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Effect of modified atmosphere on phytochemical profile of pasteurized peach purées

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ABSTRACT

Peach phytochemical profile was analysed during 90 days storage under three different gas mixtures: 10 kPa O_2 + 90 kPa N_2, 100 kPa N_2 and air (78 kPa N_2 + 21 kPa O_2 + 0.03 kPa CO_2) for both 4 and 23 °C.

The antioxidant activity increased when peach purée was stored under air at 4 °C and 100 kPa N_2 at 23 °C, while total phenolic content was not affected by atmospheres. Total carotenoids were more stable for 100 kPa N_2, where it decreases 48 and 58% respectively for 4 and 23 °C.

The content of (+)-catechin decreased 42% for 10 kPa O_2 at 4 °C, remaining constant in other atmospheres. Chlorogenic and neochlorogenic acids were well preserved in atmospheres containing oxygen, presenting an increase of 14 and 24% for 10 kPa O_2 at 4 °C. The higher content of carotenoids was obtained for 100 kPa N_2 at 23 °C.

Principal component analysis shows that atmospheres variance was associated with carotenoids while storage time was more related with total phenolics and total antioxidant capacity.

1. Introduction

Peaches are rich in polyphenols like chlorogenic acid, neochlorogenic acid, flavan-3-ols (catechin and epicatechin) and flavonols (quercetin 3-rutinoside) (Tomás-Barberán et al., 2001). It has been proven that flavonols have protective effect against cardiovascular disease (Hertog et al., 1993, 1995) and reduction of digestive tract cancer risk (Bushman, 1998).

Peaches are also a rich source of carotenoids, which are lipid soluble compounds associated with protective effects against some types of cancer, age-related macular degeneration, and heart disease. Peaches are particularly rich in lutein, zeaxanthin, β-cryptoxanthin and β-carotene (Dalla Valle, Mignani, Spinardi, Galvano, & Ciappellano, 2007). Carotenoids and other antioxidants contribute to improve freshness and fruit products shelf-life used in industry (Hidalgo & Brandolini, 2008).

Information about nutrient content of processed fruits is of interest to consumers as they are becoming more aware and interested about health benefits. Fruit processing and storage may lead to detrimental or beneficial effects concerning their nutritional value according the processing steps they are exposed to. There are instances during fruit processing where chemical reactions could release bound components leading to an increase in nutritional quality (Ravichandran, Ahmed, Knorr, & Smetanska, 2012).

On the other hand, oxidative degradation is one of the main causes of extensive losses in carotenoids. Carotenoids degradation depends on the availability of oxygen and is stimulated by other factors such as light, enzymes, metals, co-oxidation with lipid (Rodriguez-Amaya, 2001). Epoxides and apocarotenoids (carotenoids with the carbon skeleton shortened) are the initial products and subsequent fragmentations results in low-molecular weight compounds (Rodriguez-Amaya, 1997). These compounds contribute to the desirable flavour of wine and tea but can be responsible for the off flavour of dehydrated carrots and sweet potato flakes (Dutta, Chaudhuri, & Chakraborty, 2004).

Reports described a decrease of 51–52% on β-carotene and continued to 84% after 24 months in canned (lacquered epoxy) mango purée and slices stored at room temperature (Godoy &

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Rodriguez-Amaya, 1987). The stability of β-carotene improved when it was protected from oxygen. Tomato β-carotene losses reduced from 59% in air to 42% in carbon dioxide and 23% in nitrogen and vacuum after five months storage. Better protection of β-carotene was also described for carrot and spinach stored under oxygen-excluding conditions (Rodriguez-Amaya, 1997).

Most of the research done does not study the modified atmosphere effect on fruit after processing. This work came to provide accurate nutritional value on fruit after industrial processing, since more information is needed on the stability and bioavailability of compounds like flavonoids and carotenoids that form the antioxidant system of peaches.

The purpose of this work was to increase knowledge about phytochemicals profile modification under modified atmosphere (10 kPa O_2+90 kPa N_2, 100 kPa N_2 and air (78 kPa N_2+21 kPa O_2+0.03 kPa CO_2)) during 90 days storage at 4 and 23 °C for peach previously processed first through homogenization into purée and then submitted to pasteurization.

2. Materials and methods

2.1. Chemicals

The ABTS diammonium salt (2, 2-azinobis-3-ethylben zothiazoline-6-sulphonic acid), formic acid, methanol, peptone, potassium sorbate and sodium carbonate were purchased from Sigma–Aldrich (Sintra, Portugal). Folin-Ciocalteu's reagent, potassium persulfate from Merck (Algés, Portugal). Standards of ascorbic acid, gallic acid, (+)-catechin, chlorogenic acid, neochlorogenic acid, β-carotene were obtained from Sigma–Aldrich (Sintra, Portugal), whereas lutein, zeaxanthin and β-cryptoxanthin were purchased from Extrasynthıse (Lyon, France). Natamycin was purchased from Mapril (Maia, Portugal).

2.2. Peach purée gas treatments

Peaches [*Prunus persica* (L.)] were peeled, the pit removed and the flesh cut by hand with a sharp knife into cubes with *ca.* 10 mm sides. The cubes were individually quick frozen (IQF) and blended to obtain purée. Peach purée was poured in serum type reaction glass vials of 100 mL and were pasteurized at 90 °C for 10 min and then cooled to room temperature in ice for 10 min. In a flow hood under aseptic conditions the vials were flushed with a continuous flow for 3 min at 40 kPa of humidified air (control), 100 kPa N_2 and 10 kPa O_2+90 kPa N_2. The vials were sealed with aluminium seal with Teflon faced butyl septa to avoid gas losses and stored in dark for 90 days at room (*ca.* 23 °C) and cold temperature (4 °C).

Extracts were performed after 24 h of storage and along storage (7, 14, 30, 60 and 90 d). The gases were checked regularly with a PBI Dansensor CheckMate 3 (Dansensor, Ringsted, Denmark) where a needle was plunged into the vial through Teflon faced butyl septa. Three replications were done to determine oxygen, carbon dioxide and nitrogen concentrations inside the vial.

To avoid the development of contaminants that could lead to phenolics degradation, natamycin (0.25 g/L) and potassium sorbate (1.34 g/L) were added to the peach purée, prior to atmosphere modification. To control microbial growth, the total mesophylls were monitored using Plate Count Agar (PCA, Biokar Diagnostics, Solabia, France) at 30 °C during 24 h. Total yeasts and molds were also monitored with Potato Dextrose Agar - PDA (Biokar Diagnostics, Solabia, France), at 30 °C for 2 d.

2.3. Extracts preparation

The most common way to extract metabolites is to shake the homogenized plant tissue in organic solvents. Methanol, ethanol, acetone and water were the solvents tested for extraction. Polyphenols were extracted by maceration of 2.5 g of peach purée (IKA Ultra-turrax T18, Wilmington, USA) for 60 s at 24,000 rpm with 25 mL of a mixture of methanol and water at a concentration of 800 mL/L. After 30 min under agitation (300 rpm) samples were centrifuged at 4000 × *g* for 10 min. Each sample supernatant were recovered and filtered through a 0.45-μm cellulose acetate filter (Orange Scientific, Braine-l'Alleud, Belgium). A 15-mL aliquot of the extract was evaporated to dryness in a RVC 2-18 speed-vacuum evaporator (Christ.Osterode am Harz. Germany) at 30 °C and the residue dissolved in 4 mL of methanol and analysed by HPLC UV/VIS DAD.

Carotenoids were extracted as described by (Wright & Kader, 1997). Briefly, 2.5 g of peach purée were suspended in 5 mL of cold ethanol and homogenized at 24,000 rpm for 3 min using an ultra-turrax. Hexane (4 mL) was added to the homogenate and the resulting mixture was homogenized for an additional 2 min and then centrifuged for 10 min at 4000 × *g*. The hexane layer containing the carotenoids was transferred to a polypropylene tube. A solution of saturated sodium chloride (2.5 mL) and an additional 4 mL of hexane were added to the slurry and the resulting mixture was homogenized for 1 min. The mixture was centrifuged as described above, and the second hexane layer recovered and mixed with the first hexane layer for saponification. Saponification was made as described by Kimura, Rodriguez-Amaya, and Godoy (1990), where the resultant hexane fractions were mixed with 100 g/L methanolic KOH and left under agitation overnight at 300 rpm. The mixture then was washed with 100 mL/L NaCl and after three washes with deionized water the sample was collected and used for spectrophotometric and HPLC UV/VIS DAD. All extracts were performed in triplicate samples.

2.4. Measurements of total antioxidant activity, total phenolics, and total carotenoids

The ABTS method was applied to the methanolic extracts as described by Giao et al. (2007). The ABTS (7 mmol/L) was mixed with potassium persulfate (2.45 mmol/L) and kept for 12–16 h at room temperature in the dark. The ABTS solution was diluted with water to an absorbance of 0.7 (±0.02) at 734 nm. After the addition of 1.0 mL ABTS solution to 10 μL of sample the mixture the absorbance reading was made after 6 min. The % inhibition of the sample was then compared with a standard curve made from the corresponding readings of ascorbic acid (0.02–0.50 mg/mL). Results were expressed as mg of ascorbic acid equivalent per g of biomass.

Total phenolic content was determined using the Folin-Ciocalteu reagent according the method of Singleton and Rossi (1965) Briefly 50 μL of methanolic extract, 50 μL Folin-Ciocalteau reagent, 1 mL of Na_2CO_3 (75 g/L) and 1.4 mL of ultra-pure water were added to 1.5 mL microcentrifuge tubes and the samples were vortexed. The tubes were then left in the dark for 60 min at room temperature. The absorbance of the sample was read at 750 nm using gallic acid (0.015–0.50 mg/mL) as a standard. Results were expressed as mg of gallic acid equivalent per g of biomass.

Total carotenoids quantification was achieved spectrophotometric at 454 nm, as described by Kimura et al. (1990). The β-carotene (0.063–4.0 mg/L) was used as standard curve. The total carotenoids content was expressed based on mg of β-carotene equivalents per g biomass.

2.5. Qualitative analysis of phenols and carotenoids

The phenolic compounds in the current study were analysed in the peach purée according Silva, Oliveira, Ferreira, Sarmento, and