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Pomegranate fruit ripening: nutritional and bioactive compounds

M. Serrano

Department of Applied Biology, UMH, Ctra. Beniel km 3,2, 03312 Orihuela, Alicante (Spain)
E-mail: m.serrano@umh.es

Abstract. Pomegranate fruit undergoes several biochemical changes during growth and ripening on tree leading to the fruit to reach an optimal quality at full ripening stage. These changes are increase in sugar concentration (glucose and fructose), diminution in total acidity (citric and malic acids) and increase in anthocyanin concentration. In addition an increase occurs in antioxidant activity which reaches values higher than those found in other fruits of the Mediterranean diet. However, important differences are found among cultivars in these parameters responsible for organoleptic, nutritive and functional properties of pomegranate fruit and thus, cultivar is an important factor determining fruit quality. In addition, pomegranate is a perishable fruit having limited storage possibilities, due to the occurrence of several alterations due to mechanical damage during harvesting and packaging or during storage, such as dehydration, over-ripening (leading to flavor alterations and decreases of antioxidant properties), decay incidence and chilling injury (CI). CI damage appears when fruits are transferred to 20°C after storage at temperatures lower than 5°C and are manifested as pitting, with purple color, desiccation and skin browning, which can reach the carpelar membranes and arils. Then, proper harvesting, handling and storage conditions should be chosen to preserve pomegranate fruit quality attributes from tree to table.

Keywords. Fruit rippening – Quality – Sugars – Organic acids – Phenols – Antioxidant – Harvest time.

I – Introduction

Pomegranate fruit (*Punica granatum* L.) is one of the oldest of edible fruit, originated in the north of Turkish and cultivated extensively in Mediterranean countries including Spain (Ward, 2003). The fruit is originated from an infer ovary and contains the arils or seeds, which are the edible part, contributing to 55-60 % of the whole fruit, while the skin supposes the 40-45%. Skin color ranges from light yellow to deep red as well as the color of the arils, depending on the cultivar, although, in general, no correlation exists between skin and arils color. Chemical composition of pomegranate arils changes as fruit ripens on tree, so it is important to know the most appropriated harvest date to have fully ripe fruits with high quality attributes, which last from 4.5 to 6 months after full bloom, depending on cultivar and agronomic and environmental conditions (Kader, 2006).

Quality is a subjective term that includes the fruit characteristics most appreciated by consumers, which can be divided into three blocks: organoleptic, nutritional and functional. Sensory or organoleptic quality is appreciated by the senses and includes color, flavor, aroma, firmness and appearance (absence of defects or damage and uniform size and color). The nutritional quality is determined by fruit components that serve as nutrients such as carbohydrates, lipids, proteins, organic acids and minerals. Finally, the functional quality is due to the contribution of bioactive compounds with beneficial health effects, such as phenols, carotenoids and vitamins (Gil *et al.*, 2000; Mertens-Talcott *et al.*, 2006, Lansky and Newman, 2007; Aviram *et al.*, 2008).

II – Quality changes during fruit ripening on tree

During ripening of pomegranate an accumulation of sugars and a decrease in total acidity occurs in arils (Kulkarni and Aradhya, 2005). The major sugars are fructose and glucose, with concentrations at harvest between 3 and 8%, depending on cultivar the range with concentrations of soluble solids of 10 to 18% (Melgarejo *et al.*, 2000; Poyrazoğlu *et al.*, 2002; Fadavi *et al.*, 2005; Ozgen *et al.*, 2008; Mirdehghan *et al.*, 2006). The organic acid composition is different depending on the type of grenade. Thus, in the acidic group varieties, which have a total acid value of 2-2.5%, the citric acid is the majority, while sweet varieties, with an acidity of 0.2 to 0, 4%, have similar amounts of citric acid and malic acid or a higher concentration of the latter (Hernández *et al.*, 1999; Melgarejo et., 2000; Poyrazoğlu *et al.*, 2002; Mirdehghan *et al.*, 2006; Ozgen *et al.*, 2008). Special attention should be paid to ascorbic acid, for his role as vitamin C and its antioxidant properties, whose concentration decreases during the early stages of fruit development and remains more or less stable in the final stages of maturation, with values between 10 and 36 mg/100 g, depending on the variety (Aradhya and Kulkarni, 2005; Sayyari *et al.*, 2010).

The colour of the arils increases during ripening due to the accumulation of anthocyanins, the pigments responsible for pink-red colour. The major anthocyanin in acid varieties is cyanidin 3,5-diglucoside, followed by cyanidin 3-glucoside and delphinidin 3,5-diglucoside, whereas in sweet varieties the major is cyanidin 3-glucoside and delphinidin 3-glucoside and pelargonidin 3-glucoside are found in minor concentration (Miguel *et al.*, 2004, Kulkarni and Aradhya, 2005; D'Aqquino *et al.*, 2010). However, the concentration of anthocyanins in the mature fruit depends on cultivar, with values between 10 and 220 mg/100 g, leading to arils having from light pink to dark red colour (Mirdehghan *et al.*, 2006; Ozgen *et al.*, 2008; Sayyari *et al.*, 2010, 2011).

During fruit development the concentration of total phenols decreases sharply in the early stages, this decrease being slow at the end of development, reaching concentrations in the ripe fruit also different depending on cultivar, ranging from 90 to 210 mg/100 g (Kulkarni and Aradhya, 2005; Mirdehghan *et al.*, 2006; Ozgen *et al.*, 2008; Sayyari *et al.*, 2011). The main phenolic compouns in pomegranate arils are the phenolic acids gallic, chlorogenic, caffeic, ferulic and *o*-and *p*-coumaric acids, as well as catechin and quercetin (Poyrazoğlu et la., 2002). In addition, it is interesting to note that in the skin the phenol content is much higher than in the arils, for what pomegranate skin could be an important source of antioxidants (Li *et al.*, 2006).

Antioxidant activity also decreases during the early stages of fruit development, but then increases again, reaching the highest levels in the state of commercial maturity (Kulkarni and Aradhya, 2005). In a study performed with different varieties of pomegranate from the Germplasm Bank of Orihuela Polytechnic School, it has been found that pomegranate juice has high antioxidant activity, higher than other fruits typical of the Mediterranean diet. Figure 1 shows the values corresponding to the antioxidant activity of hydrophilic compounds (H-TAA) in these varieties, which were significantly different among cultivars (Fig. 1). The antioxidant activity in the liposoluble fraction (L-TAA) was much lower than the H-TAA (data not shown), indicating that the antioxidant capacity of these fruits is mainly due to hydrophilic compounds, such as phenolic compounds, anthocyanins and ascorbic acid. In fact, a high correlation was found between H-TAA and total phenolic concentration, although other studies have shown that ascorbic acid is a water-soluble compound that also contributes significantly to the antioxidant capacity of this fruit (Mirdehghan *et al.*, 2006, 2007). By other hand, L-TAA was correlated with the content on carotenoids, which are the main lipo-soluble compounds with antioxidant potential in this fruit.

Given the high organoleptic, nutritive and functional properties of pomegranate fruits, it can be concluded that pomegranate has a high potential for commercialization and new markets. However, it should be harvested at maturity stage, since if harvesting is performed too soon fruits have low quality attributes because they have not developed their color, aroma and flavor. On the contrary, if harvesting is done too late, high quality fruits could be achieve, although they deteriorate faster. Then, fruits should be harvested at full ripe stage, with high quality attributes and stored in appropriate conditions and after specific treatments to avoid the appearance of decay, chilling injury and other disorders that depreciate its quality, as will be commented by other researchers in this Symposium.

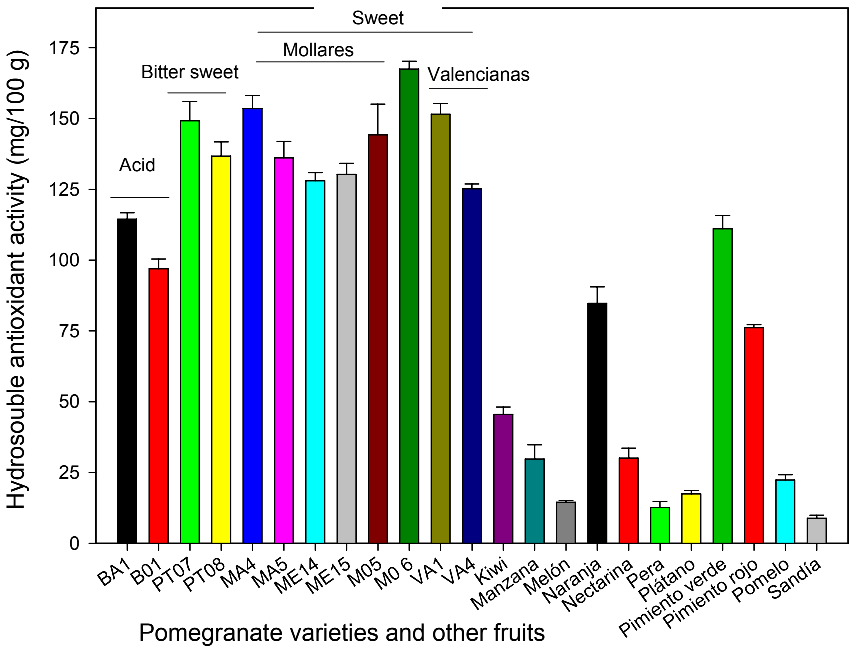

Fig. 1. Hydrophilic antioxidant activity (AAT-H) in different varieties of pomegranates and other fruits of the Mediterranean diet. Data are the mean ± SE of determinations made in five fruits.

References

Al-Maiman S.A. and Ahmad D., 2002. Changes in physical and chemical properties during pomegranate (*Punica granatum* L.) fruit maturation. In: *Food Chemistry*, 76, p. 437-441.

Aviram M., Volkova N., Coleman R., Dreher M., Reddy M. K., Ferreira, D. and Rosenblat M., 2008. Pomegranate phenolics from the peels, arils, and flowers are antiatherogenic: Studies *in vivo* in atherosclerotic apolipoprotein E-deficient (E^0) mice and *in vitro* in cultured macrophages and lipoproteins. In: *Journal of Agricultural and Food Chemistry*, 56, p. 1148-1157.

D'Aquino S., Palma A., Schirra M., Continella A., Tribulato E. and La Malfa S., 2010. Influence of film wrapping and fludioxonil application on quality of pomegranate fruit. In: *Postharvest Biology and Technology,* 55, p. 121-128.

Gil M.I., Tomás-Barberán F.A., Hess-Pierce B., Holcroft D.M. and Kader A.A., 2000. Antioxidant activity of pomegranate juice and its relationship with phenolic composition and processing. In: *Journal of Agricultural and Food Chemistry*, 48, p. 4581-4589.

Hernández F., Melgarejo P., Tomás-Barberán F.A. and Artés F., 1999. Evolution of juice anthocyanins during ripening of new selected pomegranate (*Punica granatum*) clones. In: *European Food Research and Technology*, 210, p. 39-42.

Kader A.A., 2006. Postharvest biology and technology of pomegranates. In: Seeram N.P., Schulman R.N.and Heber D. (eds), *Pomegranates. Ancient roots to modern medicine*. Boca Raton: CRC Press-Taylor & Francis. Pp. 211-218.

Kulkarni A.P. and Aradhya S.M., 2005. Chemical changes and antioxidant activity in pomegranate arils during fruit development. In: *Food Chemistry,* 93, p. 319-324.

Lansky E.P. and Newman R.A., 2007. *Punica granatum* (pomegranate) and its potential for prevention and treatment of inflammation and cancer. In: *Journal of Ethnopharmacology*, 109, p. 177-206.

Li Y., Guo C., Yang J., Wei J., Xu J. and Cheng S., 2006. Evaluation of antioxidant properties of pomegranate peel extract in comparison with pomegranate pulp extract. In: *Food Chemistry*, 96, p. 254-260.

Melgarejo P., Salazar D.M. and Artés F., 2000. Organic acids and sugars composition of harvested pomegranate fruits. In: *European Food Reearch and Technology,* 211, p. 185-190.

Mertens-Talcott S.U., Jilma-Stohlawetz P., Ríos J., Hingorani L., and Derendorf H., 2006. Absorption, metabolism, and antioxidant effects of pomegranate (*Punica granatum* L.) polyphenols after ingestion. In: *Journal of Agricultural and Food Chemistry*, 5, p. 8956-8961.

Mirdehghan S.H., Rahemi M., Martínez-Romero D., Guillén F., Valverde J.M., Zapata P. J., Serrano M., and Valero D., 2007. Reduction of pomegranate chilling injury during storage after heat treatment: role of polyamines. In: *Postharvest Biology and Technology*, 44, p.19-25.

Mirdehghan S.H., Rahemi M., Serrano M., Guillén F., Martínez-Romero D. and Valero D., 2006. Prestorage heat treatment to maintain nutritive and functional properties during postharvest cold storage of pomegranate. In: *Journal of Agricultural and Food Chemistry*, 54, p. 8495-8500.

Ozgen M., Durgaç C., Serçe S. and Kaya C., 2008. Chemical and antioxidant properties of pomegranate cultivars grown in the Mediterranean region of Turkey. In: *Food Chemistry*, 111, p. 703-706.

Poyrazoğlu E., Gökmen V. and Artik N., 2002. Organic acids and phenolic compounds in pomegranates (*Punica granatum* L.) grown in Turkey. In: *Journal of Food Composition and Analysis,* 15, p. 567-575.

Sayyari M., Babalar M., Kalantari S., Martínez-Romero D., Guillén F., Serrano M. and Valero D., 2011. Vapour treatments with methyl salicylate or methyl jasmonate alleviated chilling injury and enhanced antioxidant potential during postharves storage of pomegranates. In: *Food Chemistry*, 124, p. 964-970.

Ward C., 2003. Pomegranates in eastern Mediterranean contexts during the Late Bronze age. In: *World Archaeol*ogy, 34, p. 529-541.