of seaweed extracts to quench free radicals is known to take place over a longer period of time then rapid acting synthetic antioxidants such as BHA. This may have benefits for extending the shelf-life of processed foods during distribution and storage.

References

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