

Article

Removal of Recalcitrant Compounds from Winery Wastewater by Electrochemical Oxidation

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SUPPLEMENTARY MATERIAL

Table S1. Composition and physicochemical characteristics of the synthetic samples used in the experiments.

Synthetic sample	PhA_1	PhA_2	PhA_3	PhA_4	T_1	T_2	T_3	T_4	C_1	C_2	C_3	C_4	M_1	M_2	M_3	M_4
Composition	Phthalic acid 0.1 g L ⁻¹	✓	✓	✓	✓								✓	✓	✓	✓
	Tyrosol 0.1 g L ⁻¹				✓	✓	✓	✓					✓	✓	✓	✓
	Catechin 0.1 g L ⁻¹								✓	✓	✓	✓	✓	✓	✓	✓
	Na ₂ SO ₄ 1.85 g L ⁻¹	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	CaSO ₄ ·2H ₂ O 2.23 g L ⁻¹	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	KCl 0.13 g L ⁻¹	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	L(+) -tartaric acid 0.53 g L ⁻¹	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓
	Lactic acid solution 0.35 g L ⁻¹	✓	✓	✓		✓	✓	✓		✓	✓	✓		✓	✓	✓
	Acetic acid glacial 0.66 g L ⁻¹	✓	✓	✓		✓	✓	✓		✓	✓	✓		✓	✓	✓
	Succinic acid 0.08 g L ⁻¹	✓	✓	✓		✓	✓	✓		✓	✓	✓		✓	✓	✓
	Ethanol 5 g L ⁻¹		✓	✓			✓	✓			✓	✓			✓	✓
	Glycerol solution 0.32 g L ⁻¹		✓	✓			✓	✓			✓	✓			✓	✓
	Methanol 0.02 g L ⁻¹		✓	✓			✓	✓			✓	✓			✓	✓
	Maltose 13.2 g L ⁻¹			✓				✓				✓				✓
	Glucose 2.7 g L ⁻¹			✓				✓				✓				✓
	D(-)fructose 1.5 g L ⁻¹			✓				✓				✓				✓
COD (g L ⁻¹)	0.147 ± 0.002	1.67 ± 0.05	12.4 ± 0.2	31.7 ± 0.2	0.221 ± 0.005	1.72 ± 0.03	12.27 ± 0.06	31.6 ± 0.1	0.188 ± 0.009	1.66 ± 0.03	12.45 ± 0.04	31.73 ± 0.03	0.543 ± 0.009	2.16 ± 0.08	12.8 ± 0.3	31.9 ± 0.3
TOC (g L ⁻¹)	0.060 ± 0.001	0.77 ± 0.01	3.5 ± 0.1	11.2 ± 0.1	0.075 ± 0.001	0.79 ± 0.01	3.73 ± 0.07	10.83 ± 0.07	0.061 ± 0.002	0.80 ± 0.02	3.68 ± 0.04	10.9 ± 0.2	0.198 ± 0.001	0.93 ± 0.02	3.86 ± 0.08	11.3 ± 0.3
pH	3.47 ± 0.08	2.57 ± 0.01	2.60 ± 0.04	2.63 ± 0.06	5.88 ± 0.07	2.59 ± 0.01	2.54 ± 0.01	2.60 ± 0.01	5.18 ± 0.05	2.54 ± 0.06	2.53 ± 0.03	2.57 ± 0.03	3.33 ± 0.01	2.49 ± 0.05	2.50 ± 0.02	2.51 ± 0.01
EC (mS cm ⁻¹)	4.25 ± 0.06	4.9 ± 0.2	4.7 ± 0.2	4.5 ± 0.1	4.08 ± 0.01	4.75 ± 0.01	4.57 ± 0.02	4.35 ± 0.01	4.12 ± 0.02	4.76 ± 0.01	4.59 ± 0.06	4.33 ± 0.02	4.22 ± 0.01	4.79 ± 0.04	4.58 ± 0.01	4.42 ± 0.04

Electrochemical oxidation

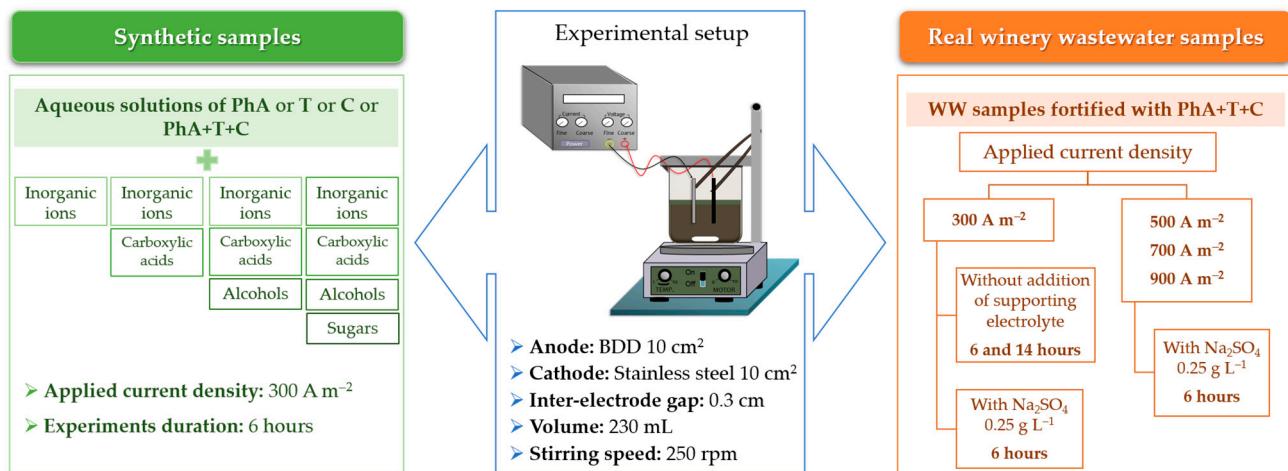
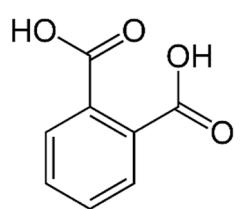
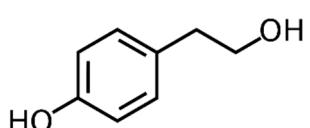


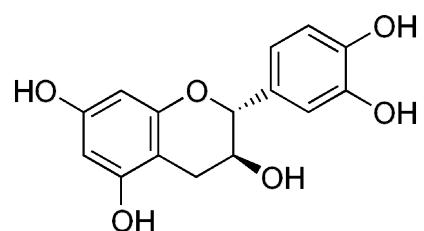
Figure S1. Graphical representation of the EO experiments performed.



(a)

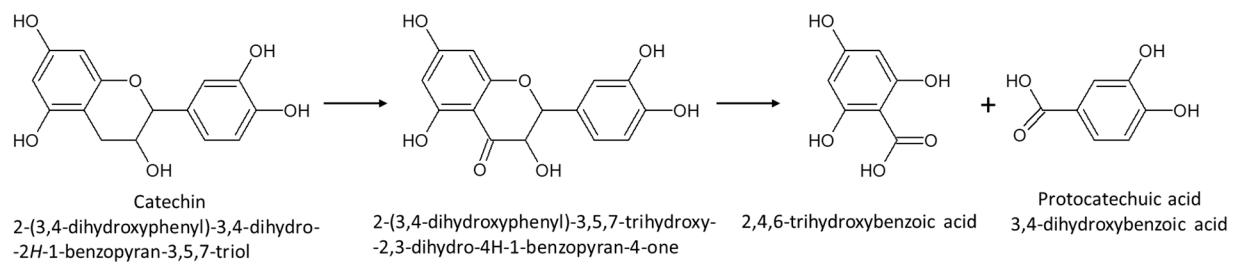


(b)

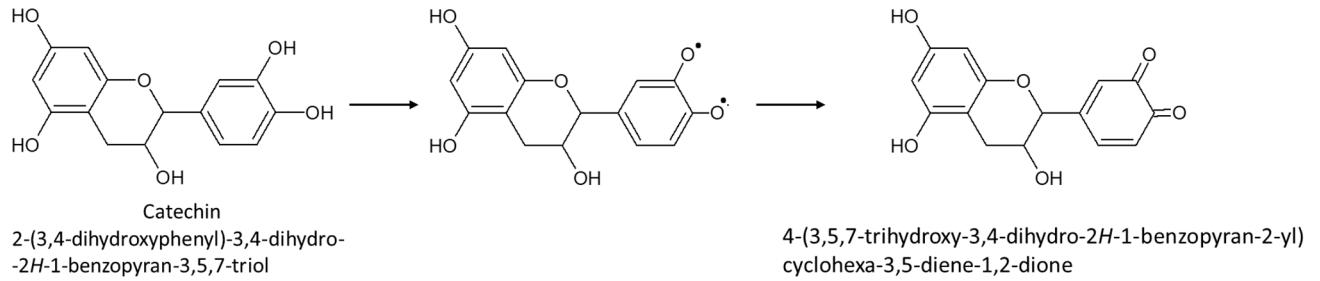


(c)

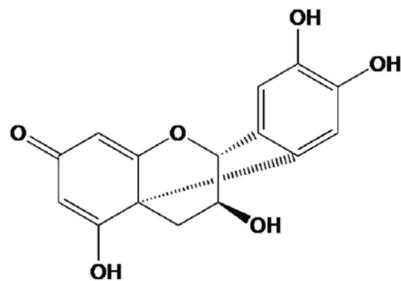
Figure S2. Molecular structure of (a) phthalic acid; (b) tyrosol; and (c) catechin.



(a)



(b)



(c)

Figure S3. Degradation pathways for catechin degradation according to the literature: (a) adapted from Hopper and Mahadevan and from Vuong et al. [28,29]; (b) adapted from Janeiro and Brett [30]; and (c) adapted from Shishido et al. [31].

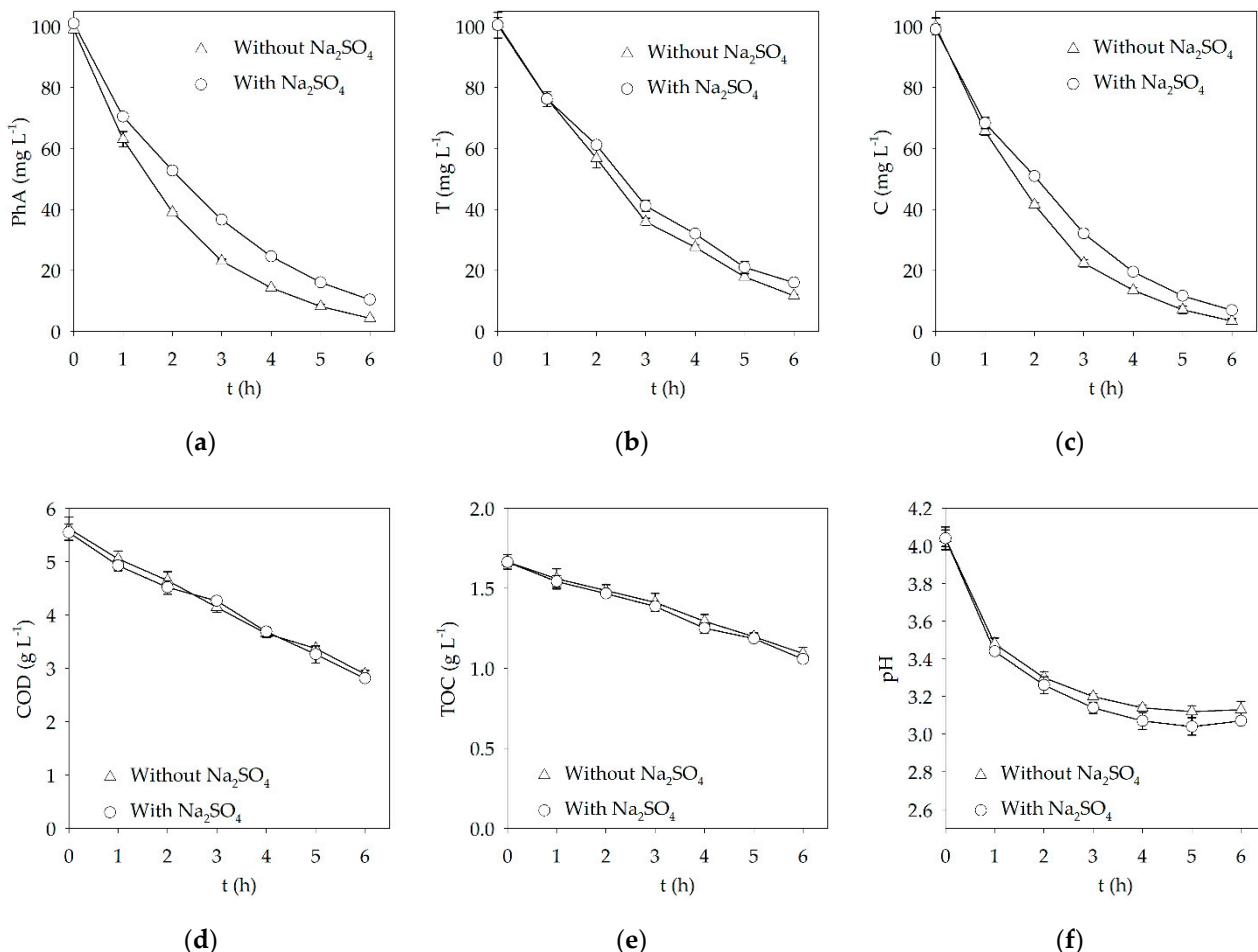


Figure S4. Decay in time of (a) phthalic acid; (b) tyrosol; (c) catechin; (d) COD; (e) TOC; and (f) pH, for the EO experiments performed with spiked winery wastewater, at an applied current density of 300 A m^{-2} , with and without the addition of supporting electrolyte, $\text{Na}_2\text{SO}_4 0.25 \text{ g L}^{-1}$.