Effect of enzymatic treatment, shear stress and temperature on the rheological behavior of blackberry (Rubus spp.)juice

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ABSTRACT

The objective of this work was to study the effect of enzymatic treatment, shear stress and temperature on the rheological behavior of blackberry juice. The juice was submitted to enzyme hydrolysis during 30 minutes using Rapidase enzyme at different concentrations (200, 400 and 600ppm). After incubation step the juice viscosity was analyzed at 20, 25, 30 and 35°C to shear rate varying between 0 and 100 s^{-1}. Experimental data were obtained in a concentric cylinders rheometer model AR-G2. The hydrolyzed blackberry juice presented pseudoplastic behavior with the flow consistency index very sensitive to temperature changes.

INTRODUCTION

The industrial production of fruit juices had initially low incomes as a result of difficulties found in performing the filtration step and to achieve an acceptable clarification of the same (BHAT, 2000). The resulting juice from pulped fruit was rich in insoluble particles and suspended materials consisting mainly of pectin, polysaccharides in general (eg, cellulose, hemicellulose and starch), proteins, tannins, metals and microorganisms (KASHYAP et al., 2001; FERNANDES, 1999). To overcome these difficulties, several researches about biochemical processes indicated the use of macerating enzymes (pectinases, cellulases and hemicellulases) during the industrialization process, mainly as a pretreatment for juices to be clarified by micro or ultrafiltration.

The applications of enzyme to change viscosity of the product is therefore very interesting for developing products for technological and market changes. The enzyme treatments decrease the viscosity of the product because it reduces the size of the macromolecules present (BALISCHI *et al.*, 2002). According to Harper and El Sahrigi (1985), the effects of shear stress and temperature on the rheological behavior of non newtonian fluids can be combined into a single equation. The information about this juice flux behavior at different temperatures makes it possible to optimize the conditions of unit operation (HAMINIUK, 2008; STEFFE, 1996).

METHODOLOGY

The juices viscosity analyses were performed in concentric cylinders rheometer model AR-G2 coupled to the software Rheology Advantage Control AR. The temperature range (20 to 35°C) was set in the range of typical operation of clarification process of fruit juices that takes into account the characteristics of thermo-sensible antioxidant compounds. Experiments were conducted in duplicate for the raw juice of blackberry and for samples previously submitted to enzymatic pre-treatment during 30 minutes, varying the enzyme concentration (200 ppm to 600 ppm). The range of enzyme concentration was selected based on literature data for microfiltration of fruits rich in pectin (Vaillant, 2001). As expected, the hydrolyzed blackberry juice presented much lower viscosity than the raw juice (Figure 1). With the evaluation of the blackberry juice viscosity it was possible to observe that the increase in enzyme concentration of 400 to 600ppm promoted an insignificant reduction in the juice viscosity. For all experimental conditions, the hydrolyzed juices presented non-Newtonian fluid behavior (pseudoplastic) as can be illustrated in Figure 2.The parameters of power law model (eq. 1) are presented in table 1. Increasing the temperature (20 to 35 °C) a relevant decrease in the flow consistency index was observed.

$$\eta = k * \left(\frac{dv}{dy} \right)^{n-1} \quad \text{.....\{1\}}$$

where:

η - apparent viscosity (cP); dv/dy – shear rate (1/s)

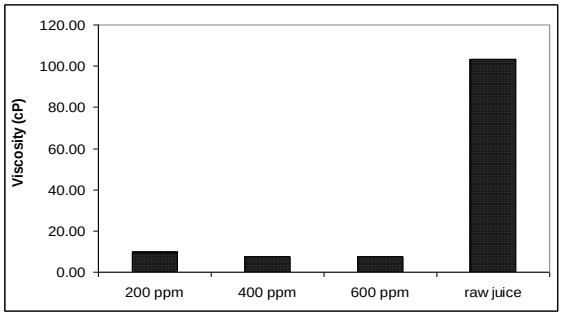

Figure 1. Effect of enzymatic treatment on blackberry juice viscosity, at 20°C

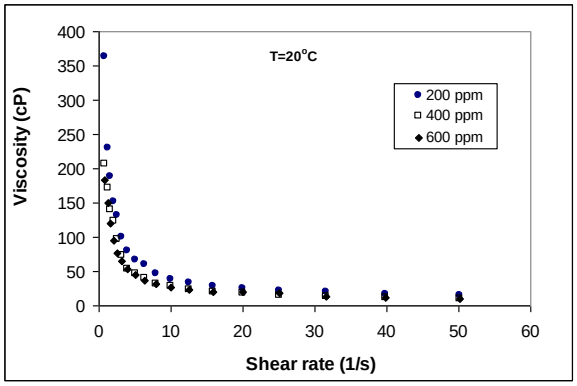

Figure 2. Rheological behavior of hydrolyzed blackberry juice.

Table 1. Parameters of power law model, as temperature function, to blackberry hydrolyzed juice

Temperature	n	k
20ºC	0.28	169.88
25ºC	0.33	90.80
30ºC	0.35	84.52
35ºC	0.36	67.53

Rapidase® Novo Industry (400 ppm of enzyme, during 30minutes)

As can be observed by Vaillant (2001) the enzyme treatment, carried out before juice clarification, has the advantage of promote a elevate reduction on juice viscosity and keeping the permeate flow rate economically viable at low temperature.

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