

Supporting Information

Unveiling the Antioxidant Potential of Halophyte Plants and Seaweeds for Health Applications

Inês João Ferreira ^{1,2,3,*}, Ana Rita C. Duarte ¹, Mário Diniz ^{2,4} and Ricardo Salgado ^{1,3}

¹ Associated Laboratory for Green Chemistry – Network of Chemical and Technology (LAQV-REQUIMTE), Department of Chemistry, NOVA School of Science and Technology, Universidade NOVA de Lisboa, Quinta da Torre, 2829-516 Caparica, Portugal; ard08968@fct.unl.pt (A.R.D.); ricardo.salgado@estsetu-bal.ips.pt (R.S.)

² Applied Molecular Bioscience Unit (UCIBIO), Department of Chemistry, NOVA School of Science and Technology, Universidade NOVA de Lisboa, Quinta da Torre, 2829-516 Caparica, Portugal; mesd@fct.unl.pt

³ Marine and Environmental Sciences Centre – Setúbal polytechnical institute (MARE-IPS), Escola Superior de Tecnologia de Setúbal, Campus do IPS, Estefanilha, 2914-508 Setúbal, Portugal

⁴ Associate Laboratory i4HB, Institute for Health and Bioeconomy, NOVA School of Science and Technology, Universidade NOVA de Lisboa, 2819-516 Caparica, Portugal

* Correspondence: ij.ferreira@campus.fct.unl.pt

Figure

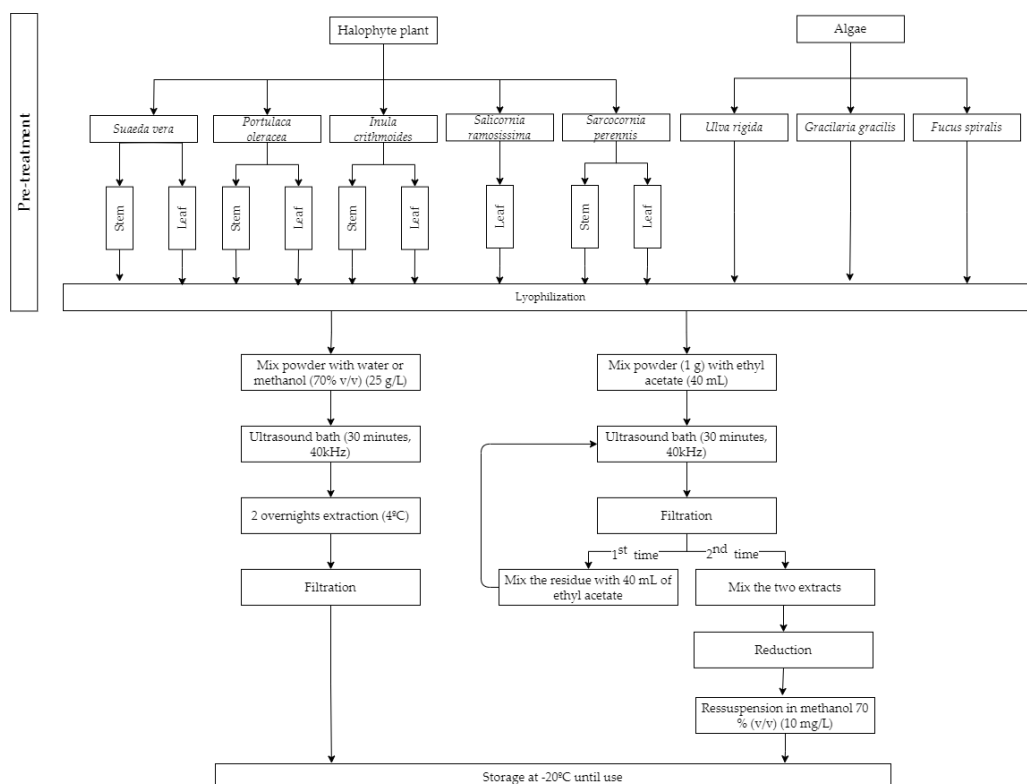


Figure S1. Workflow of the processing and extraction methodologies followed for halophytes and seaweeds.

Tables

Table S1. Results (mean \pm s.d.) of the different assays performed (Lowry, ABTS, DPPH, FRAP, TPC and TFC) on halophyte plants. * - statistical differences compared to the leaf of the corresponding halophyte plant. *p < 0.05; ** p < 0.01; p < 0.001; p < 0.0001

Lowry			
		Leaves (mg soluble protein/g DW)	Stem (mg soluble protein/g DW)
<i>Suaeda vera</i>	Ethyl acetate	24.09 \pm 1.53	6.25 \pm 0.22
	Methanol 70% (v/v)	86.34 \pm 20.58	6.21 \pm 0.34***
	Water	147.20 \pm 16.63	5.31 \pm 0.70***
<i>Portulaca oleracea</i>	Ethyl acetate	12.42 \pm 0.18	6.38 \pm 0.07
	Methanol 70% (v/v)	19.34 \pm 0.54	10.07 \pm 1.02
	Water	48.77 \pm 9.91	13.05 \pm 0.80***
<i>Inula crithmoides</i>	Ethyl acetate	10.27 \pm 0.17	10.67 \pm 0.35
	Methanol 70% (v/v)	52.55 \pm 1.33	15.71 \pm 1.14***
	Water	339.00 \pm 2.2.5	49.13 \pm 10.57***
<i>Salicornia ramosissima</i>	Ethyl acetate	7.01 \pm 0.10	---
	Methanol 70% (v/v)	60.02 \pm 6.02	---
	Water	59.70 \pm 1.29	---
<i>Sarcocornia perennis</i>	Ethyl acetate	99.82 \pm 15.42	57.14 \pm 0.49***
	Methanol 70% (v/v)	28.46 \pm 1.87	6.63 \pm 0.88*
	Water	14.23 \pm 2.66	18.74 \pm 1.50
ABTS radical scavenging assay			
		Leaves (mg TE/g DW)	Stem (mg TE/g DW)
<i>Suaeda vera</i>	Ethyl acetate	3.34 \pm 0.19	0.15 \pm 0.10***
	Methanol 70% (v/v)	4.25 \pm 0.07	1.27 \pm 0.11***
	Water	1.40 \pm 0.00	0.18 \pm 0.01***
<i>Portulaca oleracea</i>	Ethyl acetate	0.62 \pm 0.09	0.35 \pm 0.08
	Methanol 70% (v/v)	7.92 \pm 0.42	1.32 \pm 0.06***
	Water	0.45 \pm 0.04	0.43 \pm 0.06
<i>Inula crithmoides</i>	Ethyl acetate	1.13 \pm 0.03	1.40 \pm 0.10
	Methanol 70% (v/v)	4.66 \pm 0.01	3.63 \pm 0.23***
	Water	1.50 \pm 0.00	0.84 \pm 0.03***
<i>Salicornia ramosissima</i>	Ethyl acetate	1.04 \pm 0.04	---
	Methanol 70% (v/v)	4.61 \pm 0.03	---
	Water	0.74 \pm 0.08	---
<i>Sarcocornia perennis</i>	Ethyl acetate	5.53 \pm 0.09	5.18 \pm 0.26
	Methanol 70% (v/v)	3.00 \pm 0.39	2.34 \pm 0.12***
	Water	0.92 \pm 0.04	0.54 \pm 0.02*
DPPH assay			
		Leaves (μ g TE/g DW)	Stem (μ g TE/g DW)
<i>Suaeda vera</i>	Ethyl acetate	2.89 \pm 0.20	0.40 \pm 0.34***
	Methanol 70% (v/v)	6.03 \pm 0.02	0.61 \pm 0.13***
	Water	9.01 \pm 0.78	0.11 \pm 0.01***
<i>Portulaca oleracea</i>	Ethyl acetate	0.68 \pm 0.16	0.29 \pm 0.03
	Methanol 70% (v/v)	0.68 \pm 0.02	1.10 \pm 0.11
	Water	0.18 \pm 0.02	0.40 \pm 0.04
<i>Inula crithmoides</i>	Ethyl acetate	0.78 \pm 0.04	0.33 \pm 0.10

	Methanol 70% (v/v)	7.31 ± 0.67	1.17 ± 0.05****
	Water	1.39 ± 0.57	0.62 ± 0.28
<i>Salicornia ramosissima</i>	Ethyl acetate	0.50 ± 0.22	---
	Methanol 70% (v/v)	2.22 ± 0.23	---
	Water	0.54 ± 0.10	---
<i>Sarcocornia perennis</i>	Ethyl acetate	5.33 ± 0.53	1.70 ± 0.18****
	Methanol 70% (v/v)	0.73 ± 0.19	1.32 ± 0.06
	Water	0.37 ± 0.02	0.25 ± 0.13
FRAP assay			
		Leaves (μmol GAE / g DW)	Stem (μmol GAE / g DW)
<i>Suaeda vera</i>	Ethyl acetate	8.32 ± 0.14	0.76 ± 0.11****
	Methanol 70% (v/v)	9.13 ± 0.25	2.72 ± 0.13****
	Water	13.52 ± 0.37	0.67 ± 0.22****
<i>Portulaca oleracea</i>	Ethyl acetate	3.53 ± 0.12	0.60 ± 0.11****
	Methanol 70% (v/v)	4.26 ± 0.34	3.31 ± 0.16
	Water	1.95 ± 0.02	2.52 ± 0.34
<i>Inula crithmoides</i>	Ethyl acetate	1.54 ± 0.03	2.01 ± 0.06
	Methanol 70% (v/v)	14.49 ± 0.46	5.89 ± 0.45****
	Water	7.84 ± 0.43	0.82 ± 0.05****
<i>Salicornia ramosissima</i>	Ethyl acetate	2.06 ± 0.05	---
	Methanol 70% (v/v)	11.37 ± 0.89	---
	Water	2.71 ± 0.03	---
<i>Sarcocornia perennis</i>	Ethyl acetate	19.05 ± 0.67	6.52 ± 0.27****
	Methanol 70% (v/v)	6.96 ± 0.21	4.05 ± 0.12****
	Water	3.26 ± 0.06	2.79 ± 0.09
TPC			
		Leaves (mg GAE / g DW)	Stem (mg GAE / g DW)
<i>Suaeda vera</i>	Ethyl acetate	3.13 ± 0.17	0.50 ± 0.02****
	Methanol 70% (v/v)	2.51 ± 0.23	0.94 ± 0.07****
	Water	4.50 ± 0.17	0.02 ± 0.02****
<i>Portulaca oleracea</i>	Ethyl acetate	1.51 ± 0.04	0.64 ± 0.01****
	Methanol 70% (v/v)	1.39 ± 0.12	0.98 ± 0.08
	Water	0.38 ± 0.02	0.41 ± 0.03
<i>Inula crithmoides</i>	Ethyl acetate	1.42 ± 0.04	1.81 ± 0.06
	Methanol 70% (v/v)	4.18 ± 0.21	2.00 ± 0.21****
	Water	1.97 ± 0.30	0.45 ± 0.11****
<i>Salicornia ramosissima</i>	Ethyl acetate	1.35 ± 0.07	---
	Methanol 70% (v/v)	3.22 ± 0.19	---
	Water	0.88 ± 0.18	---
<i>Sarcocornia perennis</i>	Ethyl acetate	8.87 ± 0.18	5.95 ± 0.34****
	Methanol 70% (v/v)	1.82 ± 0.19	1.32 ± 0.10*
	Water	0.79 ± 0.07	0.62 ± 0.23
TFC			
		Leaves (mg QE / g DW)	Stem (mg QE / g DW)
<i>Suaeda vera</i>	Ethyl acetate	12.68 ± 0.74	2.43 ± 0.24
	Methanol 70% (v/v)	14.03 ± 0.87	2.32 ± 0.15*
	Water	11.70 ± 1.19	0.47 ± 0.03*
<i>Portulaca oleracea</i>	Ethyl acetate	7.45 ± 0.46	3.10 ± 0.61
	Methanol 70% (v/v)	3.76 ± 0.30	4.50 ± 0.90

	Water	0.08 ± 0.08	0.78 ± 0.03
	Ethyl acetate	9.33 ± 0.48	9.59 ± 0.69
<i>Inula crithmoides</i>	Methanol 70% (v/v)	47.27 ± 14.22	$13.51 \pm 5.25^{****}$
	Water	2.46 ± 0.09	1.28 ± 0.09
	Ethyl acetate	5.91 ± 0.67	---
<i>Salicornia ramosissima</i>	Methanol 70% (v/v)	30.91 ± 6.10	---
	Water	0.50 ± 0.02	---
	Ethyl acetate	13.48 ± 1.07	$24.89 \pm 8.65^*$
<i>Sarcocornia perennis</i>	Methanol 70% (v/v)	5.55 ± 0.37	3.95 ± 0.08
	Water	1.07 ± 0.11	0.86 ± 0.03

Table S2. Results (mean \pm s.d.) of the different assays performed (Lowry, ABTS, DPPH, FRAP, TPC and TFC) on seaweed.

Lowry		
	Ethyl acetate	6.00 ± 0.28 mg soluble protein/g DW
<i>Gracilaria gracilis</i>	Methanol 70% [v/v]	6.98 ± 0.32 mg soluble protein/g DW
	Water	4.99 ± 0.28 mg soluble protein/g DW
	Ethyl acetate	6.18 ± 0.13 mg soluble protein/g DW
<i>Fucus spiralis</i>	Methanol 70% [v/v]	7.61 ± 1.39 mg soluble protein/g DW
	Water	44.73 ± 4.00 mg soluble protein/g DW
	Ethyl acetate	6.18 ± 0.03 mg soluble protein/g DW
<i>Ulva rigida</i>	Methanol 70% (v/v)	33.40 ± 2.05 mg soluble protein/g DW
	Water	15.33 ± 2.77 mg soluble protein/g DW
ABTS radical scavenging assay		
	Ethyl acetate	0.30 ± 0.02 mg TE/g DW
<i>Gracilaria gracilis</i>	Methanol 70% (v/v)	0.02 ± 0.01 mg TE/g DW
	Water	nd
	Ethyl acetate	0.65 ± 0.02 mg TE/g DW
<i>Fucus spiralis</i>	Methanol 70% (v/v)	3.61 ± 0.10 mg TE/g DW
	Water	1.40 ± 0.00 mg TE/g DW
	Ethyl acetate	0.32 ± 0.04 mg TE/g DW
<i>Ulva rigida</i>	Methanol 70% (v/v)	0.70 ± 0.03 mg TE/g DW
	Water	0.20 ± 0.01 mg TE/g DW
DPPH assay		
	Ethyl acetate	0.62 ± 0.09 μ g TE/g DW
<i>Gracilaria gracilis</i>	Methanol 70% (v/v)	0.14 ± 0.02 μ g TE/g DW
	Water	0.13 ± 0.02 μ g TE/g DW
	Ethyl acetate	0.81 ± 0.22 μ g TE/g DW
<i>Fucus spiralis</i>	Methanol 70% (v/v)	0.49 ± 0.06 μ g TE/g DW
	Water	1.13 ± 0.35 μ g TE/g DW
	Ethyl acetate	0.35 ± 0.03 μ g TE/g DW
<i>Ulva rigida</i>	Methanol 70% (v/v)	0.37 ± 0.00 μ g TE/g DW
	Water	0.44 ± 0.05 μ g TE/g DW
FRAP assay		
	Ethyl acetate	0.04 ± 0.03 μ mol GAE / g DW
<i>Gracilaria gracilis</i>	Methanol 70% (v/v)	0.11 ± 0.02 μ mol GAE / g DW
	Water	0.56 ± 0.00 μ mol GAE / g DW
	Ethyl acetate	0.86 ± 0.16 μ mol GAE / g DW
<i>Fucus spiralis</i>	Methanol 70% (v/v)	3.31 ± 0.19 μ mol GAE / g DW
	Water	4.15 ± 0.12 μ mol GAE / g DW
	Ethyl acetate	0.07 ± 0.08 μ mol GAE / g DW
<i>Ulva rigida</i>	Methanol 70% (v/v)	2.54 ± 0.07 μ mol GAE / g DW

	Water	$1.40 \pm 0.19 \mu\text{mol GAE} / \text{g DW}$
TPC		
<i>Gracilaria gracilis</i>	Ethyl acetate	$0.34 \pm 0.08 \text{ mg GAE} / \text{g DW}$
	Methanol 70% (v/v)	$0.36 \pm 0.28 \text{ mg GAE} / \text{g DW}$
	Water	nd
<i>Fucus spiralis</i>	Ethyl acetate	$0.70 \pm 0.09 \text{ mg GAE} / \text{g DW}$
	Methanol 70% (v/v)	$0.94 \pm 0.06 \text{ mg GAE} / \text{g DW}$
	Water	$1.59 \pm 0.32 \text{ mg GAE} / \text{g DW}$
<i>Ulva rigida</i>	Ethyl acetate	$0.29 \pm 0.04 \text{ mg GAE} / \text{g DW}$
	Methanol 70% (v/v)	$0.74 \pm 0.07 \text{ mg GAE} / \text{g DW}$
	Water	$0.29 \pm 0.01 \text{ mg GAE} / \text{g DW}$
TFC		
<i>Gracilaria gracilis</i>	Ethyl acetate	nd
	Methanol 70% (v/v)	$0.80 \pm 0.36 \text{ mg QE} / \text{g DW}$
	Water	nd
<i>Fucus spiralis</i>	Ethyl acetate	nd
	Methanol 70% (v/v)	$9.37 \pm 1.50 \text{ mg QE} / \text{g DW}$
	Water	$2.69 \pm 0.09 \text{ mg QE} / \text{g DW}$
<i>Ulva rigida</i>	Ethyl acetate	$6.90 \pm 1.20 \text{ mg QE} / \text{g DW}$
	Methanol 70% (v/v)	$7.78 \pm 0.49 \text{ mg QE} / \text{g DW}$
	Water	$1.44 \pm 0.08 \text{ mg QE} / \text{g DW}$