Food Chemistry 177 (2015) 53–60

Contents lists available at ScienceDirect

Food Chemistry

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

Physical and chemical properties of pomegranate fruit accessions from Croatia

Mira Radunić [a,*,1], Maja Jukić Špika [a,*,1], Smiljana Goreta Ban [b], Jelena Gadže [c], Juan Carlos Díaz-Pérez [d], Dan MacLean [d]

[a] Department of Plant Science, Institute for Adriatic Crops and Karst Reclamation, Put Duilova 11, Split 21000, Croatia
[b] Institute of Agriculture and Tourism, Carla Huguesa 8, Poreč 52440, Croatia
[c] Department of Pomology, University of Zagreb, Faculty of Agriculture, Svetošimunska cesta 25, Zagreb 10000, Croatia
[d] Department of Horticulture, University of Georgia, 2360 Rainwater Road, Tifton, GA 31793, USA

ARTICLE INFO

Article history:
Received 5 September 2014
Received in revised form 24 December 2014
Accepted 29 December 2014
Available online 5 January 2015

Keywords:
Anthocyanins
Phenolic content
Antioxidant activity
Physical properties
Cultivars

ABSTRACT

The objective was to evaluate physical and chemical properties of eight pomegranate accessions (seven cultivars and one wild genotype) collected from the Mediterranean region of Croatia. Accessions showed high variability in fruit weight and size, calyx and peel properties, number of arils per fruit, total aril weight, and aril and juice yield. Variables that define sweet taste, such as low total acidity (TA; 0.37–0.59%), high total soluble solids content (TSS; 12.5–15.0%) and their ratio (TSS/TA) were evaluated, and results generally aligned with sweetness classifications of the fruit. Pomegranate fruit had a high variability in total phenolic content (1985.6–2948.7 mg/L). HPLC-MALDI-TOF/MS analysis showed that accessions with dark red arils had the highest total anthocyanin content, with cyanidin 3-glucoside as the most abundant compound. Principal component analysis revealed great differences in fruit physical characteristics and chemical composition among pomegranate accessions.

© 2015 Elsevier Ltd. All rights reserved.

1. Introduction

Pomegranate (*Punica granatum* L.) has been cultivated since ancient times throughout various countries that comprise the Mediterranean and Middle East regions, which has led to the discovery and local production of numerous unique genotypes over the centuries (Ferrara et al., 2014). All parts of the tree (fruit, leaves, flowers, and roots) have been used for medical purposes (Lansky & Newman, 2007). The edible part of the pomegranate fruit, termed arils, contain considerable amounts of sugars, vitamins, polysaccharides, polyphenols, and minerals (Al-Said, Opara, & Al-Yahyai, 2009; Ercisli, Agar, Orhan, Yildirim, & Hizarci, 2007; Ozgen, Durgaç, Serce, & Kaya, 2008). The health benefits of consuming pomegranates have been attributed to the exceptionally high antioxidant capacity that strongly correlates with the high concentration and chemical composition of phenolic compounds (Gil, Tomas-Berberan, Hess-Pierce, Holcroft, & Kader, 2000), whose antimicrobial (Reddy, Gupta, Jacob, Khan, & Ferreira, 2007), anticancer and anti-arteriosclerotic effects have been confirmed (Aviram et al., 2008; Viuda-Martos, Fernandez-Lopez, & Perez-Alvarez, 2010).

From a consumer acceptance perspective, both the physical and chemical properties of the fruit contribute to the perceived value and quality of the pomegranate. Knowledge of these traits is essential for the proper selection, cultivation, harvest, and subsequent marketing of fruit with desirable attributes (Caleb, Opara, & Witthuhn, 2011; Opara, 2009). Drogoudi, Tsipouridis, and Michailidis (2005) describe how small fruit with soft seeds that produce an abundance of juice are desirable traits in pomegranate breeding programs that select for processing purposes. Furthermore, parameters for quality assessment due to the nutritive value and impact on product desirability for consumption are biochemical components, volatile constituents and polyphenol concentrations (Glew et al., 2003). Color is one of the most important sensory attributes, and is often associated with the presence of anthocyanins. In pomegranate, there have been six previous identified anthocyanins that account for the majority of the pigment peel and aril pigment (delphinidin 3-glucoside and 3,5-diglucoside, cyanidin 3-glucoside and 3,5-diglucoside and pelargonidin 3-glucoside and 3,5-diglucoside). While antioxidant capacity, which is correlated with the presence of phenolic compounds, are

* Corresponding authors. Tel.: +385 21 434 482; fax: +385 21 316 583.
E-mail addresses: mira@krs.hr (M. Radunić), maja@krs.hr (M. Jukić Špika), smilja@iptpo.hr (S. Goreta Ban), jgadze@agr.hr (J. Gadže), jcdiaz@uga.edu (J.C. Díaz-Pérez), dmaclean@agrofresh.com (D. MacLean).
[1] These authors contributed equally to this work.

http://dx.doi.org/10.1016/j.foodchem.2014.12.102
0308-8146/© 2015 Elsevier Ltd. All rights reserved.

important in evaluating fruit for potential health benefits (Alighourchi & Barzegar, 2009; Gil et al., 2000).

When considering the important horticultural characteristics, there exists a large diversity between the numerous cultivars thus far characterized (Ruttanaprasert et al., 2014), thus, it is crucial to perform a comprehensive characterization of the commercially relevant horticultural characteristics of cultivars unique to each growing region (Otakar, Ercisli, Mlcek, Jurikova, & Hoza, 2014).

Extensive research work concerning the traits of pomegranate cultivar variability regarding genotype, growing region, climate, maturity and cultural practices has been carried out for many pomegranate producing regions (Drogoudi et al., 2005; Fawole, Opara, & Theron, 2012; Ferrara et al., 2014; Gil et al., 2000; Schwarz et al., 2009; Zarei, Azizi, & Bashiri-Sadr, 2010). Such a systemic work is lacking for cultivars grown in Croatia.

Thus, the objectives of the present research was aimed to investigate the physical properties, phenolic content, anthocyanin composition and antioxidant capacities of pomegranate accessions grown in Croatia, and to identify any relationships that may exist between the physical and chemical traits of the fruit. The results of this study will contribute to evaluation of pomegranate biodiversity, assist with future breeding efforts, and allow us to detect accessions with high fruit quality attributes for potential commercial production.

2. Materials and methods

2.1. Plant material

Fruit samples of seven pomegranate cultivated accessions ('Barski slatki', 'Ciparski rani', 'Crveni rani', 'Dividiš', 'Konjski zub', 'Sladun' and 'Šerbetaš') and one wild pomegranate were collected from a orchard in Metković, Croatia (43°01′N;17°65′E) in 2009. Trees were healthy and trained to form a bush, with three to five main trunks and planted at a spacing of 3 × 4.5 m. The orchard was drip irrigated and other cultivation practice, such as plant protection, pruning and fertilization were applied in a manner consistent with accepted commercial practices. Fruit were harvested at horticulture maturity as determined by customary local practices. For each accession, nine fruit of uniform size (3 fruit per tree × 3 trees) were randomly collected from around the canopy.

2.2. Physical properties

Fruit weight (g) was determined using a Mettler Toledo AB 204 digital balance (±0.01 g sensitivity). Fruit length without calyx (mm), equatorial fruit diameter (mm), calyx length (mm), calyx diameter (mm) and skin thickness (mm) were determined using digital micrometers. For fruit diameter and calyx diameter, two perpendicular measurements were recorded around the horizontal (equatorial) plane, while for skin thickness two measurements were recorded from opposite sides of the fruit. Fruit shape was determined by the ratio of fruit length to diameter. Calyx index (CI; %) was determined as the ratio of calyx length and total fruit length, and peel thickness index (PTI; %) as the ratio of peel thickness and equatorial fruit diameter. Fruit volume was measured using the liquid displacement method. Arils were manually separated from the pericarp/membrane and total aril weight (TAW) per fruit was recorded. Total number of arils per fruit was estimated by counting the number of arils in a 100 g sample and extrapolating the number of arils based on the total aril weight per fruit. Peel yield (%) was determined as the ratio between peel weight and fruit weight, multiplied by 100. Similarly, aril yield (%) was determined as the ratio between aril weight and fruit weight, multiplied by 100. Juice was obtained from a 50 g of arils by pressing through four layers of cheesecloth and juice yield (%) was determined as the ratio between acquired milliliters of juice per 50 g sample, multiplied by 100. Aril color was determined based on the coloration scale from cream to dark red color (cream, light pink, pink, red, dark red).

2.3. Chemical analysis

2.3.1. Total soluble solids, titratable acidity, TSS/TA ratio, pH, and total sugar content

Measurements were performed on fresh aril juice extracted after pressing through cheesecloth as previously described. Each replicate consisted of three pomegranate fruit. Total soluble solids (TSS) was determined using an Abbe refractometer (A. Krüss Optronic, Germany), with results expressed as percentage TSS (at 20 °C). Titratable acidity (TA) was measured according to the AOAC method (AOAC, 1995) and expressed as percentage of citric acid equivalents. The above values were used to calculate the TSS/TA ratio. Juice pH was measured using a digital Mettler Toledo MP 230 pH meter (at 20 °C). Total sugar content (TSC) was determined by Luff-Schoorl method (AOAC, 1995) and expressed as g/100 g.

2.3.2. Total phenolic content, antioxidant activity and anthocyanin content

Extraction: For the preparation of extract, a 30 g sample of pomegranate arils was frozen at −80 °C. Arils were lyophilized using a FreeZone 2.5 Liter Benchtop Freeze Dryer (LabConco, USA), then shipped to the University of Georgia, where, upon arrival, were stored at −80 °C until analyzed. Lyophilized arils were ground to a coarse powder under liquid nitrogen using a prechilled mortar and pestle. Powdered tissue (0.5 g) was extracted with 5 mL of extraction buffer containing methanol, water and formic acid (60:37:3) for 1 h. The homogenate was centrifuged at 4000 rpm for 10 min. Extraction of the residues was repeated once using the same conditions. The supernatants were combined and evaporated using a rotary vacuum evaporator (RC10-22TM, LabCare, USA) to a volume less than 1 mL and then centrifuged in a microcentrifuge tube (15 min at 14,000 rpm). The extract was transferred into a vial, where the volume was restored to 1 mL (1 g) with extraction buffer and kept at −20 °C until analyzed.

2.3.2.1. Determination of total phenolic content. Total phenolic content (TPC) was determined using the colorimetric Folin–Ciocalteu method (Singleton & Rossi, 1965), with modifications as follows; 300 μL of diluted extract in the ratio of 1:10 with extraction buffer [methanol: water: formic acid (60:37:3)], was mixed with 1.5 mL of 10-fold diluted Folin–Ciocalteu reagent and 1.2 ml of sodium carbonate (7.5 g/100 mL). The mixture was allowed to stand for 90 min at room temperature before the absorbance was measured by a Beckman Coulter DU730 (Allegra™ 25R Centrifuge, USA) UV–Vis spectrophotometer versus a prepared blank (760 nm). The same procedure was applied for six standard solutions of Gallic acid (50–500 mg/100 mL). Final results were expressed as Gallic acid equivalents (GAE).

2.3.2.2. Identification and quantification of individual phenolic compounds. A 20 μL sample of pomegranate extract was analyzed using an Agilent 1200 HPLC system (Agilent Technologies, CA, USA) equipped with a photodiode array detector (DAD, series G1315 D) and an autosampler (series G1329A), controlled by ChemStation (rev. B.03.01) software package. An Agilent Zorbax eclipse XDB reverse-phase C18 column (150 × 3.5 mm; particle size 5 μm) held at 30 °C was used for separation of compounds. For elution of analytes, a two solvent gradient was established using solvent A [formic acid and water (5:95, v/v)], and solvent B, acetonitrile. All solvents were HPLC grade. Elution started with

Download English Version:

https://daneshyari.com/en/article/7592353

Download Persian Version:

https://daneshyari.com/article/7592353

Daneshyari.com