Characterization of alga *Fucus* sp. extracts and residues and their application in producing edible films

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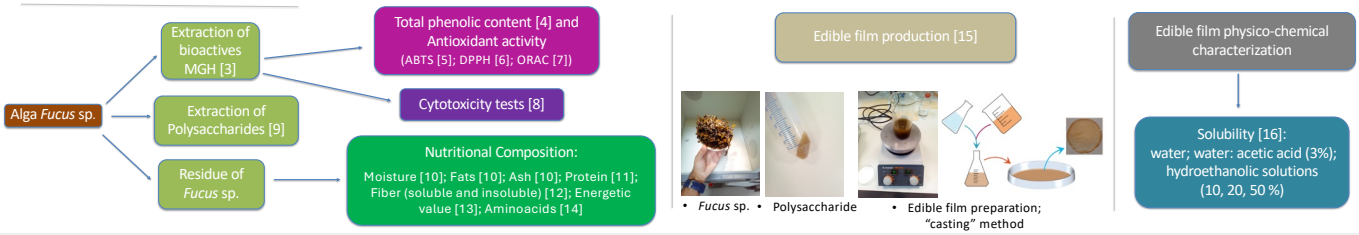
Introduction

Macroalgae are a good source of nutrients, such as carbohydrates (dietary fiber and polysaccharides), proteins, lipids and minerals, and they are sustainable, because they do not compete with food crops for arable land and potable water [1,2]. *Fucus* sp. is composed of valuable bioactive compounds, such as fucoxanthin, vitamins, water-soluble vitamins (vitamin C and of complex B) and fat-soluble vitamins (vitamins A, D, E and K), phenolic compounds, lipids (MUFA and PUFA), and polysaccharides (fucoidans and alginic acid) [1]. This brown alga has been associated with health benefits, with antioxidant, antimicrobial, anti-tumoral and anti-cancer properties [2]. Its application in the production of edible films presents high potential in food packaging, extending the shelf life of food products.

Objectives

- The integral valorization of *Fucus* sp. macroalgae, by extracting bioactive compounds, such as phenolic compounds, and extracting polysaccharides (PS).
- To evaluate the cytotoxicity and antioxidant activity of the bioactive extracts.
- To produce an edible film based on PS enriched with the bioactive extracts from *Fucus* sp.
- To test the physico-chemical properties of the edible film, such as the solubility.
- The nutritional characterization of the residues from the extractions.

Material and Methods



Results

- **Extracts obtained from microwave hydrodiffusion and gravity (MGH)**

Table 1. Total phenolic content (TPC) and antioxidant activity (AA) of the extracts

Extraction conditions	TPC (mg GAE/ 100 mL extract)	TPC (µg GAE/ 100 mg alga DW)	ABTS	DPPH	ORAC
			(µmol TE/100 mg extract DW)		
300 W, 20 min	8.6 ± 1.5 ^{a}	12.5 ± 4.2 ^{a}	3.53 ± 0.48 ^{a}	0.900 ± 0.104 ^{a}	4.38 ± 0.51 ^{a}
300 W, 30 min	4.3 ± 0.9 ^{b}	12.1 ± 1.5 ^{a}	1.99 ± 0.30 ^{b}	0.485 ± 0.090 ^{b}	1.80 ± 0.61 ^{b}
500 W, 20 min	4.5 ± 0.4 ^{b}	13.6 ± 0.8 ^{a}	1.79 ± 0.13 ^{b}	0.468 ± 0.014 ^{b}	2.15 ± 0.24 ^{b}

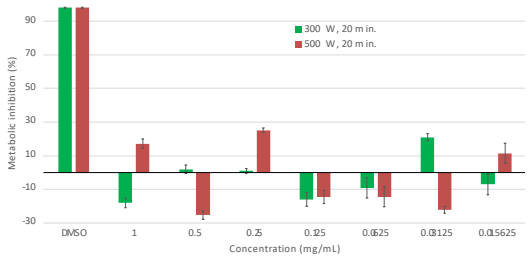


Figure 1. Metabolic inhibition of the extracts on cell line HaCat.

- ***Fucus* sp. residue**

Table 2. Nutritional composition of *Fucus* sp. residue

Component	*Fucus* sp. residue	*Fucus* sp. [1]
Moisture (%)	83.22 ± 0.75	68 – 88
Ash (g/100 g)	1.56 ± 5.4	19 – 36
Carbohydrates (g/100 g)	13.32	26 – 66
Sugars* (g/100g)	4.45	–
Fiber: insoluble; soluble (g/100g)	7.86 ± 0.07 1.01 ± 0.02	4 – 63
Protein (g/100 g)	1.5 ± 2.1	1 – 17
Fat (g/100 g)	0.4 ± 5.7	0.4 – 5
Energetic value (kcal)	63	112 – 377

*calculated by difference

Table 3. Aminoacids of *Fucus* sp. residue

Aminoacid	*Fucus* sp. residue (mg/100 mg DW)
Aspartic acid	11.60
Glutamic Acid	5.62
Cysteine	8.22
Asparagine	5.74
Histidine	22.92
Glycine	16.40
Threonine	0.37
Arginine	1.70
Alanine	ND
Tyrosine	3.60
Valine	6.89
Methionine	1.34
Isoleucine	0.99
Leucine	1.98

- **Edible film for packaging**

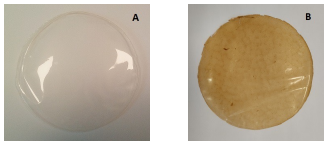


Figure 2. A – Alginate (3 %) edible film; B - Alginate (2 %) + *Fucus* sp. PS (0.5 %) + bioactives extract (0.25 %) edible film.

Table 4. Solubility of the alginate (2 %) + *Fucus* PS (0.5 %) + bioactives extract (0.25 %) edible film.

Film	H2O	Acetic acid 3 %	EtOH 10 %	EtOH 20 %	EtOH 50 %
Alginate (2 %) + *Fucus* sp. (0.5 %) + bioative extract (0.25 %)	100	20.71 ± 6.82	100	100	36.12 ± 1.01

Conclusions

Extraction at 300 W during 20 minutes is recommended for highest TPC and AA of the liquid extract. This extract showed no cytotoxicity for cells line HaCat.

The edible film based on the PS extracted from *Fucus* sp. enriched with bioactives extracted also from this alga presents 100 % solubility in water, which simulates hydrophilic foods, and lower solubility in hydroalcoholic solutions, which simulate hydrophobic foods.

This edible film has potential to be used in food packaging, whereas presenting high biodegradability.

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