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Suitability of different varieties of peaches for producing minimally processed peaches preserved by high hydrostatic pressure and selection of process parameters

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ABSTRACT

Fresh-cut products represent an easy way to include fruits in everyday meals. The aim of this work was to evaluate the suitability of two cultivars for high pressure processing (HPP), and to establish the principal parameters leading to a better quality preservation of minimally processed peaches. *Prunus persicae* cv. Flavorcrest and cv. Romea were subjected to different HPP-treatments according to a factorial design. The factors were: pressure level (500, 600 and 700 MPa) and holding time (1 and 5 min), applied at room temperature. Several determinations were carried out over the samples: texture parameters, ascorbic acid content, total phenols, and polyphenoloxidase and alcohol dehydrogenase activity. Results showed that only the 700 MPa treatments, for both holding time evaluated, provoked a significant decrease in the hardness of the HPP-product. Romea had lower polyphenoloxidase activity and higher ascorbic acid and total phenols content than Flavorcrest. The application of 600 MPa-5 min to Romea peaches successfully prevented enzymatic browning, with the additional advantage of rendering higher concentrations of ascorbic acid and phenols. This last aspect would be an asset either for the development of high-quality products or, as a pre-treatment, for increasing the yield of polyphenols to be recovered from fruit products waste.

1. Introduction

Over the last years, there has been a significant increase in the offer of minimally processed fruits in retail and food services. The main driver of this tendency is the increasing demand for convenience products suitable for the modern lifestyle, considering that they offer the advantage of saving time and effort. However, it is well-known that these products represent a technological challenge, since processes such as peeling and/or cutting, normally used for the manufacturing of fresh-cut fruits, bring about a faster physiological deterioration, biochemical changes and microbial spoilage, which altogether may result in degradation of the color, texture and flavor. As a consequence, different strategies have been developed to obtain products able to keep, during long-time storage, the freshness and quality of the original commodity. In this regard, one of the most successful approaches assayed so far has been the combination of different preservation technologies, acting synergistically, which is referred to as hurdle technology. Under this framework, high pressure processing (HPP) constitutes a promising non-thermal technology having proved highly successful for the preservation of minimally processed fruits, in combination with other processes (e.g. organic acids dipping, vacuum packing, and refrigerated storage) (Denoya, Vaudagna, & Polenta, 2015).

Since the quality and shelf-life of minimally processed fruit products is affected by several factors, it is important to develop these products under a holistic approach that includes a detailed selection of the type of cultivar, processing conditions, and storage atmosphere and temperature. Cultivar selection is probably the most important topic in these products, since genetic characteristics are closely linked to quality-related aspects such as flesh texture, skin color, and browning potential (Gorny, Hess-Pierce, &

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Kader, 1999; Putnik, BursaćKovačević, Penić, Fegeš, & Dragović-Uzelac, 2016).

The selection of varieties able to render products that adequately responds to the modern market requirements and consumer demands constitutes one of the key aspects in the development of fresh-cut fruits. In spite its relevance, studies focusing this aspect are rather scarce. In the case of peaches, the different varieties can be classified into three main categories: varieties for fresh consumption, varieties for canning, and multipurpose varieties. It was found in fruits such as melon, that the correct selection of the cultivar most suitable for preservation by HPP, had a significant impact over important quality aspects of the final product, such as vitamin C content, and color preservation, after HPP and during refrigerated storage (Wolbang, Fitos, & Treeby, 2008).

In a previous work carried out in our laboratory with peach pieces treated with pressures between 400 and 600 MPa, and holding times between 1 and 9 min, we found that 600 MPa attained the highest level of inactivation for two deterioration-related enzymes: polyphenoloxidase (PPO), the main enzyme that catalyzes browning, and alcohol dehydrogenase, an enzyme related to the induction of fermentation under anaerobic condition. In turn, this level of pressure caused no significant changes on the color parameters, and only a minor variation in the texture (Denoya et al., 2016). The incomplete inactivation attained in that study highlights the importance of assessing in depth whether the application of higher pressures would render higher levels of inactivation of the enzymes associated with deterioration. This could also offer the additional advantage of reducing the holding time, taking into account that the longer this process parameter, the more expensive would be the treatment.

According to the mentioned above, the aim of the present work was to evaluate the suitability of two peach cultivars for this kind of product, and to establish the main parameters (pressure level and holding time) leading to a better preservation of the product in terms of sensorial attributes (such as texture and color) and of health promoting compounds content (such as ascorbic acid and total phenols), while maximizing the inactivation of the deterioration-related enzymes.

2. Materials and methods

2.1. Plant material

Peaches (*Prunus Persica* (L.) Batch) from two different varieties: cv. Flavorcrest (used for fresh consumption and canning) and cv. Romea (only used for canning) were harvested from an experimental orchard in San Pedro, Buenos Aires, Argentina (Latitude 33°41_S, Longitude 59°41_W) and carefully selected according to their uniform size and ground color. Flavorcrest cultivar presented a mean value of 12 °Brix while Romea cultivar presented a mean value of 14 °Brix. The firmness in both varieties was in a range between 20 and 30 N. Peaches were stored in a cold chamber at 0 °C and 90–95% relative humidity for two weeks before processing.

2.2. Sample preparation

Prior to processing, the fruits from each variety were washed in running tap water. Cylinders (15 mm in length, 15 mm in diameter) of parenchyma tissue were cut using a stainless steel cork borer and knife. To obtain homogenous samples, the cylinders were taken from the middle zone of the mesocarp, parallel to the major axis of the fruit. Subsequently, the cylinders were dipped into tap water containing 20 ppm of HClO for 2 min. The cylinders were then drained and dipped into an aqueous solution containing 1 g/100 mL ascorbic acid (ACS, Biopack, Argentina) and 1 g/100 mL citric acid (USP, Anedra, Austria) for 2 min to prevent surface browning and to wash the remaining HClO. The cylinders were drained again, pooled, and vacuum-packed in Cryovac BB2800 bags (O_2 transmission rate: 6–14 cm^3/m^2/24 h at 23 °C, 1 atm, Sealed Air, Argentina) filled randomly with eight units each, using a double chamber vacuum packaging machine (Rapivac, Model Maximax 800, Argentina). For each variety, the samples were subjected to HPP treatments with different pressure levels and holding times, selected according to the experimental design (see below). HPP was performed in a high hydrostatic pressure system with a vessel of 2 L capacity (Stanted Fluid Power Ltd. High Pressure Iso-Lab System Model: FPG9400:922, Stansted, UK) and a maximum working pressure of 900 MPa. A mix of distilled water and propylene glycol (70/30, v/v) was used as the compression fluid. Pressure was increased at 5 MPa s^{-1}. The HPP treatments were carried out at an initial temperature of 21–24 °C and this parameter was increased by adiabatic heating. The maximum temperature of the compression fluid (at the end of compression stage) was 35 °C for 500 MPa, 38 °C for 600 MPa and 40 °C for 700 MPa and upon pressure release reduced to 20 °C.

2.3. Experimental design

A completely randomized factorial design (3 × 2) was applied for the experiments of each variety. The factors were: pressure level (500 MPa, 600 MPa, 700 MPa) and holding time (1 and 5 min). A total of 48 bags for each variety were prepared, eight for each treatment (each combination of pressure level and holding time). Eight cylinders from different bags were analyzed for each treatment, to carry out texture determinations. Three pooled samples were prepared from different cylinders to carry out biochemical determinations (PPO and ADH activity and contents of total phenols and vitamin C).

2.4. Analyses

2.4.1. Texture Profile Analysis (TPA)

Instrumental approaching for texture of fresh-cut peaches was performed by running a Texture Profile Analysis. Eight cylinders per treatment were compressed twice to 75% of their original height (1 s interval) simulating mastication. A Texture Analyzer model TA-XT plus (Stable Micro Systems LTD, Surrey, England) was used at room temperature and the following conditions were set according to the instrument manufacturer's recommendations: 3.0 mm/s pre-test speed, 0.8 mm/s test speed, 3.0 mm/s post-test speed and 25% strain. The trigger force was 0.049 N. A 35-mm diameter cylindrical probe (P/35) was used to assure that the surface area of the peach cylinder was completely covered by the probe. Force–distance–time data were recorded for two cycles.

2.4.2. Enzyme activities

2.4.2.1. Enzyme extraction. Enzymes were extracted according to the method described by Denoya, Nanni, Apóstolo, Vaudagna & Polenta (2016). Briefly, 7 g of peach cylinders were homogenized with 20 mL of 0.1 M phosphate buffer pH 7.3 containing 1 g/100 mL insoluble polyvinylpolypyrrolidone (PVPP, Sigma, USA) as a phenolic scavenger and 0.5 mM phenylmethylsulfonyl fluoride (PMSF, Sigma, Germany) as a protease inhibitor. Then, the homogenate was centrifuged at 10,000 × g for 15 min at 4 °C. The supernatant was used as the enzyme source in the following experiment.

2.4.2.2. PPO activity assay. The PPO activity assay was carried out according to the method described by Denoya, Nanni, Apóstolo, Vaudagna & Polenta (2016). PPO catecholase activity was