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Optimization of silica extraction from diatomaceous earth using the central composite design of response surface methodology

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Table S1 Central composite experimental design for Ultrasound-assisted extraction and conventional solvent extraction.

	Run	Factor A: Sonication/ stirring time (h)	Factor B: Extracting medium (NaOH/HCl) Concentration (M)	Factor C: Cycle of applied sonication waves	Factor D: Amplitude (%)	Factor E: Volume of Acid (mL)	Response 1 %Yield	Response 2 Percentage purity
Alkali	1	2.5	2.5	0.6	60	-	1.15	76.1
UAE	2	1.0	4.0	0.1	100	-	0.15	53.7
	3	4.0	1.0	0.1	100	-	0.50	52.0
	4	2.5	2.5	0.6	60	-	1.20	76.1
	5	1.0	1.0	1.0	100	-	23.3	77.9
	6	2.5	2.5	0.6	60	-	1.17	76.0
	7	4.0	1.0	1.0	20	-	17.0	74.6
	8	4.0	4.0	1.0	100	-	0.45	73.7
	9	1.0	1.0	0.5	70	-	16.4	79.2
	10	2.5	2.5	0.6	60	-	1.30	76.5
	11	4.0	4.0	0.1	20	-	0.45	73.6
	12	4.0	2.5	0.5	70	-	28.1	77.8
	13	1.0	1.0	0.1	20	-	0.25	57.7
	1	27	2.5	-	-	-	2.15	80.3
CSE	2	48	1.0	-	-	-	13.1	87.1
	3	27	2.5	-	-	-	2.20	80.8
	4	27	4.6	-	-	-	4.61	77.2
	5	6.0	4.0	-	-	-	1.93	75.1
	6	27	2.5	-	-	-	2.20	80.0
	7	48	4.0	-	-	-	1.37	78.4
	8	6.0	1.0	-	-	-	2.37	66.3
	9	57	2.5	-	-	-	15.4	77.3
	10	27	0.4	-	-	-	1.62	81.8
	11	27	2.5	-	-	-	2.19	80.3
	12	27	2.5	-	-	-	2.09	80.2
	13	48	2.5	-	-	-	3.95	80.5
	1	2.5	3.0	0.55	60	200	60.7	90.5

	2	2.0	2.5	0.60	70	200	77.0	88.2
Acid	3	1.5	3.0	0.55	80	200	76.7	93.1
UAE	4	2.5	3.0	0.55	70	250	70.3	85.3
	5	2.0	3.0	0.55	60	150	80.3	89.1
	6	2.5	2.5	0.55	70	200	74.6	86.7
	7	2.0	3.0	0.50	80	200	73.0	94.3
	8	2.0	2.5	0.55	70	150	72.6	86.1
	9	2.0	2.5	0.55	80	200	75.2	89.7
	10	2.0	3.0	0.50	70	190	74.3	92.3
	11	2.0	3.5	0.55	80	200	81.4	88.5
	12	2.5	3.0	0.60	70	200	73.5	93.6
	13	1.5	3.5	0.55	70	200	81.6	88.1
	14	2.0	3.0	0.55	70	200	84.4	87.2
	15	2.0	3.0	0.55	80	250	82.4	88.6
	16	2.0	3.0	0.60	70	250	84.3	92.1
	17	1.5	3.0	0.50	70	200	86.2	87.9
	18	2.0	3.0	0.55	80	150	84.4	85.8
	19	2.0	3.0	0.60	60	200	74.7	93.2
	20	2.5	3.0	0.50	70	200	84.7	90.4
	21	2.0	2.5	0.50	70	200	83.3	94.0
	22	2.0	3.5	0.55	60	200	83.5	95.1
	23	2.0	3.5	0.55	70	150	79.2	87.8
	24	1.5	3.0	0.55	60	200	82.5	87.2
	25	2.5	3.0	0.55	80	200	82.3	95.1
	26	2.5	3.5	0.55	70	250	81.1	87.1
	27	2.0	3.5	0.55	70	200	77.9	89.5
	28	2.0	3.0	0.55	70	200	84.8	88.7
	29	1.5	3.0	0.55	70	150	80.2	88.1
	30	2.0	3.0	0.50	70	150	82.9	94.0
	31	2.0	3.0	0.55	70	200	81.8	87.2
	32	2.0	3.5	0.50	70	200	70.5	94.9
	33	2.0	3.0	0.50	60	200	86.1	90.6
	34	2.0	3.0	0.55	60	250	81.1	83.0
	35	2.5	2.5	0.55	70	200	74.6	85.8
	36	2.0	3.00	0.50	70	250	84.0	86.6
	37	2.0	2.5	0.55	70	250	77.9	89.8
	38	1.5	2.5	0.55	70	200	84.1	87.9
	39	2.0	3.0	0.60	80	200	84.8	89.4
	40	1.5	3.0	0.60	70	200	82.2	91.5
	41	2.0	3.0	0.55	70	200	82.8	87.0
	42	1.5	3.0	0.55	70	250	83.9	88.1
	43	2.0	3.0	0.55	70	200	85.6	90.3
	44	2.0	2.5	0.55	60	200	83.6	86.3
	45	2.5	3.0	0.55	70	150	70.7	88.2
	46	2.0	3.0	0.55	70	200	81.2	91.9
	47	2.0	3.0	0.60	70	150	77.9	93.6

Table S2 Analysis of the variance of all model terms.

Responses	Model terms	F-value	p-value
Percentage yield	Model	43278.17	< 0.0001
(Alkali UAE)	A-Sonication time	1.213E+05	< 0.0001
	B-Concentration	2.044E+05	< 0.0001
	C-Cycle	482.42	< 0.0001
	D-Amplitude	15339.39	< 0.0001
	AB	14461.52	< 0.0001
	AC	92595.77	< 0.0001
	AD	1.100E+05	< 0.0001
	BC	1.274E+05	< 0.0001
	BD	85655.43	< 0.0001
Amount of silica	Model	3889.16	< 0.0001
extracted	A-Sonication time	4366.42	< 0.0001
(Alkali UAE)	B-Concentration	2273.32	< 0.0001
	C-Cycle	15140.1	< 0.0001
	D-Amplitude	7411.63	< 0.0001
	AB	1459.62	< 0.0001
	AC	5769.73	< 0.0001
	AD	4961.79	< 0.0001
	BC	4697.07	< 0.0001
	BD	6318.06	< 0.0001
Percentage yield	Model	4.19	0.0443
(CSE)	A-Stirring time	4.25	0.0783
	B-Concentration	0.8900	0.3769
	AB	3.57	0.1007
	A^2	5.04	0.0597
	B^2	0.0710	0.7975
	Residual lack of fit	9756.64	< 0.0001
Amount of silica	Model	23.21	0.0003
extracted (CSE)	A-Stirring time	67.14	< 0.0001
	B-Concentration	2.35	0.1695
	AB	35.40	0.0006
	A^2	38.97	0.0004
	B^2	0.0508	0.8282
	Residual lack of fit	290.15	< 0.0001
Percentage yield	Model	2.11	0.0370
(Acid UAE)	A-Sonication time	10.9	0.00285
	B-Concentration	0.384	0.541
	C-Cycle	0.0152	0.903
	D-Amplitude	0.186	0.670
	E-Volume of acid	1.69	0.205
	AB	0.479	0.495
	AC	0.648	0.428
	AD	9.63	0.00458
	AE	0.00513	0.943
	BC	4.33	0.0475
	BD	0.509	0.482
	BE	0.0248	0.876

	CD	6.95	0.0140
	CE	0.193	0.664
	DE	0.111	0.742
Amount of silica extracted (Acid UAE)	Model	2.24	0.0273
	A-Sonication time	0.767	0.389
	B-Concentration	3.81	0.0619
	C-Cycle	0.167	0.686
	D-Amplitude	0.941	0.341
	E-Volume of acid	1.86	0.184
	AB	1.65	0.211
	AC	0.0119	0.914
	AD	0.0706	0.793
	AE	0.621	0.438
	BC	1.06	0.312
	BD	4.20	0.0506
	BE	1.16	0.292
	CD	2.42	0.132
	CE	1.50	0.232
	DE	3.35	0.0788