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Effect of processing on rheological, structural and sensory properties of apple puree

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Abstract

The relation between rheological, structural and sensory properties of apple purees was studied taking into account the effect of processing. For this reason, a grinding - separation strategy was established in order to vary pulp content and particle size. By grinding, three different particle size distributions were obtained. A second heat treatment was applied to purees to see the impact on its rheological and structural properties. An experimental design was constructed, with two factors (pulp content and particle size) and 4 levels (25, 31, 42, 60 %) for pulp content and 3 levels (200, 500, 1100 μm) for particle size. The rheological properties of purees were characterized using a controlled stress rheometer by the flow curves obtained from 2.14 to 214 s^{-1} shear rate range; frequency sweeps measurements were performed within the linear viscoelastic region, in the range of 0.1-40 rad/s. Purees behaved as shear-thinning fluids presenting a yield stress. Apparent viscosity and yield stress increased as pulp content increased, and they decreased as particle size decreased. The least shear thinning behaviour was observed in purees with low pulp content and small particles. A second heat treatment affected cell wall structure inducing a decrease of the rheological properties of the puree. The most important attributes to explain the texture of apple purees are consistency and graininess, parameters that can be manipulated by controlling processing conditions.

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Keywords: Malus x domestica Borkh; particle size; serum; viscosity; consistency

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1. Introduction

Texture is a major quality attribute of plant-based foods; texture is defined as the sensory and functional manifestation of the structural, mechanical and surface properties of foods detected through the senses of vision, hearing, touch and kinesthetics [1]. Recently, there has been a great interest in the development of methods to predict and control the texture of plant-based foods, particularly in relation to processing and/or post harvest treatments [2]. Apple purees are concentrated plant food dispersions where soft insoluble particles (pulp) composed of cell or cell wall clusters from parenchyma are dispersed into an aqueous solution (serum) of sugars, organic acids and pectic substances [3]. In general purees of fruits and vegetables are shear-thinning (pseudoplastic) fluids and exhibit a yield stress, defined as the stress that must be exceeded for flow to occur [4]. The consistency index, apparent viscosity, yield stress are important product properties. Thus the rheological parameters are a useful tool in understanding changes in food structure during processing and to control the quality of the product. Solids content, particle size distribution of solids and serum viscosity play important roles in the rheological behaviour of plant food dispersions [3]. Structural and rheological properties of fruit purees depend also on variety and ripeness stage of the fruits. Another important parameter influencing the products properties is related to the processing conditions (heating and mechanical treatments). Schijvens et al [5] observed that cooking time seemed to influence serum viscosity in relation to pectin degradation and pulp content. At the refining stage, varying the screen opening will change the particle size and pulp content [6] and hence modify the flow properties. The mechanical properties of apple purees thus seem to be very specific to the processing parameters involved. Moreover, the processing induced changes in various mechanical attributes of these products are likely to influence their sensory perception [7]. The aim of this study is to better understand the relationship between the structural, rheological, and sensory parameters of apple puree, taking into account the impact of manufacturing process on these parameters, mainly the texture. For that reason reconstituted purees were made with defined pulp content and particle size. A second heat treatment was applied to some purees to simulate some steps of industrial processing and to understand their impact on the final product.

Nomenclature

$\dot{\gamma}$	Shear rate (s^{-1})
σ	Shear stress (Pa)
σ_o	Yield stress (Pa)
k	Consistency index (Pa-s^n)
n	Flow behaviour index

2. Materials & Methods

The studied apple puree was industrially processed by a French manufacturer using a cold-break method with a single batch of Golden Delicious. Apples were selected, washed and roughly cut, followed by the addition of ascorbic acid (500 ppm) to prevent oxidation. Then the apple pieces were refined (sieve opening of 1.2 mm) and cooked (98°C, 4 min). Puree was kept in a flow regulating tank before being sterilised. Finally purees were conditioned in hermetically sealed bags. This sample is called Native puree (N).