UNIVERSIDADE DE VIGO

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MACROALGAE AS AN ALTERNATIVE SOURCE OF NUTRIENTS AND COMPOUNDS WITH BIOACTIVE POTENTIAL

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INTRODUCTION

- Macroalgae consumption→ Asia
- Currently: ↑ **consumtion in Western countries**

Food demand

- **Good nutritional values**
- **Health benefits**

INDUSTRIAL CHALLENGE

INTRODUCTION

Macroalgas

- Rich in non-digestible polysaccharides, proteins, vitamins and minerals.
- Low lipidic content.
- Presence of biocompounds with health benefits

Composition varies

- Species
- Season
- Climate conditions
- Manufacture processess

INTRODUCTION

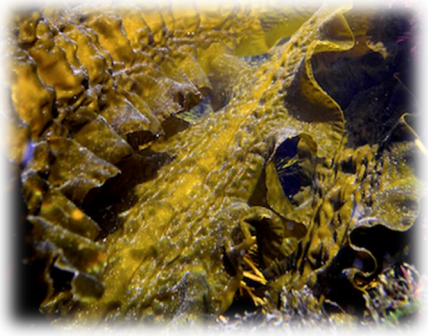
Green algae (Chlorophyta)	Brown algae (Phaeophyta)	Red algae (Rhodophyta)
Minerals	Minerals	Minerals
	Vitamins	Vitamins, specially B12
Rich in fatty acids • Linoleic acid • Oleic acid • α-linoleic acid		Rich in fatty acids • Palmitic acid • Oleic acid • Araquidonic acid
Intermediate protein levels	Low protein levels	High protein levels

OBJECTIVE

- Nutritional characterization
- Chemical composition

Himanthalia elongata

Laminaria ochroleuca



Saccharina latissima

Undaria pinnatifida

Codium tomentosum

Porphyra sp.

Palmaria palmata

MATERIAL AND METHODS

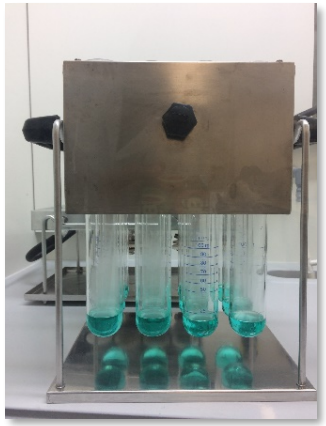
Fatty acids

GC-FID

Organic acids

UFLC-PDA

Protein

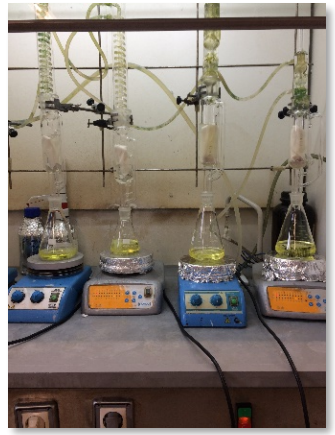


Macro-Kjedahl
(N*6,25)

Ash

Incineration
600±15°C

Lipids



Soxhlet
extraction

Carbohydrates

100- (g protein + g lipids + g ash)

Energy

Energy (Kcal)= 4 x (g de proteins + g carbohydrates) + (9 x g de lipids)

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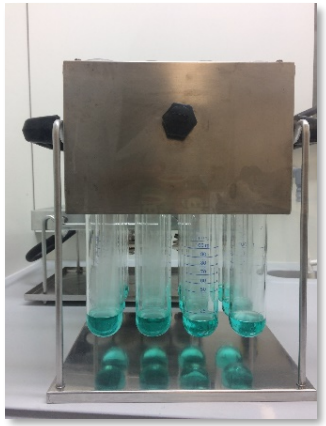

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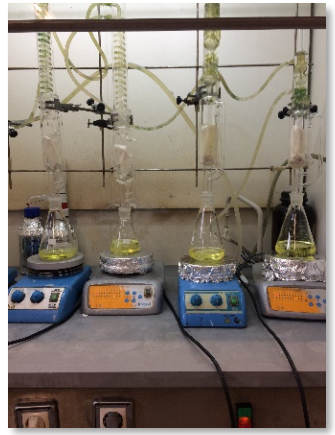

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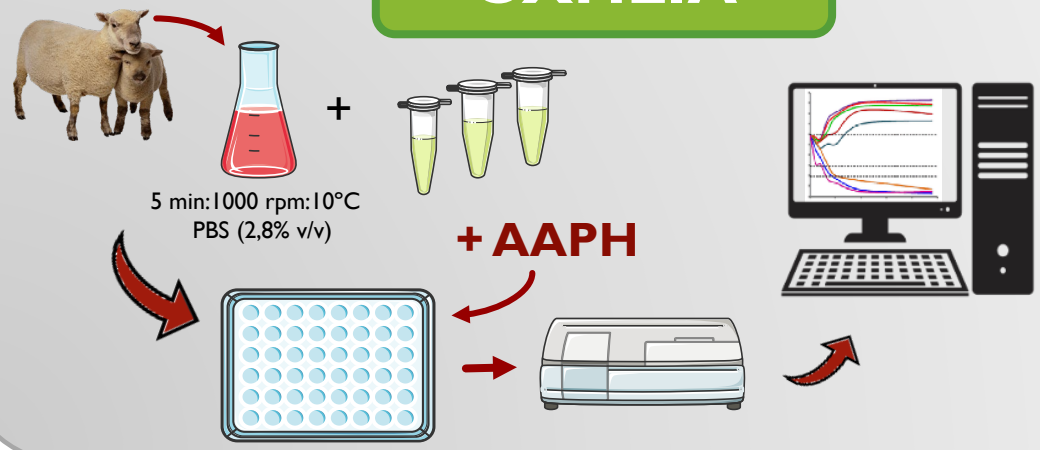
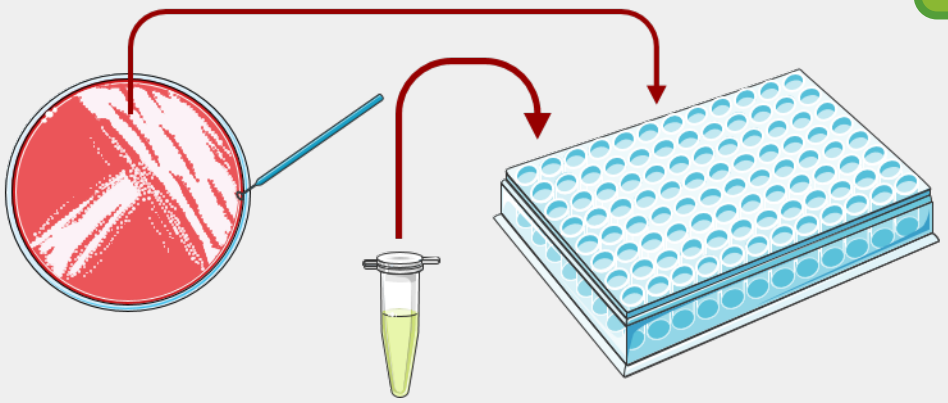
MATERIAL AND METHODS

OXHLIA



ANTIMICROBIAL

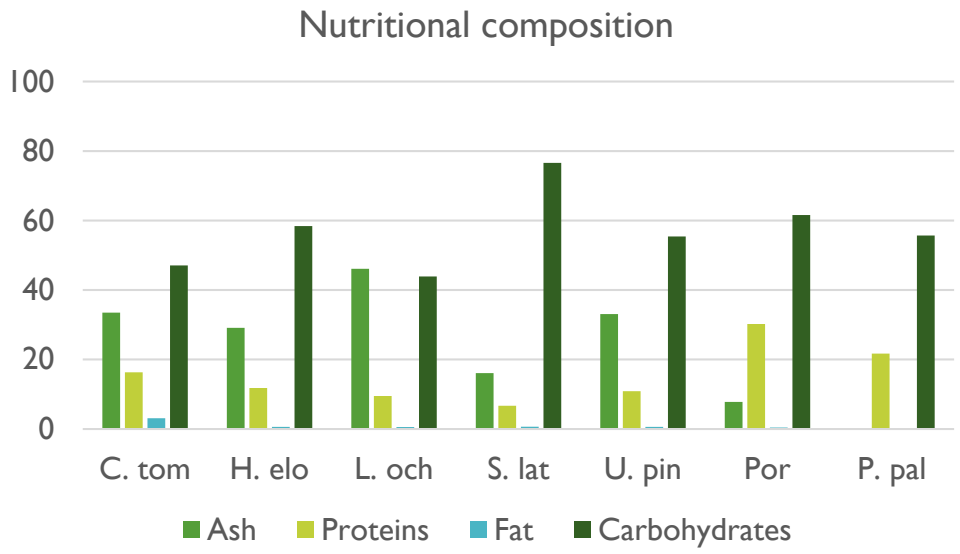
Proteus mirabilis
Salmonella typhimurium
Bacillus cereus
Micrococcus flavus
Staphylococcus aureus
Candida albicans
Candida tropicalis
Candida krusei

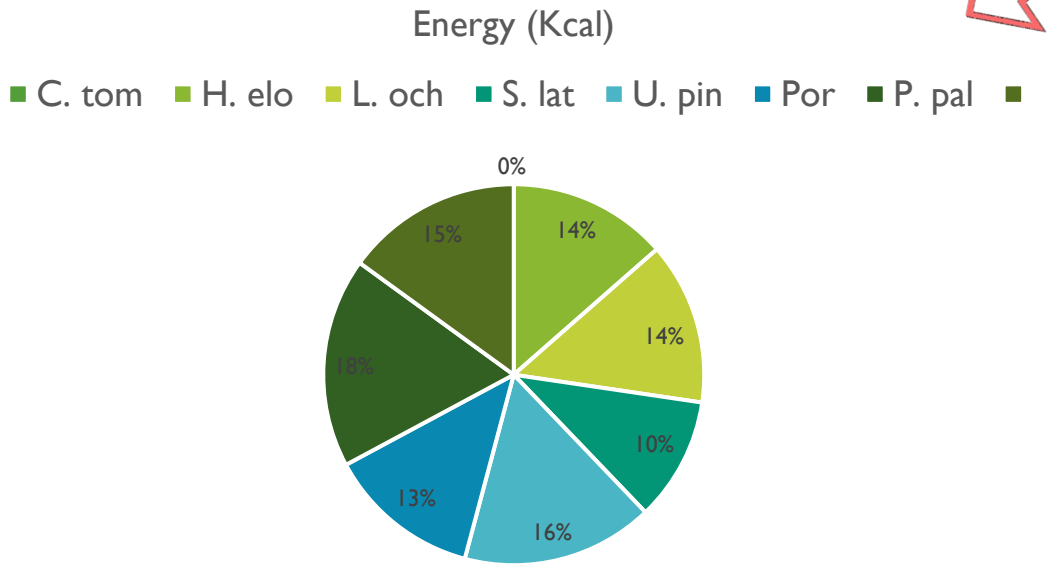


MIC
MBC
MFC

RESULTS: NUTRITIONAL COMPOSITION

	C. tom (AP)	H. elo (EM)	L. och (K)	S. lat (KR)	U. pin (W)	Por (N)	P. pal (D)
Ash (g/100 g ms)	33.5 ± 0.8	29,1 ± 0,4	46,1 ± 1,3	16,1 ± 0,5	33,08 ± 1,07	7,8 ± 0,04	22,4 ± 0,6
Proteins (g/100 g ms)	16.3 ± 0.5	11,8 ± 0,2	9,5 ± 0,2	6,7 ± 0,1	10,9 ± 0,3	30,2 ± 0,1	21,7 ± 0,7
Lipids (g/100 g ms)	3.12 ± 0.13	0,63 ± 0,02	0,55 ± 0,01	0,66 ± 0,01	0,59 ± 0,02	0,43 ± 0,01	0,29 ± 0,01
CH (g/100 g ms)	47.1 ± 0.3	58,4 ± 0,4	43,9 ± 0,8	76,6 ± 0,3	55,4 ± 0,5	61,6 ± 0,1	55,7 ± 0,9
Energy (kcal/100 g ms)	281.6 ± 1.9	286,7 ± 1,0	218,5 ± 3,8	338,8 ± 1,4	270,6 ± 3,0	370,9 ± 0,1	311,9 ± 1,7
Energy (kJ/100 g ms)	1739 ± 10	1906 ± 8	1445 ± 23	2350 ± 8	1802 ± 17	2284 ± 2	1971 ± 15

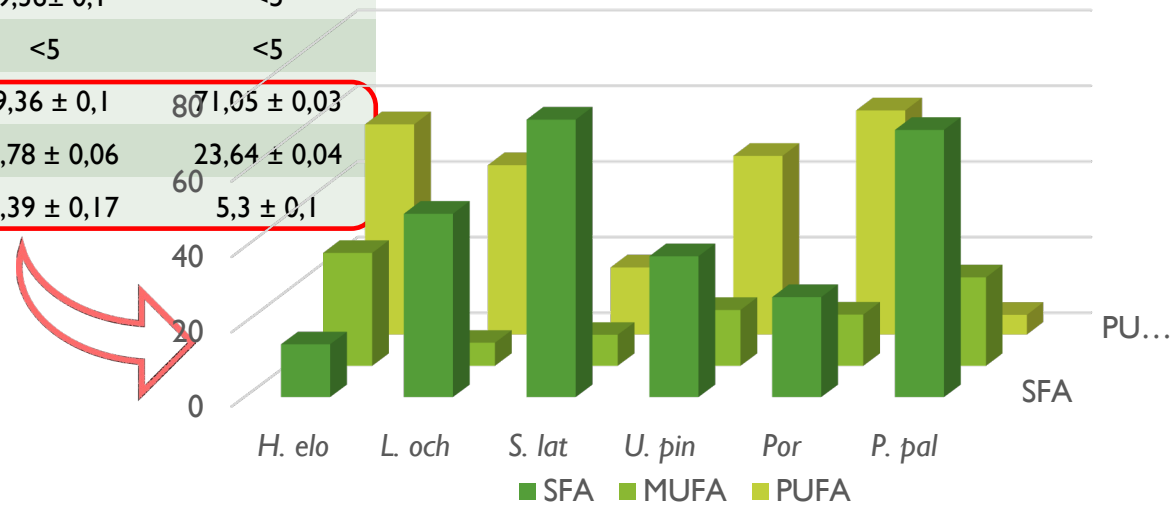




RESULTADOS: FATTY ACIDS

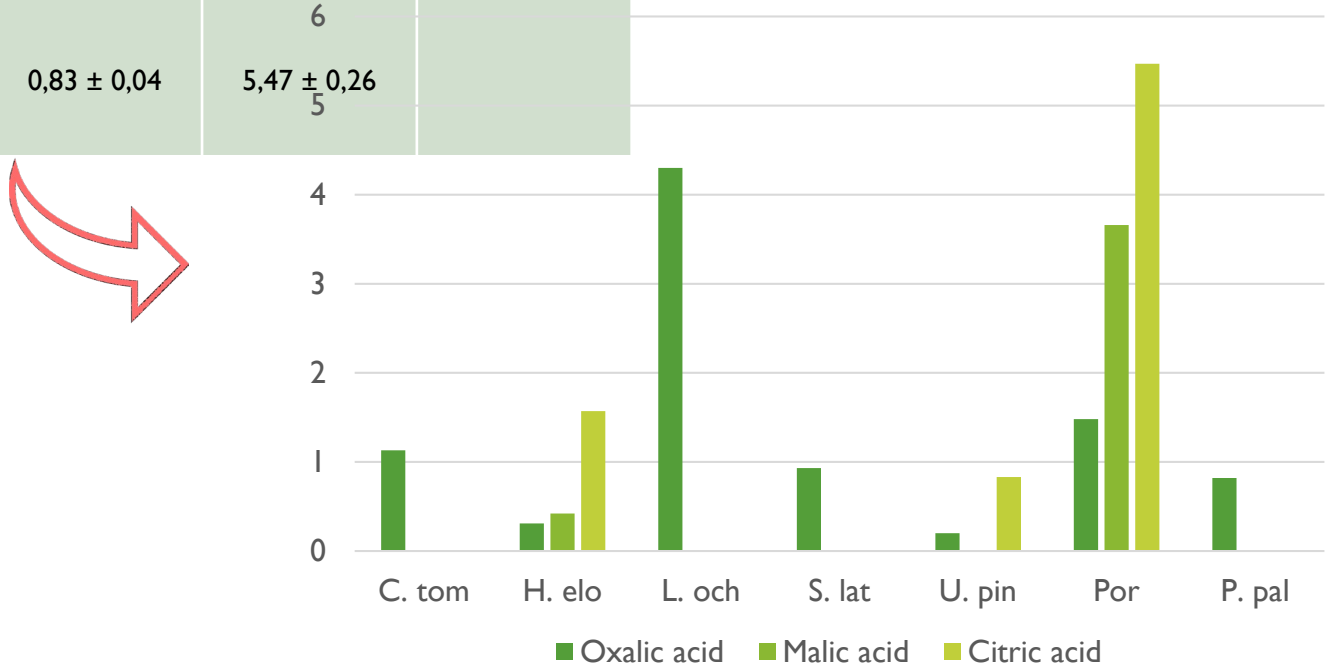
	C. tom (AP)	H. elo (EM)	L. och (K)	S. lat (KR)	U. pin (W)	Por (N)	P. pal (D)
C14:0	<5	<5	<5	8,826 ± 0,00	<5	<5	<5
C16:0	<5	<5	41,9 ± 0,1	<5	26,09 ± 0,03	<5	56,1 ± 0,2
C16:1	5.3 ± 0.2	<5	<5	6,47 ± 0,05	<5	5,77 ± 0,01	11,8 ± 0,1
C18:0	<5	<5	<5	<5	<5	<5	6,7 ± 0,1
C18:1n9c	<5	24,1 ± 0,1	<5	<5	11,58 ± 0,01	9,07 ± 0,01	8,18 ± 0,01
C18:2n6c	11.5 ± 0.1	14,12 ± 0,04	10,11 ± 0,01	9,63 ± 0,05	11,52 ± 0,01	<5	<5
C18:3n3	36.9 ± 0.1	9,0 ± 0,2	<5	<5	14,89 ± 0,02	<5	<5
C20:1	<5	<5	<5	<5	<5	10,86 ± 0,08	<5
C20:3n3	7.92 ± 0.02	25,4 ± 0,2	22,7 ± 0,1	<5	18,35 ± 0,02	16,10 ± 0,09	<5
C20:5n3	<5	5,43 ± 0,02	6,26 ± 0,02	<5	<5	39,36± 0,1	<5
C22:1	12.0 ± 0.1	<5	<5	<5	<5	<5	<5
SFA	12.94 ± 0.02	14,21 ± 0,03	48,88 ± 0,03	73,79 ± 0,18	36,64 ± 0,08	39,36 ± 0,1	71,05 ± 0,03
MUFA	18.0 ± 0.1	30,1 ± 0,1	6,21 ± 0,003	8,35 ± 0,15	15,01 ± 0,03	13,78 ± 0,06	23,64 ± 0,04
PUFA	69.0 ± 0.1	55,7 ± 0,1	44,91 ± 0,03	17,86 ± 0,13	47,36 ± 0,05	59,39 ± 0,17	5,3 ± 0,1

SFA: saturated fatty acids
MUFA: monounsaturated fatty acids
PUFA: polyunsaturated fatty acids



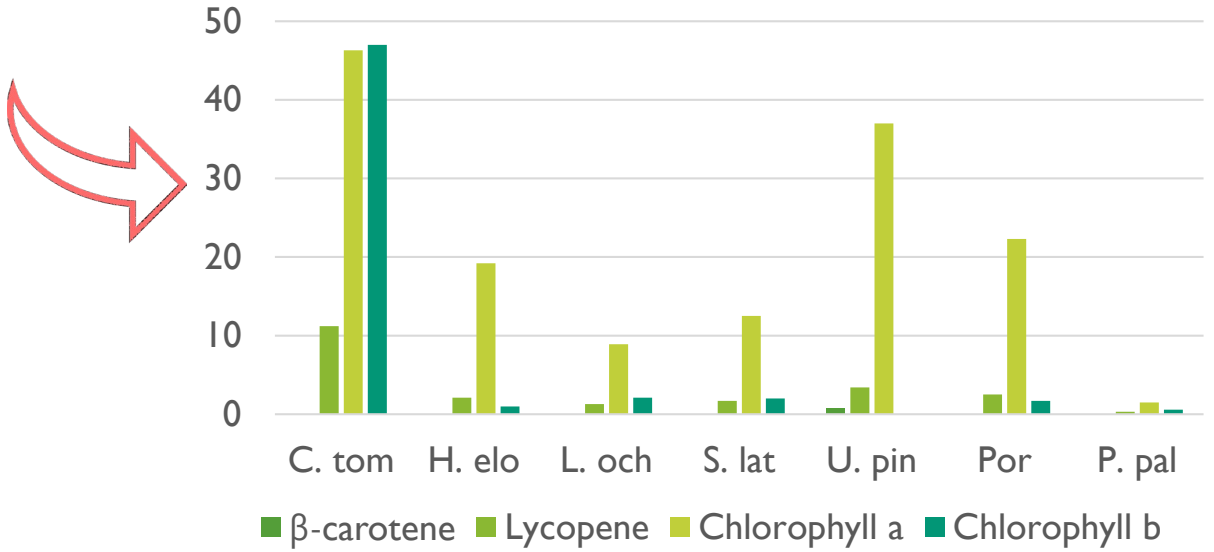
RESULTADOS: ORGANIC ACIDS

	C. tom (AP)	*H. Elo (EM)*	*L. Och (K)*	*S. Lat (KR)*	*U. Pin (W)*	*Por. (N)*	*P. pal (D)*
Oxalic acid(g/100 ms)	1.13 ± 0.01	0,31 ± 0,01	4,3 ± 0,2	0,93 ± 0,0	0,2 ± 0,01	1,48 ± 0,01	0,82 ± 0,01
Malic acid(g/100 ms)		0,42 ± 0,0				3,66 ± 0,11	
Citric acid(g/100 ms)		1,57 ± 0,04			0,83 ± 0,04	5,47 ± 0,26	



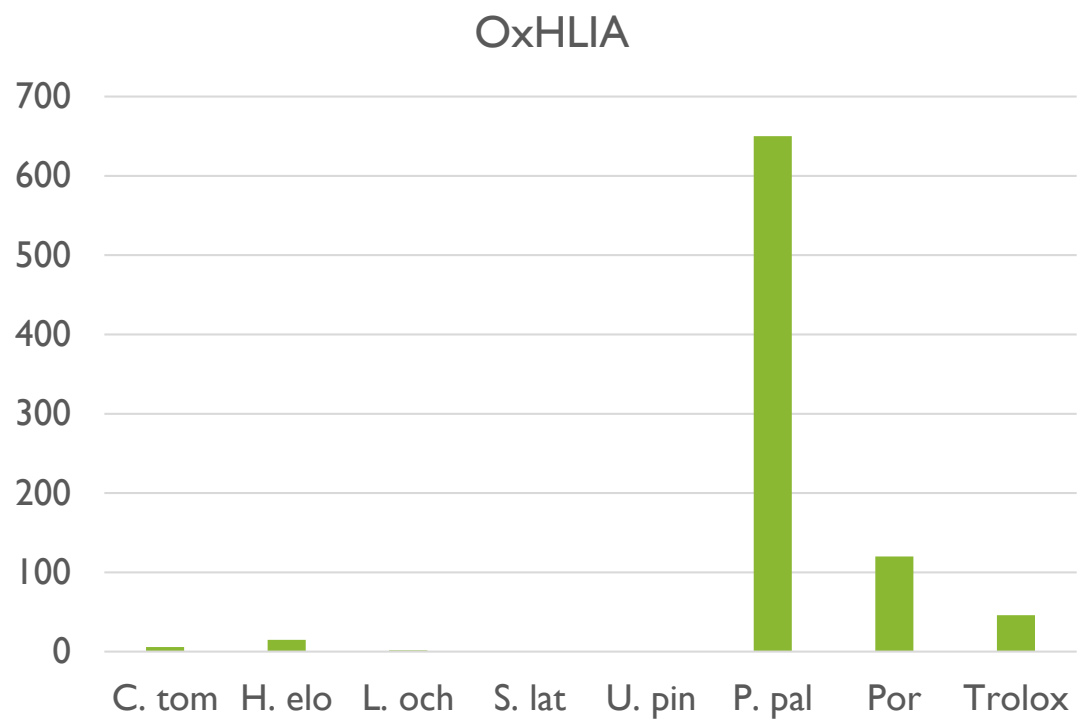
RESULTADOS: CAROTENOID CONTENT

	C. tom (AP)	H. Elo (EM)	L. Och (K)	S. Lat (KR)	U. Pin (W)	Por. (N)	P. pal (D)
β-carotene	nd	nd	nd	nd	0.78 ± 0.03	nd	nd
Lycopene	11.2 ± 0.5	2.1 ± 0.1	1.3 ± 0.03	1.7 ± 0.1	3.4 ± 0.1	2.51 ± 0.03	0.32 ± 0.02
Chlorophyll a	56.3 ± 0.3	19.1 ± 1	8.9 ± 0.4	12.5 ± 0.5	37 ± 2	22.3 ± 0.4	1.5 ± 0.1
Chlorophyll b	47 ± 2	0.98 ± 0.04	2.1 ± 0.1	2 ± 0.1	nd	1.7 ± 0.4	0.58 ± 0.03



RESULTADOS: ANTIOXIDANT ACTIVITY

	OxHLIA (EC_{50}; μg/mL); Δ= 30 min
C. tom	5.8±0.5
H. elo	15±1
L. och	1.7±0.3
S. lat	n.a.
U. pin	n.a.
P. pal	650±29
Por	120±17
Trolox	46±2



(EC50; mg/mL); Δ= 30 min

RESULTADOS: ANTIMICROBIAL ACTIVITY

Macroalgae		S. a	B. c	M. f	E. c	S. t	E. cl
C. tom	MIC	1	1	2	2	1	1
	MBC	2	2	4	4	2	4
H. elo	MIC	1	0.5	1	2	1	1
	MBC	2	1	2	4	2	2
L. och	MIC	8	8	2	>8	1	1
	MBC	>8	>8	4	>8	2	2
S. lat	MIC	2	1	1	4	0.5	1
	MBC	4	2	2	8	1	2
U. pin	MIC	4	1	2	2	1	1
	MBC	8	2	4	4	2	2
Por	MIC	4	2	2	2	1	1
	MBC	8	4	4	4	2	2
P. pal	MIC	1	8	2	4	2	2
	MBC	2	>8	4	8	4	4
Streptomycine	MIC	0.1	0.025	0.05	0.1	0.1	0.025
	MBC	0.2	0.05	0.1	0.2	0.2	0.05

S. a: Staphylococcus aureus; B. c: Bacillus cereus; M. f: Micrococcus flavus; E. c: Escherichia coli; S. t: Salmonella Typhimurium; *E. cl: Enterobacter cloacae.* MIC: minimal inhibitory concentration; MBC: minimal bactericidal concentration.

Macroalgae		A. f	A. n	A. v	A. o	P. f	P. v. c
C. tom	MIC	2	2	2	4	4	4
	MFC	4	4	4	8	8	8
H. elo	MIC	4	2	4	4	4	4
	MFC	8	4	8	8	8	8
L. och	MIC	1	1	2	1	1	2
	MFC	2	2	4	2	2	4
S. lat	MIC	0.5	0.5	0.5	1	4	4
	MFC	1	1	1	2	8	8
U. pin	MIC	4	4	2	2	2	4
	MFC	8	8	4	4	4	8
Por	MIC	4	2	2	2	2	4
	MFC	8	4	4	4	4	8
P. pal	MIC	4	2	4	4	2	4
	MFC	8	4	8	8	4	8
Ketoconazole	MIC	0.2	0.2	0.2	0.15	0.2	0.2
	MFC	0.5	0.5	0.5	0.2	0.5	0.3

A. f: Aspergillus fumigatus; A. n: Aspergillus niger; A. v: Aspergillus versicolor; A. o: Aspergillus ochraceus; P. f: Penicillium funiculosum; P. v. c: Penicillium verrucosum var. *cyclopium;* MIC: minimal inhibitory concentration; MBC: minimal fungicidal concentration.

CONCLUSIONS

- Alternative source of proteins
- Low lipid content. Presence of fatty acids grasos:
  - Linoleic acid→ Brown algae
  - Oleic acid
  - Palmitoleic acid

  } Red algae
- Oxalic acid present in all species

Potential use in the nutraceutical industry → foods with diverse biological properties

Gracias por su atención