

Supplementary Materials: Investigation of Heating and Freezing Pretreatments on Mechanical, Chemical and Spectral Properties of Bulk Sunflower Seeds and Oil

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Table 1. Tests of normality of dependent variables in relation to heating temperature, HT (°C).

Dependent variables	HT (°C)	Shapiro–Wilk test (<i>P</i> -value)	R ²
DX (mm)	*25	0.126	0.805
	40	0.048	0.771
	60	0.527	0.940
	80	0.060	0.776
OY (%)	*25	0.821	0.991
	40	0.459	0.922
	60	0.132	0.807
	80	0.626	0.962
OEE (%)	*25	0.821	0.991
	40	0.459	0.922
	60	0.132	0.807
	80	0.626	0.962
DE (J)	*25	0.074	0.783
	40	0.091	0.790
	60	0.639	0.965
	80	0.715	0.978
EVO (kJ/L)	*25	0.631	0.963
	40	0.845	0.993
	60	0.428	0.913
	80	0.415	0.909
EUV (x10 ² kJ/m ³)	*25	0.074	0.783
	40	0.091	0.790
	60	0.639	0.965
	80	0.715	0.978

P-values > 0.05 indicates the data are normally distributed; R² is the coefficient of determination.

Table 2. Post-hoc tests of OEE (%) based on Tukey HSD and Duncan ($\alpha = 0.05$).

	HT (°C)	N	Subset			
			1	2	3	4
Tukey HSD	*25	3	62.63			
	40	3		76.25		
	60	3		82.73		
	80	3			93.46	
	Sig.		1.000	0.169	1.000	
Duncan	*25	3	62.63			
	40	3		76.25		
	60	3			82.73	
	80	3				93.46
	Sig.		1.000	1.000	1.000	1.000

N: Sample size; Sig.: Significant; Means for groups in homogeneous subsets are displayed.

Table 3. Post-hoc tests of EVO (kJ/L) based on Tukey HSD and Duncan ($\alpha = 0.05$).

	HT (°C)	N	Subset		
			1	2	3
Tukey HSD	80	3	22.55		
	60	3	25.51		
	40	3	27.79	27.79	
	*25	3		33.93	
	Sig.		0.131	0.072	
Duncan	80	3	22.55		
	60	3	25.51	25.51	
	40	3		27.79	
	*25	3			33.93
	Sig.		0.195	0.302	1.000

N: Sample size; Sig.: Significant; Means for groups in homogeneous subsets are displayed.

Table 4. Tests of normality of dependent variables in relation to freezing temperature, FT (°C).

Dependent variables	FT (°C)	Shapiro–Wilk test (<i>P</i> -value)	R ²
DX (mm)	*25	0.126	0.805
	–2	0.142	0.811
	–12	0.888	0.997
	–22	0.650	0.967
	–36	0.949	0.999
OY(%)	*25	0.821	0.991
	–2	0.467	0.924
	–12	0.736	0.981
	–22	0.438	0.916
	–36	0.798	0.989
OEE (%)	*25	0.821	0.991
	–2	0.467	0.924
	–12	0.736	0.981
	–22	0.438	0.916
	–36	0.798	0.989
DE (J)	*25	0.074	0.783
	–2	0.800	0.989
	–12	0.873	0.996
	–22	0.903	0.997
	–36	0.557	0.947
EVO (kJ/L)	*25	0.631	0.963
	–2	0.231	0.846
	–12	0.555	0.947
	–22	0.153	0.816
	–36	0.178	0.826
EUV (×10 ² kJ/m ³)	*25	0.074	0.783
	–2	0.800	0.989
	–12	0.873	0.996
	–22	0.903	0.997
	–36	0.557	0.947

P-values > 0.05 indicates the data are normally distributed; R² is the coefficient of determination.

Table 5. Post-hoc tests of OEE (%) based on Tukey HSD and Duncan ($\alpha = 0.05$).

FT (°C)	Subset		
	N	1	2
Tukey HSD	-36	3	53.65
	-22	3	54.31
	-12	3	55.79
	-2	3	62.59
	*25	3	62.63
	Sig.		0.880
Duncan	*25	3	53.65
	-36	3	54.31
	-22	3	55.79
	-12	3	62.59
	-2	3	62.63
	Sig.		0.397

N: Sample size; Sig.: Significant; Means for groups in homogeneous subsets are displayed

Table 6. Post-hoc tests of EVO (kJ/L) based on Tukey HSD and Duncan ($\alpha = 0.05$).

FT (°C)	Subset			
	N	1	2	3
Tukey HSD	-36	3	26.40	
	-22	3	29.12	29.12
	-12	3	30.25	30.25
	-2	3		32.47
	*25	3		33.93
	Sig.		0.262	0.120
Duncan	*25	3	26.40	
	-36	3	29.12	29.12
	-22	3	30.25	30.25
	-12	3		32.47
	-2	3		33.93
	Sig.		0.064	0.100

N: Sample size; Sig.: Significant; Means for groups in homogeneous subsets are displayed.

Table 7. ANOVA results in relation to heating temperature, HT (°C).

Dependent variable	Effect	Sum of Squares	df	Mean Square	F-value	P-value	R ²
PV (µg/g of active oxygen)	HT (°C)	1193.1	3	397.68	287	0.000	0.995
	Error	5.542	4	1.386			
	Total	1198.6	7				
FFA (mg KOH/g)	HT (°C)	0.037	3	0.012	2.083	0.245	0.609
	Error	0.023	4	0.006			
	Total	0.060	7				

Table 8. ANOVA results in relation to heating temperature, FT (°C).

Dependent variable	Effect	Sum of Squares	df	Mean Square	F-value	P-value	R ²
PV (µg/g of active oxygen)	TP (°C)	2397.2	3	799.1	287.7	0.000	0.995
	Error	11.11	4	2.777			
	Total	2408.4	7				
FFA (mg KOH/g)	TP (°C)	0.006	3	0.002	0.664	0.616	
	Error	0.011	4	0.003			
	Total	0.017	7				

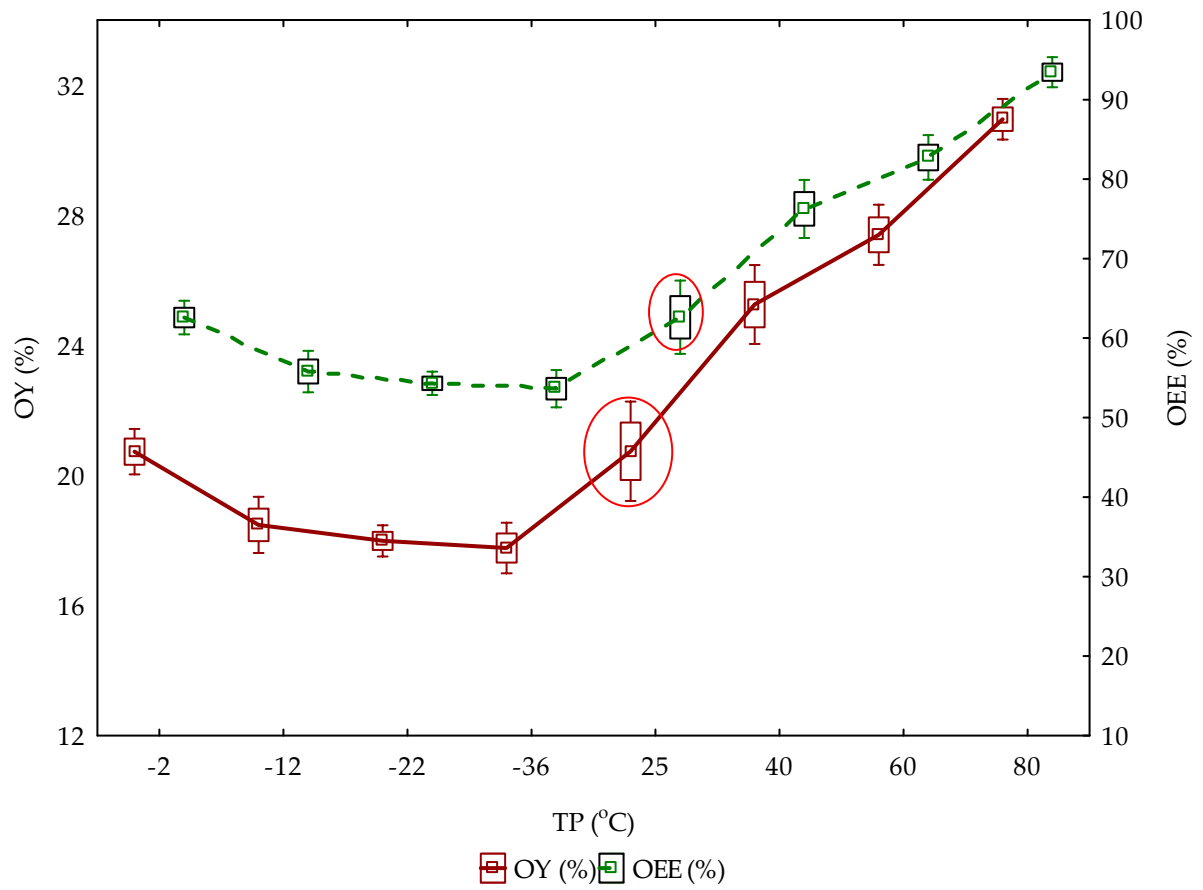


Figure 1. Box plot of OY (%) and OEE (%) grouped by TP (°C).

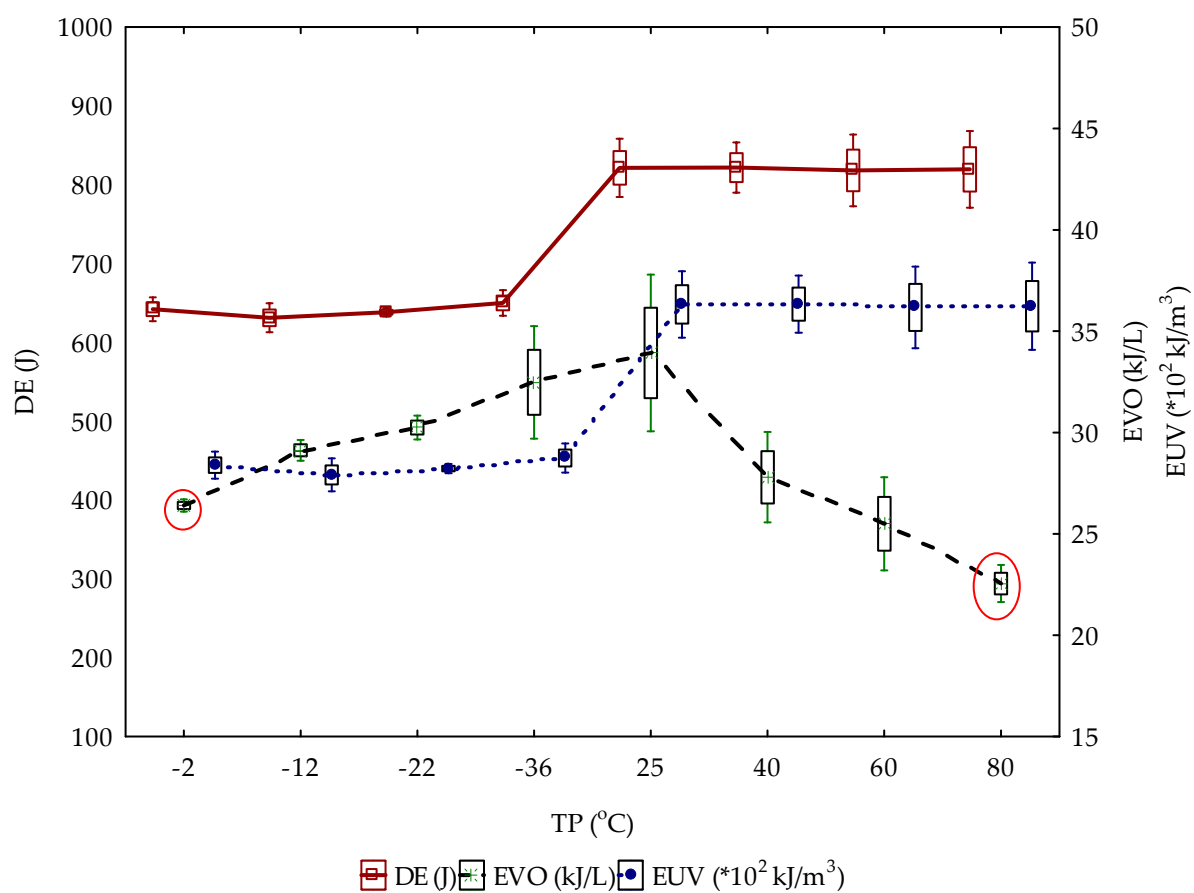


Figure S2. Box plot of multiple variables grouped by temperature (°C).

Table 9. Post-hoc tests of PV (mg KOH/g) based on Tukey HSD and Duncan ($\alpha = 0.05$).

	Temp (°C)	N	Subset					
			1	2	3	4	5	6
Tukey HSD	-2	2	31.32					
	-36	2	36.79					
	*25	2		51.22				
	-22	2		51.55				
	60	2		54.97				
	40	2			73.88			
	-12	2			76.03	76.03		
	80	2				80.06		
	Sig.		0.061	0.277	0.796	0.218		
Duncan	-2	2	31.32					
	-36	2		36.79				
	*25	2			51.21			
	-22	2			51.55			
	60	2				54.97		
	40	2					73.88	
	-12	2					76.03	
	80	2						80.06
	Sig.		1.000	1.000	0.821	1.000	0.175	1.000

N: Sample size; Sig.: Significant; Means for groups in homogeneous subsets are displayed.

Table 10. Correlation linear regression results of the effect of heating temperature.

Dependent variables	R (-)	R ² (-)	F-value (-)	P-value (-)
PV (µg/g of active oxygen)	0.598	0.358	3.346	> 0.05
FFA (mg KOH/g)	-0.622	0.387	3.786	> 0.05

R is the correlation coefficient; R² is the coefficient of determination; Non-significant: F-value < P-value or P-value > 0.05.

Table 11. Correlation and linear regression results of the effect of freezing temperature.

Dependent variables	R (-)	R ² (-)	F-value (-)	P-value (-)
PV (µg/g of active oxygen)	0.102	0.010	0.063	> 0.05
FFA (mg KOH/g)	-0.030	0.001	0.005	> 0.05

R is the correlation coefficient; R² is the coefficient of determination; Non-significant: F-value < P-value or P-value > 0.05.

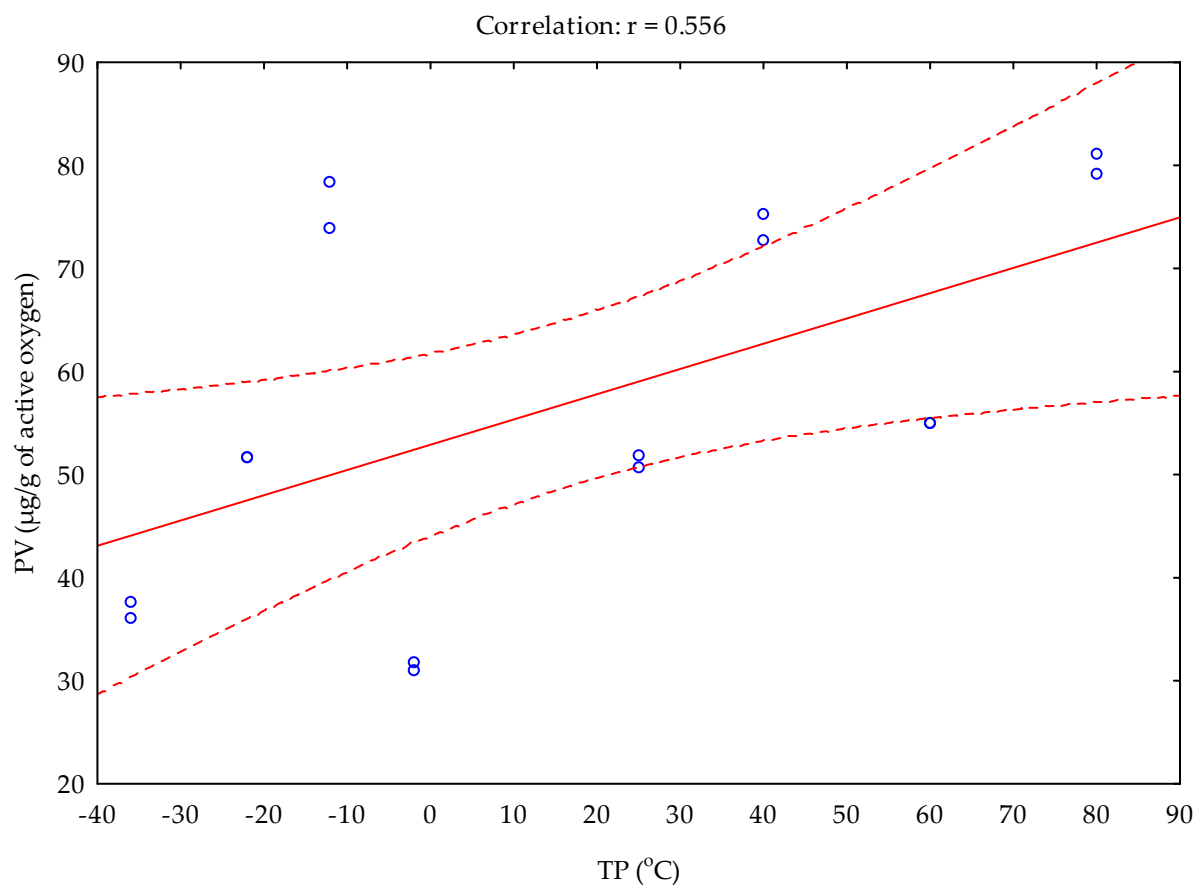


Figure S3. Scatterplot: PV (µg/g of active oxygen) versus TP (°C) based on 95% confidence interval.

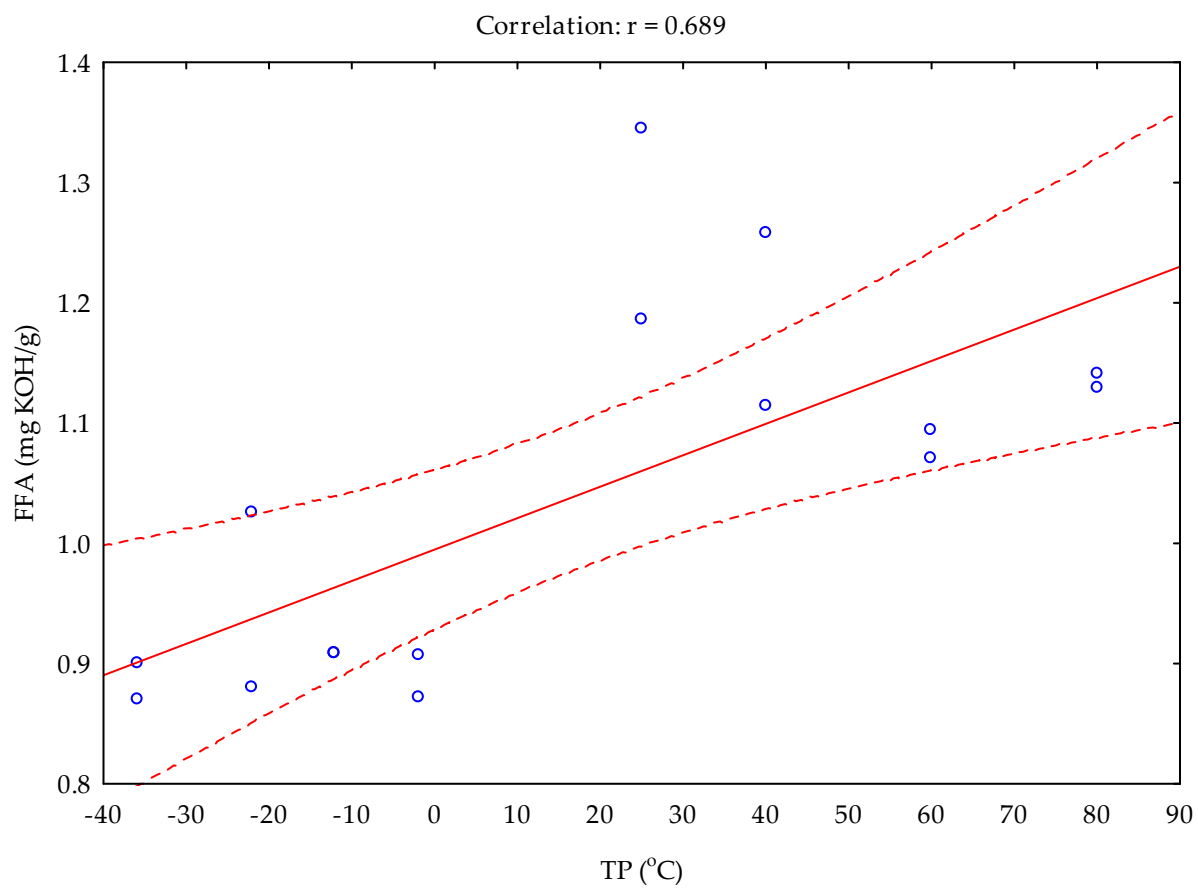


Figure S4. Scatterplot: FFA (mg KOH/g) versus TP (°C) based on 95% confidence interval.