processes

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Supplementary Materials

Article

Modelling and Optimization of Processing Factors of Pumpkin Seeds Oil Extraction under Uniaxial Loading

Abraham Kabutey [1*], Čestmír Mizera [1], Oldřich Dajbych [1], Petr Hrabě [2], David Herák [1], Cimen Demirel [1]

[1] Department of Mechanical Engineering, Faculty of Engineering, Czech University of Life Sciences Prague, 16521 Prague, Czech Republic; mizera@tf.czu.cz (Č.M.); dajbych@tf.czu.cz (O.D.); demirel@tf.czu.cz (C.D.); herak@tf.czu.cz (D.H.)

[2] Department of Materials and Manufacturing Technology, Faculty of Engineering, Czech University of Life Sciences Prague, 16521 Prague, Czech Republic; hrabe@tf.czu.cz

* Correspondence: kabutey@tf.czu.cz (A.K.); Tel.: +420 22438 3180

Table S1. Correlation results of processing factors and responses of pumpkin seeds oil extracted at 25 °C.

Factors	D_X (mm)	O_Y (%)	O_{EE} (%)	E_N (J)
Speed (mm/min)	0.06^{ns}	−0.67*	−0.67*	−0.25^{ns}
Force (kN)	0.54*	0.68*	0.68*	0.95*

D_X: Deformation (mm); O_Y: Oil yield (%); O_{EE}: Oil expression efficiency (%); E_N: Energy (J); * Significant ($P < 0.05$); ^{ns} Non-significant ($P > 0.05$)

Table S2. Determined regression models for the responses of pumpkin seeds oil extraction at 25 °C.

Effect	Model [a] D_X (mm)	Standard Error	t-value	P-value
Intercept	43.55	1.45	29.94	< 0.05*
Speed (mm/min)	0.07	0.18	0.37	> 0.05^{ns}
Force (kN)	0.02	0.01	3.17	< 0.05*
Effect	Model [b] O_Y (%)	Standard Error	t-value	P-value
Intercept	8.58	0.68	12.58	< 0.05*
Speed (mm/min)	−0.95	0.09	-11.07	< 0.05*
Force (kN)	0.04	0.00	11.28	< 0.05*
Effect	Model [c] O_{EE} (%)	Standard Error	t-value	P-value
Intercept	25.50	2.03	12.58	< 0.05*
Speed (mm/min)	−2.81	0.25	−11.07	< 0.05*
Force (kN)	0.11	0.01	11.28	< 0.05*
Effect	Model [d] E_N (J)	Standard Error	t-value	P-value
Intercept	285.87	25.14	11.37	< 0.05*
Speed (mm/min)	−17.58	3.15	−5.58	< 0.05*
Force (kN)	2.71	0.13	21.52	< 0.05*

* Significant ($P < 0.05$); ns Non-significant ($P > 0.05$); a Coefficient of determination ($R^2 = 0.24$); b Coefficient of determination ($R^2 = 0.91$); c Coefficient of determination ($R^2 = 0.91$); d Coefficient of determination ($R^2 = 0.95$); a F-value = 5.08; b F-value = 124.93; c F-value = 124.93; d F-value = 247.15

Table S3. Determined coefficients of Maxwell model with five elements at optimum processing factors.

Samples N	E_1 (MPa)	E_2 (MPa)	E_3 (MPa)	η_1 (MPa·s^{-1})	η_2 (MPa·s^{-1})
1	42.859	9.536	35.865	389.63	866.900
2	42.673	9.600	32.214	442.304	872.760
3	47.714	8.464	35.922	433.765	956.206
Mean	44.415	9.200	34.667	421.901	898.622
± SD	± 2.858	± 0.638	± 2.125	± 28.271	± 49.955

N: Samples repetitions; E_1, E_2 and E_3 are coefficients of modulus of elasticity; η_1 and η_1 are coefficients of viscosity.

Table S4. Statistical analysis of Maxwell model with five elements at optimum processing factors.

Samples N	F_{ratio} (–)	$F_{critical}$ (–)	P_{value} (–)	R^2 (–)
1	0.054	3.857	0.817	0.997
2	0.04	3.854	0.841	0.997
3	0.036	3.854	0.851	0.996
Mean	0.043	3.855	0.836	0.997
± SD	± 0.036	± 0.001	± 0.017	± 0.001

N: Samples repetitions; $F_{critical} > F_{ratio}$ and $P_{value} > 0.05$ means significant; R^2 is the model coefficient of determination

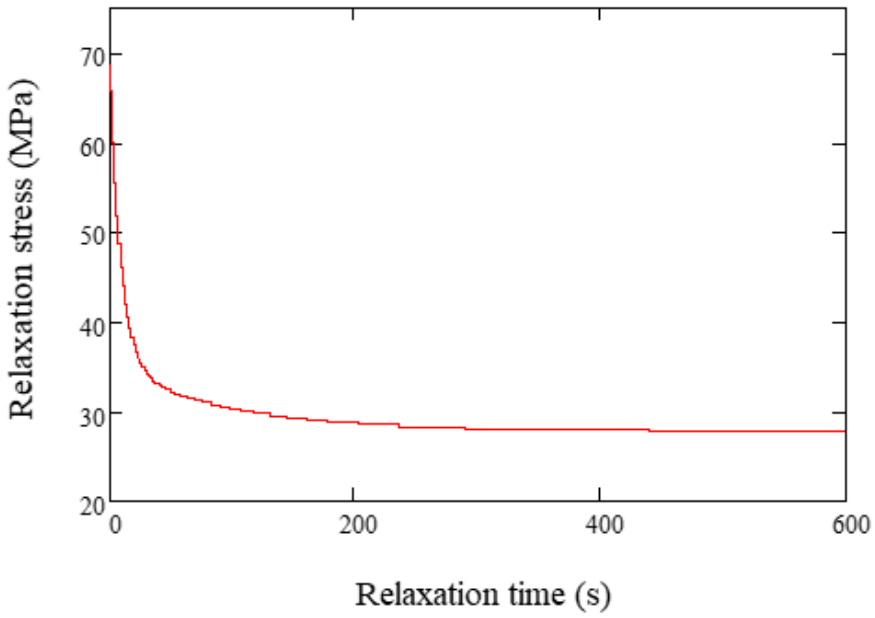

Figure S1. Relaxation stress versus time of pumpkin seeds at optimum processing factors.

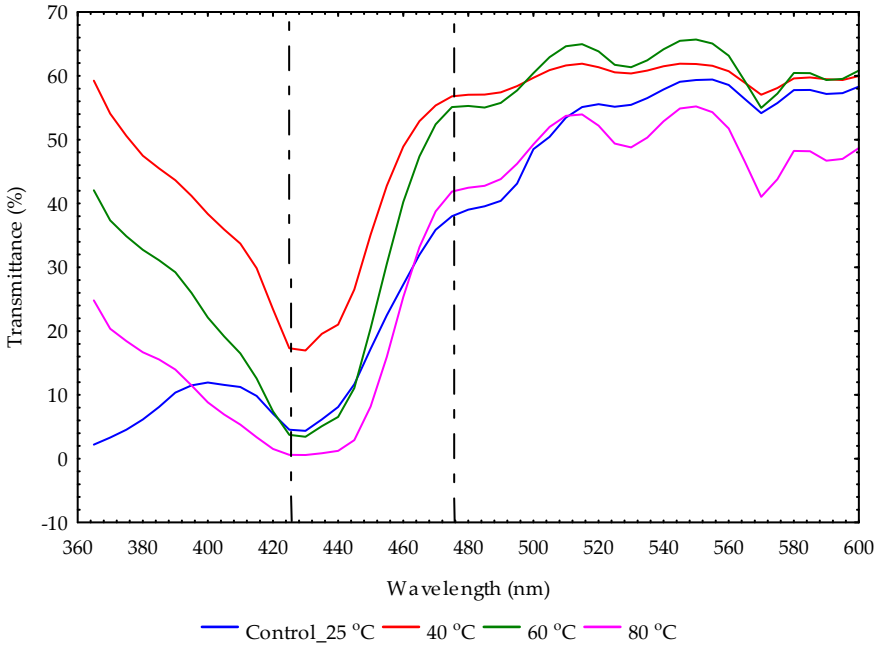

Figure S2. Transmittance versus wavelength of pumpkin seeds oil at room and heating temperatures.

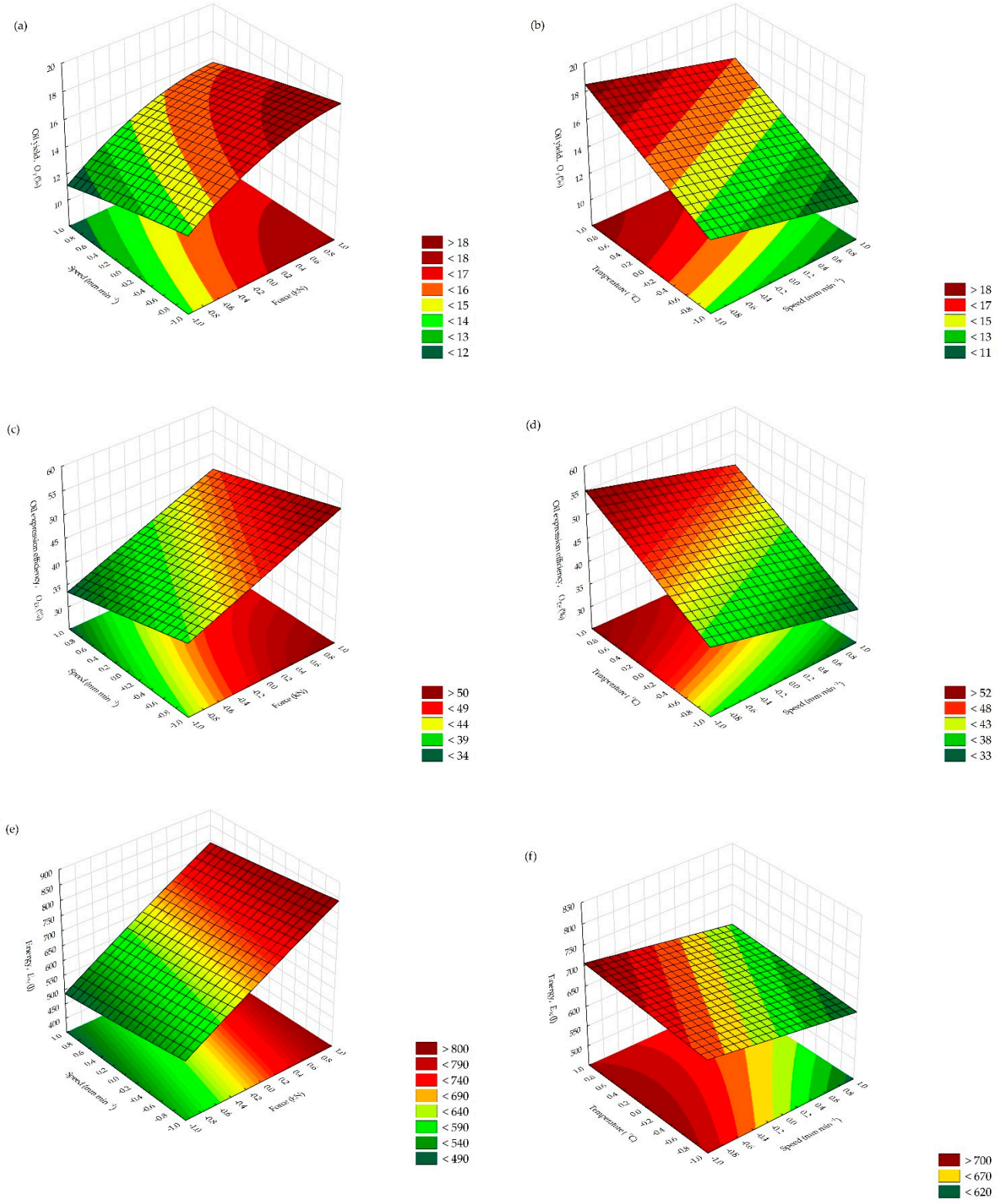

Figure S3. Surface and contour plots of factors interaction (force, speed and temperature) on the responses: oil yield (a) and (b); oil expression efficiency (c) and (d) and energy (e) and (f) of pumpkin seeds.