LWT - Food Science and Technology 44 (2011) 2119–2125

Contents lists available at ScienceDirect

LWT - Food Science and Technology

journal homepage: www.elsevier.com/locate/lwt

Physico-chemical and sensory properties of pomegranate juices with pomegranate albedo and carpellar membranes homogenate

L. Vázquez-Araújo [a,*], E. Chambers IV [a], K. Adhikari [a], A.A. Carbonell-Barrachina [b]

[a] The Sensory Analysis Center, Department of Human Nutrition, Kansas State University, Manhattan 66506-1407, KS, USA
[b] Grupo Calidad y Seguridad Alimentaria, Departamento de Tecnología Agroalimentaria, Universidad Miguel Hernández, 03312 Orihuela, Alicante, Spain

ARTICLE INFO

Article history:
Received 7 October 2010
Received in revised form
8 July 2011
Accepted 11 July 2011

Keywords:
Punica granatum L.
Volatile compounds
Phenolic content
SPME-GCMS
Sensory

ABSTRACT

Five pomegranate juice samples were studied: one made only from pomegranate arils, two with different concentrations of albedo and carpellar membranes homogenate (20 and 50 g L^{-1}), and two with the same levels of homogenate , but strained after 48 h to eliminate residual particles from the albedo. Total soluble solids content, pH, tritatable acidity, total phenolic content, volatile composition, and sensory flavor analysis were conducted to determine the main differences among samples. Samples with 5 g L^{-1} homogenate (either with or without straining) had significantly higher total phenolic content than the other samples. Only slight differences in intensity of sensory properties were found among the juices, which might be due to fruit variability. Only slight variability was found in the volatile composition of the samples. Aldehydes, alcohols and terpene compounds were the three volatile groups present in all samples. Adding albedo and carpellar membranes homogenate, and straining the juice (some hours later) could be a good tool to increase healthy properties without decreasing acceptance of the product.
Published by Elsevier Ltd.

1. Introduction

It has been demonstrated that pomegranate (*Punica granatum* L.) and pomegranate juice are products containing high antioxidant activity, directly related to their phenolic content (Borochov-Neori et al., 2009; Ozgen, Durgaç, Serçe, & Kaya. 2008; Mousavinejad, Emam-Djomeh, Rezaei, & Khodaparast, 2009). The high antioxidant activity of pomegranate is located mainly in the fruit's rind, because of its higher presence of punicalagins and ellagic acid derivatives (Gil et al., 2000).

Recent studies have indicated the healthy properties of pomegranate: antiatherogenic, antioxidant, antihypertensive, etc. (Basu & Penugonda, 2009; Hong, Seeram & Heber, 2008; Rettig et al., 2008; Saruwatari et al., 2008). Also, pomegranate rind extract has antibacterial, anti-inflammatory and anti-allergic activities and could be considered a nutraceutical (Panichayupakaranant, Tewtrakul, & Yuenyongsawad, 2010). Although, Panichayupakaranant et al. (2010) did not recommend using pomegranate rind extract as a natural preservative in food because of its narrow spectrum antibacterial activity, Kanatt, Chander and Sharma (2010) reported that pomegranate rind extract enhanced the shelf life of chicken meat 2–3 weeks during chilled storage without changes in the sensory properties of the meat.

The phenolic content of pomegranate juices has been reported previously: e.g. 2566 mg L^{-1} in commercial juices from the United States (Gil et al., 2000), or 2602–10,086 mg gallic acid equivalents (GAE) L^{-1} in commercial juices from Turkey (Tezcan, Gültekin-Özgüven, Tuğba, Özçelik, & Erim, 2009). Those large differences may be related to the method of processing the fruit. Some methods for extracting the juice can involve rubbing the internal part of the rind, and may contribute to the extraction of the phenolic compounds.

One common practice during the manufacturing of pomegranate juice is clarification. The intent of clarification is to reduce the amount of particles and phenolic substances in the juice, improving sensory properties (e.g. color, turbidity, overall appearance, and bitterness) (Vardin & Fenercioglu, 2003). Unfortunately, this can also reduce the healthy properties in the product. No studies have been conducted to determine whether the phenolic compounds would migrate from the particles into the juice.

Koppel and Chambers (2010) determined a sensory lexicon and the main sensory attributes of 33 commercial pomegranate juices, and found large variations among the different juices. Some of those differences, such as astringency, bitterness, or toothetch might be caused by processing (use of clarification, concentration, pasteurization, etc.), presence/absence of some preservatives, or presence/absence of added flavorings in the juices.

* Corresponding author. Tel.: +1 785 5325158; fax: +1 785 5320176.
E-mail address: lvazque@ksu.edu (L. Vázquez-Araújo).

0023-6438/$ – see front matter Published by Elsevier Ltd.
doi:10.1016/j.lwt.2011.07.014

The purpose of this study is to describe, sensory and instrumentally, the aromatic and flavor differences, and phenolic composition of five juices made using fresh squeezed pomegranates and pomegranates with albedo and carpellar membranes homogenate added . Until now, a lot of information has been published about pomegranate antioxidant activity and the main physico-chemical characteristics of this fruit and its derivate juices; however, from all these publications, only two papers provided information relative to the volatile composition of fresh pomegranates or juices, all from Spanish cultivars (Calín-Sánchez et al., 2011; Melgarejo et al., 2011), but no descriptive sensory analyses were conducted in these studies. The relevance of the present manuscript is that provides information, not only about the volatile composition of the Wonderful cultivar (the most popular one in the US), but also about which of the volatile compounds may migrate from the albedo to the juice, changing its sensory properties. Increasing the phenolic content of pomegranate juices without adding off-flavors to the juice may be a great tool for the industry when trying to develop and promote new and healthy products, but well accepted for consumers.

2. Materials and methods

2.1. Samples

Over fifty pomegranates (*P. granatum* L. cultivar "Wonderful"), were purchased on three different dates during November and December (2009) from local grocery stores in Manhattan (Kansas, USA). After discarding damaged fruits, the arils from all the fruits were removed manually and frozen (−20 °C) until juice extraction. The albedo and carpellar membranes of each pomegranate rind were grated to obtain "albedo and carpellar membranes homogenate". The albedo and carpellar membranes were blended in a food processor and frozen (−20 °C) until juice preparation.

For physico-chemical and sensory analysis, three juice batches were prepared with a juice extractor (Model 67,800 HealthSmart; Hamilton Beach Brands, Washington, NC, USA), one batch per day on three days. Each batch had five samples: one made only from arils, two samples made from arils with 20 g L^{-1} of homogenate, and two samples made from arils with 50 g L^{-1} of homogenate extract. Forty eight hours after preparing one batch of juices, one sample of the 20 g L^{-1} homogenate, and one sample of the 50 g L^{-1} rind homogenate were filtered using a strainer (mesh size < 1 mm) to remove rind particles and pulp. At that time, the five samples for the study were prepared: "arils" (*A*), "arils + 20 g L^{-1} homogenate" (*A2*), "arils + 50 g L^{-1} homogenate" (*A5*), "arils + 20 g L^{-1} homogenate, strained 48 h after addition" (*A2R*), and "arils + 50 g L^{-1} homogenate, strained 48 h after addition" (*A5R*). Twelve hours after straining the juices (60 h after initial preparation), physico-chemical and sensory tests were conducted.

2.2. Physico-chemical analysis

2.2.1. Total soluble solids, tritatable acidity, and pH

Total soluble solids (TSS) were measured with a digital refractometer (Model PR-101a; Atago, Bellevue, DC, USA) at 20 °C with values being expressed as °Brix. The tritatable acidity (TA) was determined by titrating 1 mL of each sample (diluted to 20 mL final volume with deionized water) with 0.1 mol L^{-1} NaOH. Results were expressed as g citric acid 100 mL^{-1} sample. The pH was measured in each sample with a pH meter (Accumet Basic AB15, Thermo Fisher Scientific, Waltham, MA, USA). All analyses were repeated 3 times on each of the 3 different batches to ensure accuracy. Maturity index (MI), a ratio of TSS to TA, was calculated for each batch. *BrimA* (a TSS:TA ratio used to determine acceptability of juices that takes into account the tongue's sensitivity index -*k*-) was calculated as well, using the formula reported by Jordan, Seelye, and McGlone (2001): $BrimA = TSS - k^{*}$total acid (total solid expressed as kg per kg of juice, and total acid expressed as kg equivalents of citric acid per kg of juice).

2.2.2. Total phenolic content

Total phenolic content (TPC) was measured as indicator of the antioxidant activity in the juices. TPC was determined by using the Folin-Ciocalteau method with some modifications (Vázquez-Araújo, Chambers, Adhikari, & Carbonell-Barrachina, 2010). Results were expressed as mg of Gallic acid equivalents per L of juice. Experiments were run in triplicate.

2.3. Analysis of volatile composition

2.3.1. Volatile aroma compounds extraction procedure

Two mL of each sample were placed in a 10 mL vial with a polypropylene hole cap PTFE/silicone septa. The internal standard used to semi-quantify the volatile compounds was 1,2-Dimethoxybenzene (final concentration in the sample of 4 mg kg^{-1}). The vials were equilibrated during 10 min at 60 °C in the autosampler (Pal system, model CombiPal, CTC Analytics. Switzerland). After this equilibration time, a 50/30 μm DVB/CAR/PDMS fiber was exposed to the sample headspace for 30 min at 60 °C.

After sampling, the desorption of analytes from the fiber coating was made in the injection port of GC at 250 °C during 5 min in splitless mode.

2.3.2. Chromatographic analyses

The isolation, identification, and quantification of the volatile compounds were performed on a gas chromatograph (Varian GC CP3800; Varian, Inc. Walnut Creek, CA, USA), coupled with a Varian mass spectrometer detector (Saturn 2200) and operated with the MS Workstation software. The GC–MS system was equipped with aVF-5MS column (Varian, Inc. Walnut Creek, CA;

Table 1
Physico-chemical characteristics of pomegranate juices 60 h after preparation.

Physico-chemical characteristics[a]					
Sample	pH	Total soluble solids (°Brix)	Tritatable acidity (g citric acid L^{-1} juice)	Maturity index	BrimA
A	3.40 ± 0.11	16.8 ± 0.9	13.0 ± 2.0	13.5 ± 2.1	0.16 ± 0.01
A2	3.30 ± 0.02	18.1 ± 0.9	10.0 ± 0.6	18.3 ± 1.8	0.18 ± 0.01
A5	3.30 ± 0.12	17.9 ± 0.6	14.9 ± 2.5	12.6 ± 1.9	0.17 ± 0.01
A2R	3.31 ± 0.15	17.5 ± 0.5	10.2 ± 0.4	17.2 ± 0.8	0.17 ± 0.01
A5R	3.30 ± 0.13	18.1 ± 0.8	11.5 ± 1.0	15.9 ± 1.0	0.18 ± 0.01

No significant differences were found among samples ($p > 0.05$), Tukey's honestly significant differences (HSD).
[a] Mean of 3 replications.