

RHEOLOGICAL STUDY OF TWO PEACH PUREES WITH 11.9°BRIX

A. Massa¹; C. González¹; A. Maestro¹; J. Labanda¹ and A. Ibarz²

¹Departament d'Enginyeria Química, Universitat de Barcelona, Martí i Franquès 1, 08028
Barcelona, Spain

²Departament de Tecnologia d'Aliments UTPV-XaRTA, Universitat de Lleida, Av. Rovira
Roure, 191, 25198 Lleida, Spain

almasra@telefonica.net

1. Introduction

Rheology is one of the most important physical features of fruit purees. Mainly, peach purees contain pectin and fiber that provide to the purees a kind of internal structure, which is responsible of their rheological behaviour. Several mathematical models were postulated for the characterization of the rheological behaviour (Barnes, 1997; Abu-Jdayil, 2003; Labanda *et al.*, 2006). High structured purees use to be difficult to manage due to their high viscosity, and low structured purees can present sedimentation of some components, such as fibers. The design of fruit fluids processing operations and equipment can be improved by the knowledge of their rheological properties (Ma *et al.*, 1996; Shukla *et al.*, 1995). Peach purees are very important for the food industry and can be used as ingredients in many products. For example, juices or purees obtained after pasteurisation are used for fruit beverages; concentrated purees produced through the use of evaporators after pasteurisation are mainly used for jellies or jams and baby foods (Maceiras *et al.*, 2007). The aim of this study was to perform a rheological characterization at rest and under flow conditions of two peach purees with 11.9 °Brix.

2. Materials and methods

Samples were provided by an industry in the Lleida (Spain) area, according to the following process. Peach fruits were washed and selected before the grinding step. One peach puree with 11.9°Brix was obtained directly from the pasteurization at 90°C after the grinding step of washed peach fruits (natural peach puree). Later, this puree was filtered through a 4.5 µm hole size filter and it was partially concentrated to 21°Brix using a two effect evaporator at 60-70°C. The puree was later aseptically stored at -18°C. Finally, the puree was diluted with deionized water to 11.9 °Brix (diluted peach puree). Soluble solids content was determined with a digital refractometer Atago RX-1000 (Atago Co., Ltd, Tokyo, Japan) and expressed as °Brix.

Rheological measurements were carried out using a Haake RS 150 rheometer provided with a coaxial cylinder sensor system and at four temperatures (5°C, 25°C, 45°C and 65°C). The rheological behaviour at rest was analyzed with the oscillatory frequency-sweep test at constant shear in the linear region. The steady-state behaviour was determined by a shear rate sweep test, when shear stress at each shear rate was measured and noted down only when a constant value with time was obtained.

3. Results and discussion

Both purees showed the typical viscoelastic behaviour of a weak gel and the two moduli, G' and G'' , decreased with temperature. Figure 1 shows the experimental results obtained with the diluted peach puree for three temperatures. It can be seen that G' is higher than G'' over the whole frequency range, indicating a predominance of elastic behaviour. Moreover, both moduli slightly decreased with the increase in temperature.

Figure 2 shows the steady state shear stress, σ , as a function of shear rate, $\dot{\gamma}$, and temperature for both peach purees. Both purees showed shear thinning behaviour that was evaluated by the Herschel-Bulkley equation:

$$\sigma = \sigma_o + K_{eq} \cdot \dot{\gamma}^n \quad (1)$$

where σ_o is the yield stress, K_{eq} is the consistency index and n is the flow index. The yield stress is calculated by the Casson equation at very low shear rates, and the consistency index and flow index were calculated by linear regression. Tables 1 and 2 summarize the parameter values that better fitted the experimental data. Strong correlation was observed since R^2 was higher than 0.98. The values of all parameters decreased as the temperature was increased. The main difference in the rheological behavior between both peach purees was obtained in the consistency index. The diluted peach puree showed lower values of K_{eq} at all temperatures. Then, the diluted peach puree forms a less developed internal structure than the natural peach puree.

In addition, both peach purees showed thixotropy under non-steady conditions. Thixotropy was quantified by a second-order kinetic process of structure breakdown with good agreement.

4. Conclusions

The rheological behaviour of both peach purees (natural and diluted) was very similar. Both purees showed a gel-like behaviour when the viscoelasticity was measured in the linear

region. In steady state conditions, both purees showed shear thinning behaviour following the Herschel-Bulkley equation. The main rheological difference between both peach purees was observed in the consistency index, which presented lower values for the diluted peach puree. Then, the concentration process of 11.9°Brix peach puree by evaporation does not change the pectin content and the diluted peach puree with 11.9°Brix shows similar rheological properties than the natural peach puree.

References

- Abu-Jdayil, B. 2003. Modelling the time dependent rheological behavior of semisolid foodstuffs. *Journal of Food Engineering*, 57, 97–102.
- Barnes, H.A. 1997. Thixotropy-a review. *Journal of Non Newtonian Fluid Mechanics*, 70, 1-33.
- Labanda, J., Llorens, J. 2006. A structural model for thixotropy of colloidal dispersions. *Rheologica Acta*, 45, 305-314.
- Ma, L., Grove, A., Barbosa-Cánovas, G.V. 1996. Viscoelastic characterisation of surimi gel: effect of setting and starch. *Journal of Food Science* 61, 881-883.
- Maceiras, R., Alvarez, E., Cancela, M.A. 2007. Rheological properties of fruit purees: Effect of cooking. *Journal of Food Engineering*, 80, 762-769.
- Shukla, A., Rizvi, S.S.H. 1995. Viscoelastic properties of butter, *Journal of Food Science* 60, 902-905.

Table 1. Yield stress calculated by Casson equation for both peach purees.

T (°C)	Natural peach puree		Diluted peach puree	
	σ_o (Pa)	R ²	σ_o (Pa)	R ²
5	1.47 ± 0.17	0.9901	1.59 ± 0.14	0.9882
25	1.11 ± 0.11	0.9914	1.07 ± 0.08	0.9953
45	0.950 ± 0.091	0.9859	1.01 ± 0.12	0.9868
65	0.817 ± 0.123	0.9946	0.772 ± 0.075	0.9882

Values are the mean of three independent determinations ± confidence interval (P<0.05).

Table 2. Steady state parameters of Herschel-Bulkley equation for both peach purees.

T (°C)	Natural peach puree			Diluted peach puree		
	K _{eq} (Pa·s ⁿ⁻¹)	n (-)	R ²	K _{eq} (Pa·s ⁿ⁻¹)	n (-)	R ²
5	3.13 ± 0.20	0.335 ± 0.015	0.9901	2.57 ± 0.35	0.358 ± 0.010	0.9985
25	2.46 ± 0.13	0.339 ± 0.015	0.9929	2.07 ± 0.26	0.346 ± 0.013	0.9933
45	1.63 ± 0.10	0.375 ± 0.019	0.9928	1.52 ± 0.12	0.360 ± 0.014	0.9947
65	1.49 ± 0.15	0.381 ± 0.018	0.9914	1.13 ± 0.23	0.384 ± 0.011	0.9921

Values are the mean of three independent determinations ± confidence interval (P<0.05).

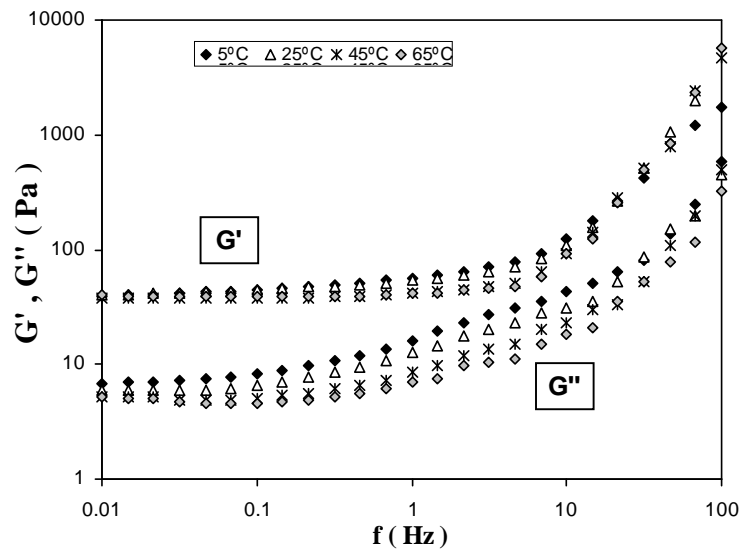


Figure 1. Linear viscoelastic functions (G' and G'') as a function of oscillatory frequency for the 11.9°Brix diluted peach puree at different temperatures

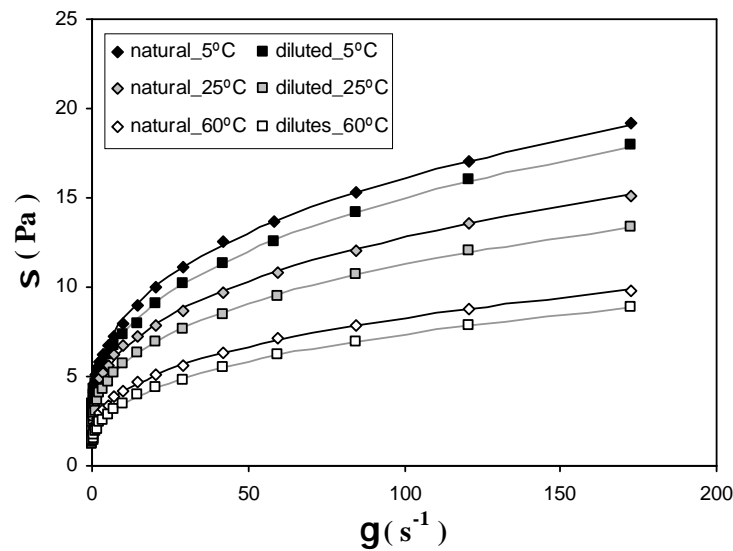


Figure 2. Steady state shear stress as a function of shear rate for both natural and diluted 11.9°Brix peach purees at different temperatures. Lines correspond to the Herschel-Bulkley model.