Kinds of honey	Place of gathering	Content of carboxydrates, %		
		Turan.*	Malttr.*	Meliz.*
Various flowers	Ludza	2.14	0.09	0.96
Various flowers	Jekabpils	2.18	0.62	0.56
Various flowers	Cesis	1.83	0.12	0.10
Wild flowers	Cesis	1.17	0.65	0.67
Wild.flowers	Madona	2.26	2.22	0.02
Lime blossom	Riga	2.12	0.82	0.35
Lime blossom	Talsi	1.83	0.72	0.56
Dropwort flow.	Valka	1.38	-	0.61
Heather flowers	Limbazi	3.78	1.46	0.82
Meadow flowers	Riga	0.97	0.44	-
Buckwheat flow.	Saldus	0.92	0.09	
Phacelia flowers	Jelgava	5.01	1.09	0.97
Sweet flowers	Riga	1.80	0.21	0.11

* Sach. – sacharose; Gluc. – glucose; Fruc. – fructose; Malt. – maltose; Turan. – turanose; Malttr. – maltotriose; Meliz. – melizitose.

RESPONSE SURFACE METHODOLOGY IN RHEOLOGICAL CHARACTERIZATION OF QUINCE PUREE

Bilge Arıkan, Meral Kılıç, Ozgul Evranuz
Istanbul Technical University, Food Engineering Department,
34469 Maslak, Istanbul, Turkey

Table 1
Independent variables and their coded and actual values used in the experiments

Independent variable	Units	Symbol	Coded levels		
			-1	0	+1
Temperature	°C	X_1	25	50	75
pH		X_2	3.0	3.5	4.0
Total solids	% (w/w)	X_3	10	14	18

Rheological properties of quince puree were investigated with respect to processing conditions by using response surface methodology. Effects of total solids content (10-18%), pH (3-4) and temperature (25-75°C) that could be encountered during processing on rheological properties of quince puree were determined in a central composite design. Flow behavior of quince puree was found to be pseudoplastic that could be described by Herschel-Bulkley model under all conditions studied. Temperature and total solids content were found effective on the consistency coefficient of quince puree. Yield stress of quince puree was found to change with pH and total solids content.

Table 2.
erimental design and data for the responses; consistency index (k), flow index (n), yield stress (τ_o) and thixotropy of quince puree under different conditions

T (°C) (*X1*)	**pH** (*X2*)	**C (%)** (*X3*)	**k (Pa.s^n)** (*Y1*)	**n** (*Y2*)	**τ_o (Pa)** (*Y3*)	**Thixotropy (Pa/s)** (Y_4)
25	4	10	2.2	0.49	3.6	23
25	3	18	18.8	0.38	71.2	2472
75	4	18	6.1	0.48	36.8	1091
50	3.5	14	5.2	0.43	13.0	664
50	3.5	14	5.3	0.43	14.5	654
75	3	10	0.8	0.54	4.6	3
50	3.5	14	4.5	0.46	14.6	587
75	3	18	4.5	0.51	37.6	1426
50	3.5	14	4.7	0.46	12.7	474
25	3	10	2.0	0.50	4.1	58
75	4	10	1.0	0.52	3.5	2
25	4	18	29.1	0.33	49.0	2694
50	3	14	3.3	0.49	20.8	870
25	3.5	14	9.4	0.39	18.0	746
50	3.5	18	9.8	0.46	46.5	1587
50	3.5	14	4.9	0.45	17.1	692
50	3.5	14	4.9	0.46	19.9	736
50	4	14	4.6	0.45	20.4	797
50	3.5	10	1.3	0.51	2.1	36
75	3.5	14	3.7	0.43	8.4	412

Thixotropy in the samples decreased with increase in temperature. Interactive effects of some processing parameters were found significant on consistency coefficient, yield stress and thixotropy of quince puree. Rheological properties of quince puree were found to depend on processing conditions.

$$\tau = \tau_0 + K(\dot{\gamma})^n \qquad \text{(Equation 1)}$$

where, τ is the shear stress (Pa), τ_0 is the yield stress (Pa), $\dot{\gamma}$ is the shear rate (s^{-1}), k is the consistency index ($Pa.s^n$) and n is the dimensionless flow behaviour index.

$$Y = b_0 + \sum_{n=1}^{3} b_n x_n + \sum_{n=1}^{3} b_{nn} x_n^2 + \sum_{n=m=1}^{3} b_{nm} x_n x_m \qquad \text{(Equation 2)}$$

where the coefficients of the polynomial were represented by b_0 (constant term); b_1, b_2 and b_3 (linear effects); b_{11}, b_{22} and b_{33} (quadratic effects); and b_{12}, b_{13} and b_{23} (interaction effects).

Table 3.
Regression coefficients and correlation coefficient (R^2) for the response functions†

Coefficient of independent variables	**k ($Pa.s^n$)** (Y1)	**n** (Y2)	**τ_o (Pa)** (Y3)	**Thixotropy (Pa/s)** (Y4)
b_0	6.646	1.163	1.834	0.246
T (X1) (b_1)	-0.35	-0.004	0.192	**-57.95***
pH (X2) (b_2)	1.646	-0.173	**-42.422***	-51.71
C (X3) (b_3)	**4.29***	-0.043	-2.488	73.76
TxT (X1xX1) (b_{11})	**-0.003***	-0.003	-0.003	-0.071
pHxpH (X2xX2) (b_{22})	-1.816	0.0311	**-20.81***	11.87
CxC (X3xX3) (b_{33})	**0.316****	0.001	**0.558***	**847.94***
TxpH (X1xX2) (b_{12})	-0.024	0.004	**0.209***	-5.24
TxC (X1xX3) (b_{13})	**-0.062****	0.002	**-0.058***	**-3.22****
pHxC (X2xX3) (b_{23})	0.345	-0.005	**-1.338***	-4.74
R^2	**0.995**	**0.971**	**0.991**	**0.984**

† b: coefficients of polynomial equation; b_0 (constant); b_1. b_2 and b_3 (linear effects); b_{11}. b_{22} and b_{33} (quadratic effects); and b_{12}. b_{13} and b_{23} (interaction effects). (* Significant at $p \leq 0.05$. ** Significant at $p \leq 0.001$.)

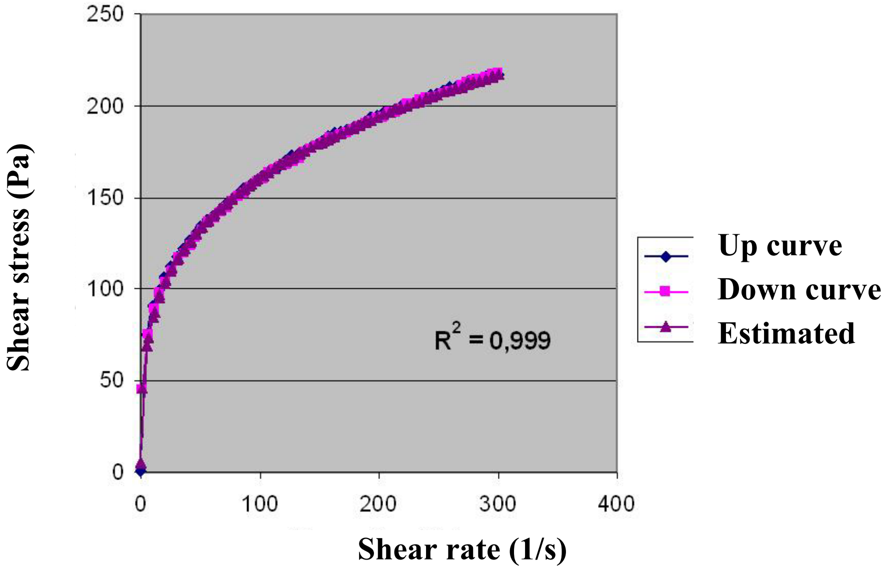

Figure 1
Experimental and estimated (Herschel-Bulkley model)
flow curve of quince puree at 18% total solids, pH 4 and 25°C.

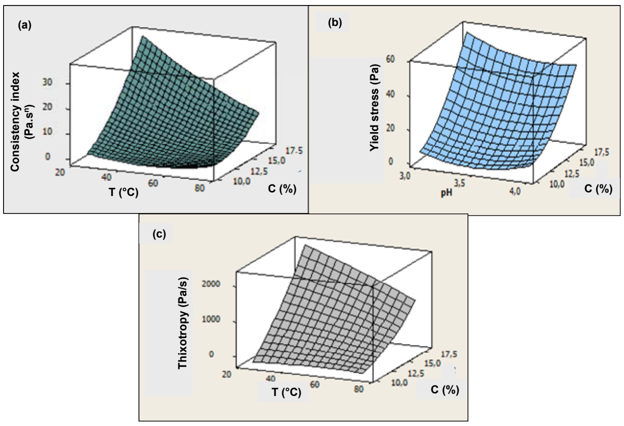

Figure 2
Interactive effects of processing parameters on consistency index (a),
yield stress (b) and thixotropy (c) of quince puree