

SUPPLEMENTARY MATERIAL

**Table S1.** Parametric results of the three-level Box-Behnken full factorial design presented in Eq. [5] combining the effects of extraction time ( $X_1$ ) and irradiation dose ( $X_2$ ) on the recovery of phytochemicals from *T. lignosa* as function of the extracted residue. The analysis of significance of the parameters ( $\alpha=0.05$ ) and the statistical information of the fitting procedure to the model are presented

		FITTING COEFFICIENTS OBTAINED AFTER APPLYING THE BOX-BEHNKEN MODEL						STATISTICAL INFORMATION OF THE FITTING ANALYSIS						
		Intercept	Linear effect		Quadratic effect		Interactive effect	Obs	R <sup>2</sup>	R <sup>2</sup> adj	MSE	RMSE	MAPE	DW
		$b_0$	$b_1(t)$	$b_2(D)$	$b_{11}(t^2)$	$b_{22}(D^2)$	$b_{12}(t \times D)$							
<b>EXTRACTION YIELD</b>	Residue	10.17±0.56	8.49±0.39	-0.89±0.39	-1.69±0.68	<i>ns</i>	-0.48±0.27	27	0.9902	0.988	64.1	8.2	5.6	2.3
<b>ANTIOXIDANT ACTIVITY</b>	DPPH <sup>•</sup> scavenging activity	32.65±1.17	17.12±0.64	<i>ns</i>	-16.58±1.11	1.57±1.11	<i>ns</i>	27	0.9947	0.994	332	18.2	3.0	2.5
	Reducing power	25.50±1.51	12.47±0.83	<i>ns</i>	-14.22±1.43	1.78±1.43	-1.56±1.01	27	0.9859	0.984	196	14.0	4.9	1.9
	β-Carotene bleaching inhibition	30.53±10.76	17.55±7.61	<i>ns</i>	-12.98±13.17	<i>ns</i>	<i>ns</i>	27	<u>0.5438</u>	0.560	574	24.0	33.5	2.4
	TBARS formation inhibition	6.17±2.22	3.21±1.57	<i>ns</i>	-2.96±2.72	<i>ns</i>	<i>ns</i>	27	<u>0.5039</u>	0.468	22.5	4.7	83.4	2.6
<b>ORGANIC ACIDS</b>	Oxalic acid	21.70±6.27	8.76±4.43	<i>ns</i>	-12.95±7.68	<i>ns</i>	<i>ns</i>	27	<u>0.5447</u>	0.526	209	14.4	51.1	1.8
	Quinic acid	17.57±1.27	6.50±0.90	3.45±0.90	-11.07±1.56	<i>ns</i>	3.92±1.10	27	0.9622	0.954	93.7	9.7	10.5	2.5
	Shikimic acid	47.54±2.31	15.96±1.26	2.15±1.26	-30.10±2.19	-2.22±2.19	<i>ns</i>	27	0.9857	0.983	490	22.1	5.8	2.7
	Succinic acid	2.01±0.01	18.95±2.38	-6.08±2.38	16.94±2.38	<i>ns</i>	-9.11±2.92	27	0.9508	0.948	514	22.7	8.5	1.6
	TOTAL	85.33±9.28	50.16±6.56	<i>ns</i>	-35.17±11.36	<i>ns</i>	-7.93±8.03	27	0.9278	0.913	2744	52.4	13.2	1.5
<b>ELLAGITANNIN DERIVATIVES</b>	Punicalin	5.47±0.77	4.35±0.55	1.05±0.55	-1.12±0.95	<i>ns</i>	1.64±0.67	27	0.9355	0.922	20.35	4.51	16.01	2.7
	Punicalagin (isomer 1)	15.25±1.18	7.80±0.65	0.63±0.48	-6.14±1.12	-1.96±1.12	<i>ns</i>	27	0.9724	0.971	66.22	8.14	6.61	3.2
	Punicalagin gallate (isomer 1)	1.24±0.27	0.79±0.19	<i>ns</i>	-0.45±0.33	<i>ns</i>	0.28±0.23	27	0.7975	0.792	0.81	0.90	32.89	1.4
	Punicalagin (isomer 2)	31.51±1.88	17.22±1.03	<i>ns</i>	-13.32±1.78	-1.47±1.35	<i>ns</i>	27	0.9842	0.983	310.2	17.61	5.88	2.5
	Punicalagin gallate (isomer 2)	1.75±0.35	1.65±0.43	0.55±0.43	<i>ns</i>	<i>ns</i>	1.18±0.53	27	0.8975	0.876	4.1	2.6	58.1	1.4
	TOTAL	55.67±3.65	31.81±2.00	2.32±2.00	-21.34±3.46	-3.78±3.46	4.75±2.45	27	0.9839	0.980	1036	32.2	6.3	1.8
<b>OTHER PHENOLIC COMPOUNDS</b>	Luteolin-6-C-glucose-8-C-glucose	48.43±2.53	27.13±1.38	<i>ns</i>	-22.83±2.40	2.29±2.19	<i>ns</i>	27	0.9888	0.988	789.9	28.11	4.9	3.3
	5-O-p-Coumaroylquinic acid	45.08±4.21	29.62±2.98	-7.29±2.98	-15.46±5.16	<i>ns</i>	-10.34±3.65	27	0.9597	0.950	966	31.08	11.2	2.2
	Luteolin-8-C-glucoside	79.82±6.21	69.09±4.39	13.60±4.39	<i>ns</i>	-12.93±7.60	17.30±5.38	27	0.9814	0.980	4553	67.5	7.3	2.4
	Apigenin-8-C-glucoside	134.2±0.87	72.90±0.62	1.56±0.62	-61.34±1.07	<i>ns</i>	2.34±0.76	27	0.9997	1.000	5637	75.1	0.8	1.7
	Quercetin-3-O-rutinoside	22.94±1.41	19.21±1.00	3.06±1.00	-3.73±1.73	<i>ns</i>	4.23±1.22	27	0.9873	0.985	342.8	18.52	6.5	1.3
	Apigenin-6-C-glucoside	121.1±1.56	70.29±1.10	2.42±1.10	-50.84±1.91	<i>ns</i>	2.95±1.35	27	0.9989	0.999	4988	70.6	1.7	3.1
	Kaempferol-3-O-rutinoside	64.34±2.69	50.67±1.90	-6.19±1.90	-13.67±3.30	<i>ns</i>	-4.11±2.33	27	0.9931	0.992	2312	48.09	5.1	2.7
	Luteolin-6-C-hexoside	1.34±0.37	1.99±0.26	-0.31±0.26	0.65±0.45	<i>ns</i>	<i>ns</i>	27	0.9210	0.903	3.90	1.98	41.0	1.6
	TOTAL	520.7±7.85	340.9±4.30	7.87±4.30	-173.6±7.45	-9.36±7.45	13.13±5.27	27	0.9993	0.999	1084	329	1.2	1.9

*ns*: non significant coefficient;  $R^2$ : Correlation coefficient;  $R^2adj$ : Adjusted coefficient of determination;  $MSE$ : Mean squared error;  $RMSE$ : Root mean square error;  $MAPE$ : Mean absolute percentage error; and  $DW$ : Durbin-Watson statistic.

**Table S2.** ANOVA table for the models developed with Eq. [5] for the *in vitro* assays used to evaluate the antioxidant activity of the extracts.

<i>Source</i>	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F<sub>statistic</sub></i>	<i>Pr &gt; F</i>
<b><i>DPPH<sup>•</sup> scavenging activity</i></b>					
<i>Model</i>	5	536282.7	107256.5	128.9	< 0.0001
<i>Error</i>	21	17478.9	832.329		
<i>Lack of fitting</i>	19	16497.3	868.2	1.8	0.4225
<i>Pure error</i>	2	981.7	490.8		
<i>Total corrected</i>	26	553761.6	0.000		
<b><i>Reducing power</i></b>					
<i>Model</i>	5	330499.6	66099.9	88.4	< 0.0001
<i>Error</i>	21	15699.5	747.594		
<i>Lack of fitting</i>	19	14744.8	776.0	1.6	0.4490
<i>Pure error</i>	2	954.7	477.358		
<i>Total corrected</i>	26	346199.1	0.000		
<b><i>β-Carotene bleaching inhibition</i></b>					
<i>Model</i>	5	520924.4	104184.9	4.6	0.0055
<i>Error</i>	21	477845.3	22754.5		
<i>Lack of fitting</i>	19	475661.7	25034.8	22.9	0.0426
<i>Pure error</i>	2	2183.6	1091.7		
<i>Total corrected</i>	26	998769.7	0.000		
<b><i>TBARS formation inhibition</i></b>					
<i>Model</i>	5	22401.0	4480.2	5.5	0.0022
<i>Error</i>	21	17193.0	818.7		
<i>Lack of fitting</i>	19	17172.2	903.8	87.0	0.0114
<i>Pure error</i>	2	20.8	10.		
<i>Total corrected</i>	26	39594.0	0.000		

*df*: degree of freedom; *SS*: Sum of squares; *MS*: Mean square.

**Table S3.** ANOVA table for the models developed with Eq. [5] to evaluate the effects of the ionizing radiation dose on the extraction kinetics of organic acids.

<i>Source</i>	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F<sub>statistic</sub></i>	<i>Pr &gt; F</i>
<b><i>Oxalic acid</i></b>					
<i>Model</i>	5	48.3	9.757	11.3	< 0.0001
<i>Error</i>	21	18.0	0.858		
<i>Lack of fitting</i>	19	15.3	0.807	0.6	0.7827
<i>Pure error</i>	2	2.7	1.337		
<i>Total corrected</i>	26	66.3			
<b><i>Quinic acid</i></b>					
<i>Model</i>	5	30.5	6.145	43.7	< 0.0001
<i>Error</i>	21	2.9	0.139		
<i>Lack of fitting</i>	19	2.0	0.105	0.2	0.9748
<i>Pure error</i>	2	0.9	0.470		
<i>Total corrected</i>	26	33.4			
<b><i>Shikimic acid</i></b>					
<i>Model</i>	5	155.2	31.05	122.1	< 0.0001
<i>Error</i>	21	5.3	0.254		
<i>Lack of fitting</i>	19	5.0	0.263	1.5	0.4650
<i>Pure error</i>	2	0.3	0.170		
<i>Total corrected</i>	26	160.5			
<b><i>Succinic acid</i></b>					
<i>Model</i>	5	315.6	63.18	90.4	< 0.0001
<i>Error</i>	21	14.7	0.698		
<i>Lack of fitting</i>	19	14.4	0.760	7.0	0.1322
<i>Pure error</i>	2	0.2	0.109		
<i>Total corrected</i>	26	330.3			
<b><i>TOTAL</i></b>					
<i>Model</i>	5	1374.6	274.9	138.5	< 0.0001
<i>Error</i>	21	41.7	1.984		
<i>Lack of fitting</i>	19	35.1	1.846	0.6	0.8055
<i>Pure error</i>	2	6.6	3.299		
<i>Total corrected</i>	26	1416.2			

*df*: degree of freedom; *SS*: Sum of squares; *MS*: Mean square.

**Table S4.** ANOVA table for the models developed with Eq. [5] to evaluate the effects of the ionizing radiation dose on the extraction kinetics of ellagitannins.

<i>Source</i>	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F<sub>statistic</sub></i>	<i>Pr &gt; F</i>
<b><i>Punicalin</i></b>					
<i>Model</i>	5	10.5	2.12	78.5	< 0.0001
<i>Error</i>	21	0.6	0.027		
<i>Lack of fitting</i>	19	0.5	0.025	0.5	0.8316
<i>Pure error</i>	2	0.1	0.048		
<i>Total corrected</i>	26	11.1			
<b><i>Punicalagin (isomer 1)</i></b>					
<i>Model</i>	5	32.3	6.54	69.9	< 0.0001
<i>Error</i>	21	1.9	0.092		
<i>Lack of fitting</i>	19	1.8	0.097	2.2	0.3584
<i>Pure error</i>	2	0.1	0.044		
<i>Total corrected</i>	26	34.2			
<b><i>Punicalagin gallate (isomer 1)</i></b>					
<i>Model</i>	5	0.4	0.1	21.1	< 0.0001
<i>Error</i>	21	0.1	0.003		
<i>Lack of fitting</i>	19	0.1	0.004	4.6	0.1931
<i>Pure error</i>	2	0.0	0.001		
<i>Total corrected</i>	26	0.4			
<b><i>Punicalagin (isomer 2)</i></b>					
<i>Model</i>	5	155.4	31.1	100.8	< 0.0001
<i>Error</i>	21	6.5	0.308		
<i>Lack of fitting</i>	19	6.4	0.338	11.0	0.0866
<i>Pure error</i>	2	0.1	0.031		
<i>Total corrected</i>	26	161.8			
<b><i>Punicalagin gallate (isomer 2)</i></b>					
<i>Model</i>	5	1.9	0.477	17.5	< 0.0001
<i>Error</i>	21	0.5	0.022		
<i>Lack of fitting</i>	19	0.5	0.024	13.1	0.0731
<i>Pure error</i>	2	0.0	0.002		
<i>Total corrected</i>	26	2.4			
<b><i>TOTAL</i></b>					
<i>Model</i>	5	526.1	105.2	94.0	< 0.0001
<i>Error</i>	21	23.5	1.119		
<i>Lack of fitting</i>	19	23.5	1.236	96.4	0.0103
<i>Pure error</i>	2	0.0	0.013		
<i>Total corrected</i>	26	549.6			

*df*: degree of freedom; *SS*: Sum of squares; *MS*: Mean square.

**Table S5.** ANOVA table for the models developed with Eq. [5] to evaluate the effects of the ionizing radiation dose on the extraction kinetics of flavonoids and phenolic acid.

<i>Source</i>	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F<sub>statistic</sub></i>	<i>Pr &gt; F</i>
<b><i>Luteolin-6-C-glucose-8-C-glucose</i></b>					
Model	5	384.3	76.9	677.2	< 0.0001
Error	21	2.4	0.113		
Lack of fitting	19	2.0	0.107	0.6	0.7743
Pure error	2	0.3	0.173		
Total corrected	26	386.7			
<b><i>5-O-p-Coumaroylquinic acid</i></b>					
Model	5	564.1	112.8	254.1	< 0.0001
Error	21	9.3	0.444		
Lack of fitting	19	9.0	0.471	2.6	0.3164
Pure error	2	0.4	0.183		
Total corrected	26	573.4			
<b><i>Luteolin-8-C-glucoside</i></b>					
Model	5	2665.4	533.1	109.6	< 0.0001
Error	21	102.1	4.86		
Lack of fitting	19	100.9	5.30	8.4	0.1111
Pure error	2	1.3	0.62		
Total corrected	26	2767.5			
<b><i>Apigenin-8-C-glucoside</i></b>					
Model	5	2778.3	555.7	390.2	< 0.0001
Error	21	29.9	1.42		
Lack of fitting	19	29.8	1.56	26.6	0.0368
Pure error	2	0.1	0.059		
Total corrected	26	2808.2			
<b><i>Quercetin-3-O-rutinoside</i></b>					
Model	5	197.1	39.4	206.0	< 0.0001
Error	21	4.0	0.19		
Lack of fitting	19	3.9	0.20	3.7	0.2354
Pure error	2	0.1	0.056		
Total corrected	26	201.1			
<b><i>Apigenin-6-C-glucoside</i></b>					
Model	5	2568.0	513.6	320.5	< 0.0001
Error	21	33.7	1.60		
Lack of fitting	19	33.6	1.76	38.7	0.0255
Pure error	2	0.1	0.05		
Total corrected	26	2601.7			
<b><i>Kaempferol-3-O-rutinoside</i></b>					
Model	5	1419.2	283.8	1350.2	< 0.0001
Error	21	4.4	0.210		
Lack of fitting	19	4.1	0.215	1.3	0.5316
Pure error	2	0.3	0.169		
Total corrected	26	1423.6			
<b><i>Luteolin-6-C-hexoside</i></b>					
Model	5	2.3	0.5	76.1	< 0.0001
Error	21	0.1	0.006		
Lack of fitting	19	0.1	0.006	2.1	0.3678
Pure error	2	0.0	0.003		
Total corrected	26	2.5			
<b>TOTAL</b>					
Model	5	60556.1	12111.2	536.5	< 0.0001
Error	21	474.1	22.5		
Lack of fitting	19	473.4	24.9	77.8	0.0128
Pure error	2	0.6	0.32		
Total corrected	26	61030.2			

*df*: degree of freedom; *SS*: Sum of squares; *MS*: Mean square.