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Physico-chemical and rheological changes of fruit purees during storage

Federica Balestra[a]*, Emiliano Cocci[a], G. Marsilio[a], Marco Dalla Rosa[a]

[a]*Department of Food Science, University of Bologna, Piazza Goidanich,60. Cesena 47521, Italy*

Abstract

A large number of purees of fruits and vegetables are produced commercially; some are usually consumed directly, while others are used as intermediate products and ingredients. The fruit purees studied were realized with peach, apple and pear. Immediately after the production (t_0) and after the storage period (t_n) the pH, soluble solids content, titratable acidity, ascorbic acid content and Bostwick consistency of samples were evaluated. Furthermore after the storage period (t_n) the moisture content, the water activity and the colour parameters were also determined. Rheological properties were evaluated by using a controlled stress–strain rheometer and a cone and plate geometry sensor. The viscosity (η) against shear rate ($\dot{\gamma}$) were evaluated to study the rheological behaviour of all fruit purees. In this study the flow curves were also evaluated and fitted according to the rheological model of *Casson*. The experimental measurements showed that the viscosity variation against the shear rate of fruit purees is exponential and therefore they are non-Newtonian fluids. The *Casson* model was found to fit adequately ($R^2 \geqslant 0.84$) over the entire shear-rate range. Moreover significant and interesting correlations between Bostwick consistency and some rheological parameters were found. Unfortunately a scanty production's standardization over the years was observed.

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Keywords: fruit purees; physico-chemical characteristics; rheological properties; storage;

1. Introduction

Fruit purees are elaborated with varied fruits (peach, apple, pear and banana, or others like apricot, orange or pineapple), and enriched or not with vitamins. Water or juices are added to fruits [1]. There are several steps in the preparation of fruit and vegetable purees: peeling of the skin of the fruit, size reduction, heating to either soften the tissue and/or inactivate enzymes, straining of the heated mass

* Corresponding author. Tel.: +39 0547 636120; fax: +39 0547 382348.
E-mail address: federica.balestra@unibo.it

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through finishers (finishing), and the addition of starch or sugar to obtain the desired consistency. The finishing operation (screen size and finisher speed) can be expected to have significant influence on the consistency of the sauce due to its effect on the quantity and the dimensions of the pulp [2].

Flow properties of fruit purees are of considerable interest in the development of fruit products for technological and marketing reasons. Together with others, they provide the information necessary for the optimum design of unit processes; contribute to the quality control in both manufacturing processes and final product; limit the acceptability and the field of application of a new product; and finally, they are a powerful tool into understanding molecular structure changes [3]. Moreover considering the consumer demand for processed foods with high quality, there is a need to define changes in rheological properties of foods in processing operations and during the storage that may affect their overall acceptability [4].

Rheology offers vocabulary and specific terminology to discuss foods and their textural characteristics as well as mathematical references to describe these textural characteristics. Fluids could be characterized by their viscosity and/or by their consistency. Consistency can be defined as a quality of food that is perceptible to touch or as the resistance to permanent deformation. The term 'body' is also used in reference to consistency. A broader definition of consistency could be the characteristic of a mixture of fluid and solid foods. Szczesniak referred to consistency as the mouthfeel characteristics of semi-solids or liquids. Therefore, sensory concepts such as mouthfeel and body could be associated with consistency as well as more rheological definitions referring to the texture characteristics of the products [5].

Knowledge of the rheological properties of food products is essential for product development, design and evaluation of process equipment such as pumps, piping, heat exchangers, evaporators, sterilizers and mixers. Rheological measurements have also been considered as an analytical tool to provide fundamental insight of the structural organization of food. Various factors affecting the rheological behaviour of fruit puree and concentrates include temperature, total soluble solids/concentration, particle size [6].

This study had three main objectives: a) to evaluate the storage stability of fruit purees regarding the physico-chemical characteristics; b) to determine, over the years, the production's standardization as regards physical and chemical properties; c) to evaluate the rheological behaviour of the purees and to determine a possible correlation between the Bostwick consistency and the rheological parameters (such as viscosity and yield stress values) obtained applying the *Casson* model to the flow curves obtained by using a rheometer.

2. Material & Methods

The fruit purees studied were realized with peach, apple and pear. The peach and apple purees were produced in 2008 and 2009 and the pear purees in 2007, 2008 and 2009. The samples were supplied by a local factory, Italfrutta S.r.l (Rovigo, Italy). The fruit purees were stored in aseptic bag at room temperature.

Immediately after the production (t_0) and after the storage period (t_n) the pH (ph meter, mod. Cyberscan 510), soluble solids content (SSC) (refractometer, PR-1 Atago, Japan), titratable acidity (expressed in citric acid equivalent), ascorbic acid content (iodometric method) and Bostwick consistency (Bostwick consistometer) were evaluated. Furthermore after the storage period (t_n) the moisture content (at 70°C until constant weight), the water activity (water activity meter, Decagon Devices Inc., Pullman, Usa), the colour parameters (colour-spectrophotometer mod. Colorflex, Hunterlab, Usa), and the rheological characteristics by using a controlled stress–strain rheometer (MCR 300, Physica/Anton Paar) and a cone and plate geometry sensor (50mm diameters, 2° angle with a gap distance of 1mm) were also determined. The flow ramp was performed at 25°C in a range of shear rate from approximately 0 to 300 s^{-1}. The viscosity (η) against shear rate ($\dot{\gamma}$) was evaluated to study the rheological behaviour of all fruit purees.