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Fruit quality characterization of seven pomegranate accessions (*Punica granatum* L.) grown in Southeast of Spain

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ABSTRACT

This study evaluated the characteristics of seven pomegranate accessions (CRO2, ME14, ME16, PTO3, PTO4, PTO7, and PTO8). All are indigenous to two provinces in Spain where the species shows high variability. Morphological, chemical and organoleptic characterizations of the fruits and arils were investigated. ME14 and ME16 were the accessions the sensory panel granted major acceptance. Furthermore, PTO8 and CRO2 showed the heaviest arils and ME14 and ME16 the lightest. The latter accession presented the highest values for crude fiber content, total soluble solids and lower titratable acidity (TA); its flavor could be classified as sweet, while the PTO7 accession are classified as sour-sweet. All of them can be considered acceptable for fresh consumption, and the cultivars receiving the highest overall assessment were ME14 and ME16. The fact that these two cultivars were those that showed higher maturity index influenced this assessment.

1. Introduction

A pomegranate is a fruit tree with deciduous leaves, which in recent years has seen great expansion in several countries, especially those with Mediterranean-like climates, where fruit of excellent quality can be obtained.

Pomegranates, a temperate climate species requiring high temperatures to mature properly, are cultivated in the Mediterranean Basin, Southern Asia and several countries in North and South America. Its successful adaptation to the Mediterranean climate has led to its wide dispersion and the creation of a multitude of new individuals over time.

The main regions for pomegranate cultivation and production are Iran, Afghanistan, India, Mediterranean countries (Morocco, Spain, Turkey, Tunisia and Egypt) and Middle Eastern countries (Jbir et al., 2008; Melgarejo et al., 2009). The possibilities for its expansion into arid and semi-arid zones of the world are enormous, especially where salinity and water scarcity are limiting factors for other crops. In Spain in 2012, total production exceeded 32,606 t and covered an area of 2610 ha. Alicante is the leading province in Spain in production and surface area (30,794 t and 2029 ha, respectively) (MAGRAMA, 2012).

There is growing interest in this fruit not only because it is pleasant to eat, but also because it is considered a functional product with great benefit for the human diet, as it contains several groups of substances that are useful for disease prevention (Çam et al., 2009; Fawole and Opara, 2013; Melgarejo and Salazar, 2002). It has always been allocated for fresh consumption, but recently there is a huge demand for industrial processing to obtain pomegranate juice, jams, etc. Because of market demand, it has become increasingly important to characterize its different varieties and clones to obtain a high quality product with economic interests.

Since pomegranate consumption is driven by both the fresh market and processing industry, it is crucial to acknowledge all of the fruit's characteristics not only to classify varieties from a botanical point of view, but also to meet current market demand for quality fruits.

The aim of this work was to determine the physico-chemical characteristics, for the seven accessions grown in Southeast of Spain in order to gain more knowledge about the potential of these fruits.

2. Materials and methods

2.1. Plant material

The selected plant material (CRO2, M14, ME16, PTO3, PTO4, PTO7 and PTO8) belong to the principal pomegranate germoplasm bank of the EU, which is located at the experimental field station of Miguel Hernández University in the province of Alicante, Spain

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Table 1
Geographic origin of the seven Spanish pomegranate accessions.

Genotypes	Geographic origin	Latitude North	Longitude West	Altitude (m)	Rainfall (mm)
CRO2	Valle de Ricote (Murcia)	38° 08′	1° 20′	117	290
ME14	Elche (Alicante)	38° 08′	0° 38′	15	264
ME16	Elche (Alicante)	38° 08′	0° 38′	15	264
PTO3	Valle de Ricote (Murcia)	38° 08′	1° 20′	130	290
PTO4	Valle de Ricote (Murcia)	38° 08′	1° 20′	130	290
PTO7	Valle de Ricote (Murcia)	38° 08′	1° 20′	130	290
PTO8	Valle de Ricote (Murcia)	38° 08′	1° 20′	130	290

(02°03′50″ E, 38°03′50″ N, and 25 masl). The pomegranate germoplasm bank is cultivated under homogeneous conditions. These seven accessions selected from two provinces in Spain (Table 1). Four trees were harvested at commercial ripening the same day to obtain the fruit sample of each accession (20 kg). The fruit samples were then transported to the laboratory soon after harvest, and those pomegranates showing defects (sunburns, cracks, cuts or bruises in peel) were discarded. Afterwards pomegranates were stored in cold storage at a temperature of 5 °C and a relative humidity of 95%. In the following days the fruit was processed in the laboratory. This study was conducted during the years 2011 and 2013.

2.2. Characteristics of the fruits

From each accession, 20 pomegranates were randomly picked every single year. The following physical fruit characteristics were studied: fruit weight (FW) (g), equatorial diameter (D1) (mm), calyx diameter (D2) (mm), fruit length without calyx (L1) (mm), total fruit length (L2) (mm), calyx length (L3) (mm), number of carpels (Nc) counted in the equatorial section, rind weight plus weight of carpellary membranes (Rw + Cm) (g), rind thickness (Rt) (mm) (the measurements were performed on two opposite faces in the equatorial zone), arils yield (Ay) = [FW − (Rw + Cm)/FW] × 100 (%), fruit form index, If = (D1/L1) × 100 (%), fruit calyx index, Ic = (L3/L2) × 100 (%) and fruit rind thickness index, Irt = (Rt/D1) × 100 (%).

The diameter, fruit length and rind thickness were measured with an electronic digital slide gauge (Mitutoyo) with 0.01 mm accuracy. The fruit and rind weights plus the weight of carpellary membranes were taken (Sartorius Model BL-600) with an accuracy of 0.1 g.

2.3. Characteristics of the arils and seeds

After extracting the arils by hand, 25 of them were randomly chosen every year from a homogenized sample. The following aril characteristics were studied:

- Maximum width (*W*) and length (*L*), measured by a digital caliper (Mitutoyo) with 0.01 mm accuracy.
- Aril weight (Aw), determined by a precision weighing device (Mettler AJ50), with an accuracy of 0.0001 g.
- The moisture (*M*) percentage of pulp was determined after being dried in a hot air oven at 50 °C until reaching a constant weight. Four repetitions per variety were carried out.
- Juice content (V_{juice}), using an electric extractor and a 100 g aril sample.
- Total soluble solids (TSS) were determined in triplicate with the juice obtained from each sub-sample with an Atago N1 digital refractometer (Atago Co., Ltd., Tokyo, Japan) at 20 °C, and expressed as a percentage (°Brix).
- Total titratable acidity (TA) was also determined in triplicate from each sub-sample by automatic titration (877 Titrino plus, Metrohm) with 0.1 N NaOH up to pH 8.1, using 1 ml diluted juice in 25 ml distilled H_2O, and the results expressed as grams of citric acid per liter.
- Maturity index, MI (TSS/TA). At present, the following classification has been established for Spanish cultivars (Martínez et al., 2006): sweet cultivars, MI = 31–98; sour-sweet cultivars, MI = 17–24; and sour cultivars, MI = 5–7.

The parameters measured in the seeds were:

- Maximum width (*w*) and length (*l*), measured by a digital caliper as previously mentioned.
- Weight of the seed (Ws) using the preceding precision scales.
- Seed index (Si), determined from the Ws/Aw ratio × 100 (%).
- Crude fiber (CF) contents were determined by a digester, an Ankon fiber analyzer model A220 made in USA, following the official methodology established by the Spanish Ministry of Agriculture, Fisheries and Food (M.A.P.A., 1993). Three repetitions per variety were carried out.

To evaluate the hardness of the seeds, quality overall appreciation, taste and visual color, a panel of ten expert tasters was set up. Seed hardness was scored on a scale from 1 to 3 in increasing order of hardness. The quality was established according to the following scale: poor, acceptable, good and excellent. Three categories of taste were established: sweet, sour-sweet and sour. For color, the following categories were established: pink, pink-red, red and deep red (Martínez et al., 2006).

2.4. Statistical treatment of the data

Statistical analyses were performed using SPSS 22.0 for Windows (SPSS Science, Chicago, IL, USA). A basic descriptive statistical analysis was followed by an analysis of variance test for mean comparisons. The method used to discriminate among the means was Fisher's Least Significant Difference (LSD) procedure at a 95.0% confidence level. Principal component analysis (PCA) and cluster analysis (CA) were also performed. Cluster analysis was applied to the standardized data for hierarchical associations employing Ward's method for agglomeration and the squared Euclidean distance as dissimilarity measure.

3. Results

3.1. Physical characteristics of the fruits

The average fruit weights for the Spanish accessions tested vary within the range of 333.50 g for ME14 and 464.25 g for PTO7 (Table 2), and these classify them as large in size according to the criteria utilized by Martínez et al. (2006) for Spanish cultivars. PTO7 was the largest fruit, but was not significantly different from PTO3 or PTO4, and ME14, ME16, PTO8 and CRO2 were the smallest.

Aril yields vary between 52.67% for the ME14 accession and 65.87% for PTO7 (Table 2).

The If of these 7 accessions was always superior to 100, indicating that the equatorial diameter in all fruits was superior to the