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The effect of fruit cultivar/origin and storage time on sorbets quality

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ABSTRACT

Fruit quality is one of the main factors that influence the sorbets' quality. The aim of this study was to evaluate the effects of two different cultivars of five fruits (mandarin, lemon, melon and mango) or origin (strawberries) on the overall quality of sorbets, right after being produced and after being preserved for 21 days at −18 °C. Total soluble solids (TSS), titratable acidity (TA) and firmness were used to characterize the fruits. Colour, pH, antioxidant capacity (AC) and total phenolic content (TPC), as well as sensory attributes, were evaluated on fruits and respective sorbets. Fruit processing led to a loss of TPC and AC. Nevertheless, no significant changes were observed on sorbets over storage time. In spite of chemical, physical and sensorial differences registered among fruits from different cultivars or origin, the sensory profiles of sorbets from the same pair of studied fruits are very similar.

Multivariate analysis clearly shows that the sorbets produced maintain the same sensorial quality regardless of the cultivar or the origin of the fruits.

1. Introduction

Sorbets are frozen desserts essentially made of water and sugar, with a fruit content of at least 25%. No fat substances should be added (Goff & Hartel, 2013), or any chemical agent that increases or accelerates the production process. The cultivar, origin and ripeness degree of fruits are the factors that most influence the fruit quality and derivative products, such as sorbets. There are several examples of such influence on pears (Markowski, Zbrzezniak, Mieszczakowska-Frac, Rutkowski, & Popinska, 2012), mandarins (Simón-Grao et al., 2014), mangos (Ngamchuachit, Sivertsen, Mitcham, & Barrett, 2015) and melons (Botia, Navarro, Cerdá, & Martınez, 2005).

The processing of sorbets is characterized by the incorporation of small amounts of air, making it a dispersion of ice crystals randomly distributed in a freeze-concentrated liquid phase (Corvitto, 2005). Small ice crystals are desired to deliver a product with a smooth texture and good palatability (Arellano, Benkhelifa, Flick, & Alvarez, 2012; Corvitto, 2005).

Representing approximately 90% of the final product, fruit takes the role of main ingredient, being crucial to ensure the highest quality of this raw material. Its availability depends on the season, thus cultivar/origin used will not always be the same, which may influence the physical, chemical and sensory parameters of sorbets. Likewise, storage conditions of fruits, mainly time and temperature, are very important to achieve high quality sorbets (Corvitto, 2005). At the reception, fruits should be at an ideal ripening stage and must not have any injury.

Mango (*Mangifera indica* L.) is a popular and economically important tropical fruit throughout the world, due to its excellent eating quality (bright colour, sweet taste and luscious flavour) and nutritional composition (vitamins, minerals, fibres, and phytochemicals) (Kim, Lounds-Singleton, & Talcott, 2009). Mango is considered to be a source of antioxidants including ascorbic acid (mangos provide about 50% of the recommended daily intake of vitamin C) and carotenoids. The best quality of mango fruits should be achieved with a 50% green and 50% red colouration and its "shoulders" ought to be above the insertion of the stalk region and its "cheeks" rounded.

Melon (*Cucumis melo* L.) is one of the most consumed and appreciated fruits. The quality attributes of melon mainly depend on

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the genotype, maturity stage and storage temperature. Cantaloupe melons are low in energy but excellent sources of nutrients, in particular provitamin A and vitamin C (Lester, 2006). Cantaloupe and Ogeon (commonly designated by Gália) melons, belonging to Cantaloupensis group, are climacteric and fast senescing fruits and are very aromatic. Due to its highly appreciated sensory attributes, Gália melons are currently a potential raw material for the fresh cut or other fruit derivatives (Aguayo, Escalona, & Artés, 2004), such as sorbets. Mature melons should present a hard and bright green peel and a firm and proper colouration of flesh at the moment of reception.

Strawberries (*Fragaria x ananassa* Duch.) are widely consumed both fresh and processed. The overall quality of strawberries is mainly dependent on the genetic and environmental factors, ripeness and storage conditions (Tulipani et al., 2011; Shin, Ryu, Liu, Nock, & Watkins, 2008). Harvesting at the right maturity stage is crucial for keeping optimal quality during storage and handling (Sturm, Koron, & Stampar, 2003). In order to produce high quality sorbets, strawberries should have a medium size, firm texture and intense red colour.

Citrus fruits are non-climacteric fruits with low respiration and ethylene production rates and do not undergo any major softening or compositional changes after harvest (Kader, 1985). Citrus fruits are a good source of nutrients, including flavonoids, citric acid, vitamin C and minerals. In these fruits, colour is the most important parameter at reception, therefore orange and mandarin must have an intense orange colour, and lemon an intense yellow, both of all with a thin peel.

The present work was developed at a worthy artisanal industry of ice creams, the sorbets being premium products of the company. Having in mind that: (i) an ideal sorbet should maintain all the fresh fruit flavour characteristics, (ii) it is important to maintain the sorbet quality throughout the year, (iii) the fruit production is seasonal making it necessary to use different sources or cultivars of the fruits and (iv) the sorbets are stored at least for 21 days at −18 °C; the main objective of the present work was to study the effect of cultivar and/or origin and storage time on the overall quality of the sorbets.

2. Material and methods

2.1. Fruits

Six fruits from two different cultivars or origins, available in the Portuguese market, were selected as raw materials for sorbet manufacture: Mandarin (*Citrus reticulate)*—Encore (E) and Ortanique (O); lemon (*Citrus lmon)* – Eureka(Eu) and Lunário (Lu); orange (*Citrus sinensis)* –Navelate (N) and Lanelate (L); melon (*Cucumis melo* L. *var. cantaloupensis Naud.)*—Gália (G), and Cantaloupe (C); mango (*Mangifera indica* L.)—Palmer (P) and Haden (H) and Strawberry (*Fragaria x ananassa Duch*) – Spain (Sp) and Portugal (Pt).

All fruits were purchased from a local market at the commercial ripening stage. Fruits were selected according to external skin colour, uniform size and absence of any physical damage. Sampling of fruits occurred randomly upon reception.

2.2. Sorbet production

Sorbets processing operations were carried out according to Fig. 1. The processing operations were the same for every fruits. The recipe was adjusted according to each fruit category independently of cultivar or origin, taking into account the TSS, defined by the company's (Santini) quality department.

Temperature lowering is one of the most important steps. At this stage temperature is lowered from 4 °C to −11 °C, under stirring and cooling by contact, over 20 min, approximately. From this moment, the stirring system allows an incorporation of air and the distribution of small air bubbles throughout the mixture is observed. The cooling process is fast until the temperature reaches -6 °C, lowering thereafter, once the freezing temperature is becoming lower due to the rise of soluble solids concentration. Since the sorbet is an unstable product as it contains a considerable amount of free water, the stabilizing step must performed as quickly as possible. As such, sorbet is stored in a cold storage room for the thermal centre to reach temperatures about −18 °C as soon as possible, in order to prevent the formation of ice crystals, achieving its stabilization.

2.3. Analytical procedures

Analytical procedures were carried out at least in triplicate, on two sampling dates – after processing (day 1) and after 21 days of storage at −18 °C (day 21).

2.3.1. Total soluble solids, titratable acidity and pH

Total soluble solids (TSS) of fruits were determined by using a refractometer (Pocket Refractometer Pal-1 Atago).

Titratable acidity (TA) was measured by titration method with a standard solution of sodium hydroxide (NaOH), by using an alcoholic solution of 1.0% phenolphthalein as indicator (ISO 750:1998). Results were expressed in % citric acid by the conversation factor in citric acid (vol. NaOH (mL) x 0.07). Sampling fruits was carried out in triplicate and acidity determination was carried out in duplicate.

A potentiometer (Denver Instrument Model 220) previously calibrated at 20 °C with standard solution at pH 4.01 and 7.0 was used to determined pH of fruits and sorbets samples.

2.3.2. Firmness

Firmness of fruits was measured with a penetrometer (Force Gauge PCE-FM 200). Sampling was carried out in triplicate and results were expressed in Newton (N).

2.3.3. Colour

Colour measurements were performed with a colorimeter (Minolta Chroma Metre CR 300) by measuring the CIE L*a*b* parameters. The instrument was calibrated using a standard white tile ($L^* = 97.10$, $a^* = 0.19$, $b^* = 1.95$). Data was converted to C (Chromaticity) and °h (hue angle) according to the follow equations: $C^* = \sqrt{a^{*2} + b^{*2}}$; °h = arctg $\left(\frac{b^*}{a^*}\right)$ if $a* > 0$; $b* > 0$; °h = $180 + \text{arctg}\left(\frac{b^*}{a^*}\right)$ if $a* < 0$; $b^*>0$; °h $= 270 + \text{arctg}\left(\frac{b^*}{a^*}\right)$, if $a* < 0$; $b^*<0$ and °h $= 360 + \text{arctg}\left(\frac{b^*}{a^*}\right)$ if $a* > 0$; $b^*<0$ (Hunt, 2004; Sahin & Sumnu, 2006).

2.4. Total phenolic content

Total phenolic content (TPC) was determined using the Folin–Ciocalteu reagent (Swain & Hillis, 1959). Samples (5 g) were homogenized with methanol (20 mL) and left in the dark overnight at 4 °C. Homogenates were centrifuged at 29000 g for 15 min at 4 °C and the clear supernatant (methanolic extract) was used for total phenolic content determination according to the method described by Swain and Hillis (1959). Methanolic extracts (150 μL) were diluted with nanopure water (2400 μL) in test tubes, followed by the addition of 0.25 N Folin-Ciocalteu reagent (150 μL). The mixture was incubated for 3 min, and then, 1 N Na_2CO_3 (300 μL) was added. The final mixture was incubated for 2 h in darkness conditions at room temperature. Spectrophotometric readings at 725 nm were collected using an ATI Unicam UV/VIS 4 spectrophotometer (Unicam Sistemas Analíticos, Lisboa, Portugal). The extraction was