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Filling the gap on *Grateloupia turuturu* and *Porphyra umbilicalis* nutritional and functional profiling: red seaweeds as sustainable alternatives to terrestrial crops

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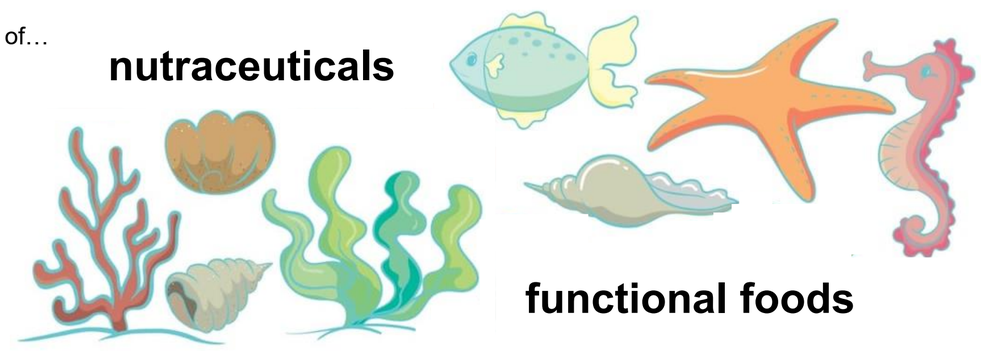
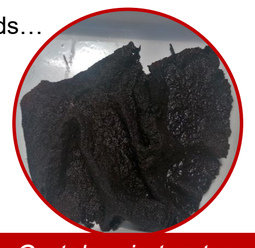
INTRODUCTION AND AIMS

The number of…



…from marine origin is increasing in the worldwide market [1].

Specifically, the red seaweeds…



Grateloupia turuturu

Porphyra umbilicalis

…have shown their potential considering… bioactive compounds nutritional value [1,2].

Nevertheless, it is pertinent to explore knowledge gaps regarding their **nutritional composition** and **bioactivities**.

The main objectives of this work included the determination of *G. turuturu* and *P. umbilicalis* proximate composition, mineral profile and neuroprotective and immunostimulatory activities.

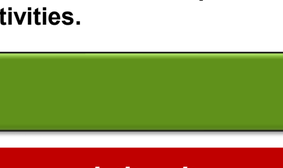
METHODS

Grateloupia turuturu *Porphyra umbilicalis*

For nutritional analyses

Seaweeds **proximate composition** was determined as:

Dry matter,
Ash,
Organic matter,
Crude protein (Kjeldahl method),
Crude lipid (gravimetric method),
Total fibre (TDF), Soluble fibre (SDF), Insoluble fibre (IDF) (enzymatic kit assay),
Total-soluble carbohydrates (TSC) (anthrone method),
(as % dw) [3].



Mineral profiling was carried out using ICP-OES/ICP-MS for:
Macrominerals Ca, K, Mg, Na and P (g kg^{-1} dw) and microminerals B, Fe, I, Mn and Zn (mg kg^{-1} dw).

For evaluation of bioactivities

Seaweeds were freeze-dried and **hydroethanolic and water (infusion and decoction) extracts** were prepared for the evaluation of:

Acetylcholinesterase (AChE) inhibitory activity (Ellman's method; % inhibition AChE) [4].

RAW 264.7 cells

control cells

cells exposed to seaweed

24 h

Immunostimulatory activity
(Griess method; as % NO production relative to control) [5].

RESULTS AND DISCUSSION

Proximate composition

Table 1. Proximate composition of *G. turuturu* and *P. umbilicalis*.

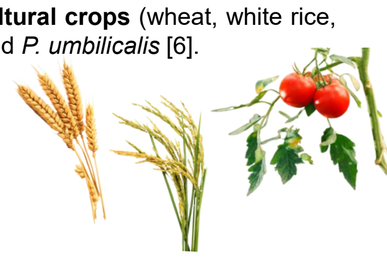
Proximate composition	Seaweed species	
	Grateloupia turuturu	*Porphyra umbilicalis*
Ash (% dw)*	30.98 ± 0.18	21.61 ± 0.40
Organic matter (% dw)*	69.02 ± 0.18	78.39 ± 0.40
Crude protein (% dw)*	20.16 ± 0.48	22.32 ± 0.24
Crude lipid (% dw)	1.52 ± 0.05	1.52 ± 0.05
TDF (% dw)	**40.15 ± 3.88**	**48.22 ± 3.45**
SDF (% dw)*	27.00 ± 3.40[a]	15.07 ± 2.35[b]
IDF (% dw)*	13.15 ± 0.48[a]	33.14 ± 1.10[b]
TSC (% dw)*	7.77 ± 0.41	18.96 ± 0.61

Abbreviations: dw, seaweed dry weight; TDF, total dietary fibre; SDF, soluble dietary fibre; IDF, insoluble dietary fibre; TSC, total-soluble carbohydrates. * significant ($p < 0.01$) differences between seaweed species for each parameter. [a, b] significant ($p < 0.005$) differences amongst SDF vs. IDF for *G. turuturu* and *P. umbilicalis*, respectively. Data in **bold** display the parameter with the greatest content for each species ($p < 0.001$).

Mineral profile

- **Sodium** was the most abundant **macromineral** in both species, while **zinc** and **iodine** were among the most abundant **microminerals** in *G. turuturu* and **iron** in *P. umbilicalis*;

A literature-anchored comparison of nutritional value with **conventional agricultural crops** (wheat, white rice, tomatoes) showed greater **protein**, **fibre** and **mineral** contents in *G. turuturu* and *P. umbilicalis* [6].



AChE inhibitory activity

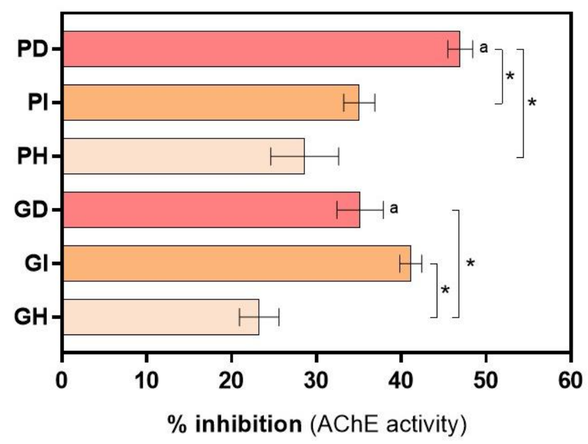


Fig. 1. AChE inhibitory activity (as % inhibition of blank) of *G. turuturu* and *P. umbilicalis* hydroethanolic (GH and PH, respectively), infusion (GI and PI, respectively) and decoction (GD and PD, respectively) extracts (at 1 mg mL^{-1}). * significant ($p < 0.001$) differences among extracts of the same species; [a] significant ($p < 0.001$) difference between the aqueous decoctions of both species.

Immunostimulatory activity

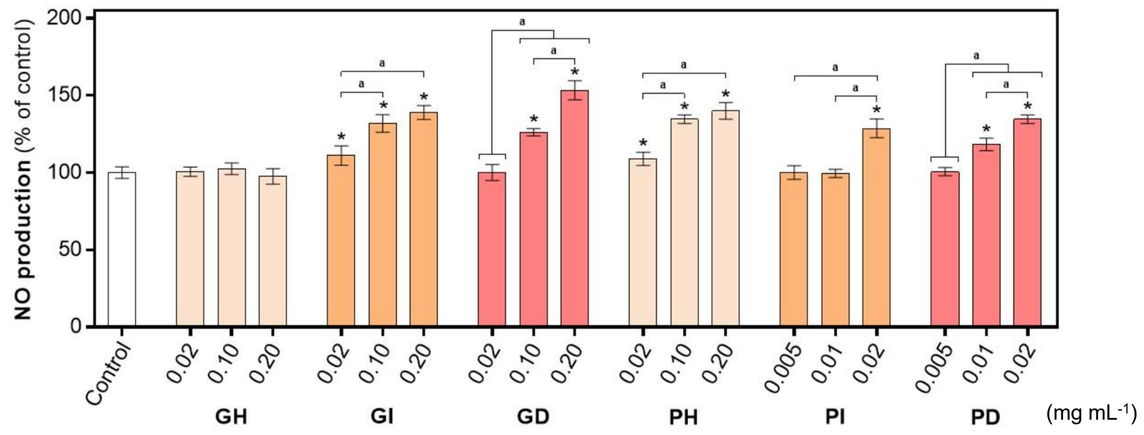


Fig. 2. Immunostimulatory activity of *G. turuturu* and *P. umbilicalis* hydroethanolic (GH and PH, respectively), infusion (GI and PI, respectively) and decoction (GD and PD, respectively) extracts. Results are expressed in % nitric oxide (NO) production relative to control. * significant ($p < 0.05$) differences in relation to control; [a] significant ($p < 0.001$) differences among concentrations of the same seaweed extract.

CONCLUSIONS

- **Unlike conventional agricultural crops, which have a considerable environmental footprint, these seaweeds can grow without requiring land, freshwater or chemical inputs, while providing higher levels of protein, fibre and minerals.**
- **These results reinforce the potential of *G. turuturu* and *P. umbilicalis* as promising functional food, highlighting their relevance as sustainable, nutrient-rich resources with promising neuroprotective and immunostimulatory properties.**

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