

Natural Deep Eutectic Solvents as a Novel Bio-Based Matrix for Ready-to-Use Natural Antioxidants-Enriched Ingredients: Extraction and Formulation Optimization

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Table S1: TFC and TCC results of NaDES screening

Solvent	TFC (mg equiv rutin/g biomass)	ANOVA Tuckey	TCC (µg/g biomass)	ANOVA Tuckey
EtOH 96%	54.90 ± 2.33		79.14 ± 5.05	<i>l, m, n, o</i>
Hex: Acetone	2.31 ± 0.20	<i>a</i>	169.98 ± 7.23	
Castor oil	2.27 ± 0.14	<i>a</i>	20.45 ± 1.64	
C8: C10	9.82 ± 0.32	<i>b, c</i>	89.81 ± 5.66	<i>l, n, o, p</i>
C9:C12	11.83 ± 0.26	<i>b, c, d</i>	94.11 ± 5.83	<i>p, q</i>
C9:C10:C12	8.09 ± 0.22	<i>b</i>	72.06 ± 4.52	<i>m, r, s</i>
C8:Lac	24.26 ± 2.04	<i>e, f</i>	126.43 ± 5.74	<i>t</i>
Pro:Gly	12.91 ± 2.43	<i>c, g</i>	51.05 ± 3.00	<i>u</i>
Pro:Lev	16.43 ± 2.11	<i>g, h, i</i>	86.58 ± 4.04	<i>n, v, w</i>
Bet:Gly	76.58 ± 6.84		129.11 ± 19.55	<i>t</i>
Bet:Lev	23.52 ± 0.72	<i>e, j</i>	110.85 ± 5.94	
Lev:Gly	25.72 ± 3.38	<i>f, j</i>	81.05 ± 3.80	<i>o, q, r, v</i>
Prop:Lev	16.30 ± 0.79	<i>h, i, k</i>	66.41 ± 3.43	<i>w</i>
Prop:Gly	14.01 ± 1.35	<i>d, k</i>	56.75 ± 4.24	<i>s, u</i>

a to w : sample that share letter are non-significantly different $p > 0.05$

Table S2: Statistics for UAE DoE

TCC (µg/g biomass)					
Source	Sum of Squares	df	Mean Square	F-value	p-value

Model	57148.74	6	9524.79	34.11	< 0.0001	significant
A-S/L ratio	17785.19	1	17785.19	63.69	< 0.0001	
B-Temp.	913.73	1	913.73	3.27	0.1081	
C-Time	1548.46	1	1548.46	5.54	0.0463	
AB	3837.66	1	3837.66	13.74	0.0060	
AC	3.42	1	3.42	0.0123	0.9146	
A ²	33060.27	1	33060.27	118.39	< 0.0001	
Residual	2234.05	8	279.26			
Lack of Fit	1844.69	6	307.45	1.58	0.4370	not significant
Pure Error	389.36	2	194.68			
Cor Total	59382.79	14				

Std. Dev.	16.71	R²	0.9624
Mean	214.34	Adjusted R²	0.9342
C.V. %	7.80	Predicted R²	0.8581
		Adeq Precision	16.3056

TFC (mg Equiv Rutin/mg biomass)

Source	Sum of Squares	df	Mean Square	F-value	p-value
Model	452.15	6	75.36	18.83	< 0.0001 significant
A-S/L ratio	34.90	1	34.90	8.72	0.0145
B-Temp	1.33	1	1.33	0.3311	0.5777
C-Time	0.6235	1	0.6235	0.1558	0.7014
AB	27.40	1	27.40	6.85	0.0257
AC	15.54	1	15.54	3.88	0.0771
A ²	372.35	1	372.35	93.04	< 0.0001
Residual	40.02	10	4.00		
Lack of Fit	18.72	6	3.12	0.5861	0.7341 not significant
Pure Error	21.30	4	5.32		
Cor Total	492.17	16			
Std. Dev.	2.00	R²	0.9187		
Mean	18.63	Adjusted R²	0.8699		
C.V. %	10.74	Predicted R²	0.7550		
		Adeq Precision	11.1877		

Table S3: Statistics for DAC DoE

TCC (µg/g biomass)						
Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	77079.81	6	12846.64	28.67	< 0.0001 significant	
A-S/L ratio	8877.04	1	8877.04	19.81	0.0021	
B-time	809.46	1	809.46	1.81	0.2158	
C-Speed	105.23	1	105.23	0.2348	0.6409	
AC	1799.27	1	1799.27	4.02	0.0800	
BC	2045.57	1	2045.57	4.57	0.0651	
A²	53561.69	1	53561.69	119.54	< 0.0001	
Residual	3584.67	8	448.08			
Lack of Fit	2625.43	5	525.09	1.64	0.3624 not significant	
Pure Error	959.24	3	319.75			
Cor Total	80664.48	14				
Std. Dev.	21.17	R²		0.9556		
Mean	254.50	Adjusted R²		0.9222		
C.V. %	8.32	Predicted R²		0.7704		
		Adeq Precision		15.8151		

TFC (mg equiv rutin/g biomass)						
Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model		783.51	5	156.70	42.75	< 0.0001 significant
A-S/L ratio		401.70	1	401.70	109.60	< 0.0001
B-time		30.69	1	30.69	8.37	0.0178
AB		20.88	1	20.88	5.70	0.0408
A²		460.06	1	460.06	125.52	< 0.0001
B²		104.99	1	104.99	28.64	0.0005
Residual		32.99	9	3.67		
Lack of Fit		24.89	6	4.15	1.54	0.3888 not significant
Pure Error		8.09	3	2.70		
Cor Total		816.50	14			
Std. Dev.	1.91	R²		0.9596		
Mean	32.31	Adjusted R²		0.9372		
C.V. %	5.93	Predicted R²		0.8494		
		Adeq Precision		16.8166		

Figure S1

Pictures of the BGCE-enriched creams prepared

