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Volatile composition and descriptive sensory analysis of pomegranate juice and wine☆

Antonio J. Andreu-Sevilla [a,1], Pedro Mena [b,1], Nuria Martí [c], Cristina García Viguera [b,*], Ángel A. Carbonell-Barrachina [a]

[a] Food Quality and Safety, AgroFood Technology Department, Miguel Hernández University, E-03312, Orihuela, Alicante, Spain
[b] Department of Food Science and Technology, CEBAS-CSIC, P.O. Box 164, E-30100, Espinardo, Murcia, Spain
[c] Institute of Molecular and Cell Biology, Miguel Hernández University, E-03202, Elche, Alicante, Spain

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ABSTRACT

Pomegranate (*Punica granatum* L.) juices and their respective wines were assessed in order to establish their sensory potential as alternative to employ second quality and over-ripe fruits. Comprehensive analysis of the volatile profiles by HS-SPME/GC–MS and descriptive sensory profiles by using a trained panel was performed. The terpene limonene was the most abundant volatile compound in pomegranate juices whilst the volatile profiles of the wines were very different, with ethyl octanoate clearly predominating. In addition, juices and wines showed varietal differences in the relative abundance of alcohols, terpenes, aldehydes, esters, and organic acids as well as in their sensory profiles (odour, flavour, and colour). Differences in the volatile composition and sensory properties of the varietal pomegranate juices and their corresponding wines, as a result of winemaking, were determined thanks to partial least square regression (PLS).

1. Introduction

The processing of deteriorating second quality and/or over-ripe fruits into fermented beverages has been revealed as a new and promising alternative to generate extra revenues whilst conducting a sustainable exploitation of wastes. Concerning this, the manufacture of wines from fruits other than grapes has boosted in recent years. "Fruit wines" have been prepared from berries (Duarte et al., 2010; Heinonen, Lehtonen, & Hopia, 1998), mango (Pino & Queris, 2011), banana and pineapple (Isitua & Ibeh, 2010), lychee (Alves, de Oliveira Lima, Nunes, Dias, & Schwan, 2011), cacao, and other tropical fruits (Duarte et al., 2010).

Spain is the main European pomegranate producer and its production is mainly located in the Valencia Community, especially in the province of Alicante (Andreu Sevilla, Signes Pastor, & Carbonell Barrachina, 2008). The most important Spanish pomegranate cultivar is *Mollar de Elche*, whilst the most widely grown cultivar worldwide is *Wonderful*. Pomegranate, a fruit with a myriad of health-promoting features (Mena, Gironés-Vilaplana, Moreno, & García-Viguera, 2011) has also been pointed out as useful for the manufacturing of wines rich in bioactive compounds (Mena, Gil-Izquierdo, Moreno, Martí, & García-Viguera, 2012; Mena, Gironés-Vilaplana, Martí, & García-Viguera, 2012). It is also important to highlight that healthy effects have been described for fermented pomegranate juices (wines), probably linked to its phenolic composition (Fazeli, Bahmani, Jamalifar, & Samadi, 2011; Schubert, Lansky, & Neeman, 1999); however, the volatile composition and complete sensory profiles have not been yet described for this novel wine.

Volatile compounds play a key role in determining the sensory quality of wines, and certainly it also influences consumers' preferences (King, Osidacz, Curtin, Bastian, & Francis, 2011). Wine aroma is controlled by several factors, such as fruit type, cultivar, climate, yeast strains, and winemaking procedures (Styger, Prior, & Bauer, 2011). The final combination of volatile compounds will define the characteristic wine aroma and it will play a major role in distinguishing wines according to their quality. In fact, some specific volatile compounds could be involved in the distinctive characteristics of varietal wines (Sun, Jiang, & Zhao, 2012).

In general, winemaking increases the number and total concentration of the volatiles initially present in the fruit juice or must (Lim, Jeong, & Shin, 2012). Consequently and considering the low aromatic intensity of pomegranates and the differences existing among cultivars (Calín-Sánchez et al., 2011), winemaking can be considered as an interesting option to enhance the aroma properties of pomegranates and lead to a characteristic, aromatic and healthy fruit wine.

Considering the aforementioned information, this study will simultaneously report the volatile composition and the descriptive sensory profiles of pomegranate juices and wines in order to establish their sensory potential as alternative to employ second quality and over-ripe

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* Corresponding author at: Phytochemistry Lab., Department of Food Science and Technology, P.O. Box 164, E-30100, Espinardo, Murcia, Spain. Tel.: +34 968 396304; fax: +34 968 396213.
E-mail address: cgviguera@cebas.csic.es (C. García Viguera).
[1] These two authors have contributed equally to the present work.

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fruits. A comprehensive analysis of the volatile profiles was performed by HS-SPME/GC–MS whilst descriptive sensory profiles were prepared using a trained panel in order to gather detailed information on the main changes happening during winemaking. Juices and wines were prepared with fruits from two of the most widely cultivated cultivars but with very different sensory attributes: (i) *Wonderful*, a sour cultivar and (ii) *Mollar de Elche*, a sweet cultivar. In addition, *Coupage* juice and wine were prepared by mixing juices from both cultivars at a 1:1 ratio (v/v); it was expected that wines elaborated by mixing two cultivars at the vinifying stage (cofermentation) will present more complex volatile and sensory profiles than monovarietal wines (García-Carpintero, Sánchez-Palomo, Gómez Gallego, & González-Viñas, 2011).

2. Materials and methods

2.1. Chemicals and reagents

Yeast, *Saccharomyces cerevisiae* var. *bayanus* (Awri R2; Mauri Yeast Australia, Toowoomba, Queensland, Australia), potassium metabisulfite, and a fermentation activator containing ammonium phosphate, Actimax PLUS (Agrovin, Alcázar de San Juan, Ciudad Real, Spain), were used for winemaking.

All the aroma standards used for identification and quantification purposes were obtained from Sigma-Aldrich (Madrid, Spain).

2.2. Pomegranate juice samples

Second quality pomegranate fruits from cv. *Wonderful* and *Mollar de Elche*, harvested in Alicante region (SE Spain), were provided by "Cambayas Coop. V." (Elche, Alicante, Spain). Pomegranates were cut in halves and juices of each cultivar were obtained by pressure with a laboratory pilot press (Zumonat C-40; Somatic AMD, Valencia, Spain) (Pérez-Vicente, Serrano, Abellán, & García-Viguera, 2004).

Freshly squeezed *Wonderful* and *Mollar de Elche* juices were mixed in a 1:1 ratio (v/v) in order to assess the effect of cofermentation on the sensory parameters. This sample was labelled as *Coupage*. All juices were stored at −20 °C until analysed. All samples were prepared in triplicate.

2.3. Winemaking procedure. Laboratory assays

Pomegranate wine was produced in accordance to Mena et al. (2012). Briefly, juices were introduced into 750 mL glass vessels; later, potassium metabisulfite and Actimax PLUS were added at rates of 60 mg/L and 200 mg/L, as recommended by the producer to protect the juices and to favour yeast activity, respectively. Next, fermentation was started after yeasting (300 mg/L of juice) once the dried yeast was rehydrated according to the producer's recommendations and temperature was kept at 22 ± 1 °C throughout the fermentation process (9 days); a latex glove served as pressure CO_2 release valve and it was affixed to the neck of the vessel with a rubber band. Once fermentation was finished, the wines were clarified and racked for one day at 4 °C. Then, the wines were transferred to new glass vessels; potassium metabisulfite (60 mg/L of wine) was added again and they were left to stabilise for 10 days in darkness and at room temperature (Duarte et al., 2010). Wine samples were stored at −20 °C until analysed. All samples were prepared in triplicate.

2.4. Quality parameters of juices and wines

Titratable acidity (TA) (expressed as g citric acid/L), pH, total soluble solids (TSS), volatile acidity (VA), and alcohol (%) (v/v) were determined as oenological quality parameters (OIV, 1990).

2.5. Extraction and chromatographic analyses of volatile compounds

Volatile compounds were extracted from pomegranate juices and pomegranate wines, using headspace solid phase micro-extraction (HS-SPME). After several preliminary tests to optimise the extraction system, 25 mL of pomegranate juice or wine was hermetically placed

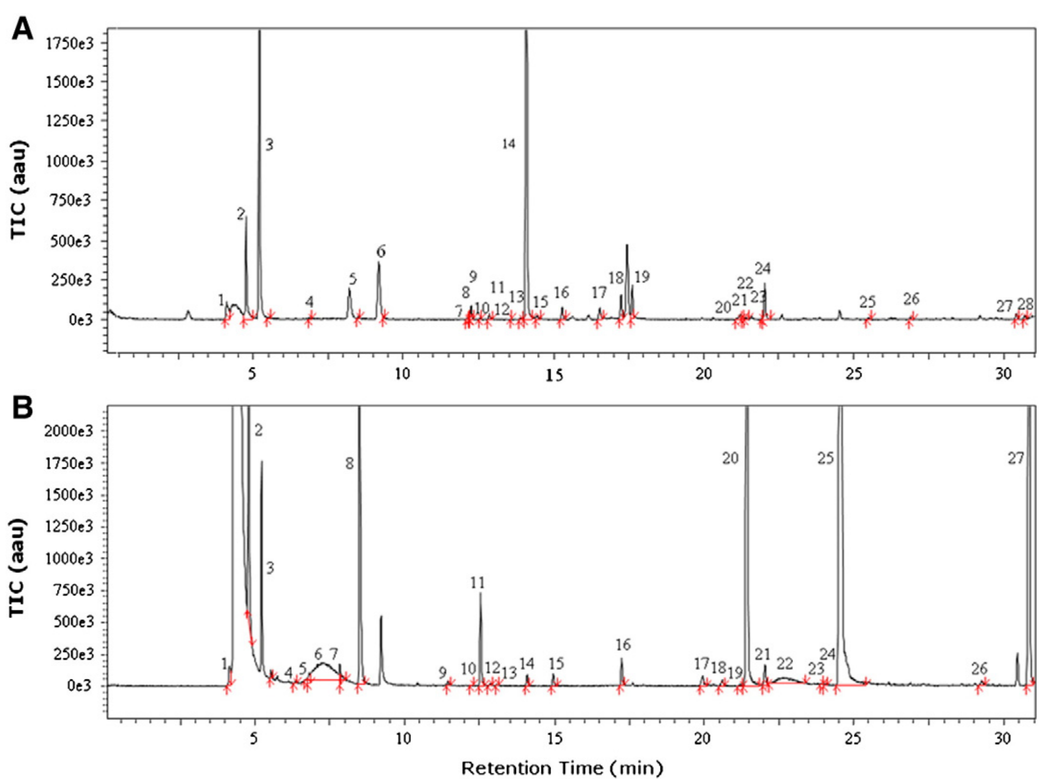

Fig. 1. Model chromatograms (HS-SPME and GC–MS) of pomegranate juice (A) and wine (B). Numbers at the chromatograms correspond with the codes indicated at Tables 3 and 4 for juice and wine, respectively.