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Potential of Spanish sour-sweet pomegranates for juice industry

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Abstract. Commercial juices of sweet pomegranates and fresh juices of sour-sweet pomegranates were analysed for organic acids, sugars, antioxidant activity, volatile composition, sensory profile and consumer liking. Organic acids and sugars were analysed by HPLC, while volatiles were extracted using hydrodistillation and analysed by GC-MS and GC-FID. Malic acid was predominant in sweet juices while citric acid predominated in sour-sweet samples. Fructose and glucose were found as the predominant sugars in all juices. The high potential of sour-sweet pomegranate fruits for the juice industry was supported by (i) the high values of positive attributes, such as colour and fresh pomegranate flavour and (ii) the high overall liking of consumers.

Keywords. Antioxidant activity – Sensory evaluation – Volatile compounds.

I – Introduction

Pomegranate, *Punica granatum* L., is one of the oldest known edible fruits. Pomegranate (PG) arils can be consumed fresh; however, there is a huge amount of fruits which quality is not good enough to be consumed in fresh. For this reason, it is necessary to find a commercial application for the fruits which cannot be commercialised in fresh. The low quality of fruit appearance is not only due to the fact that PG tree produces at different ripening stages, but also produces low quality fruits as the ripening happens later (Melgarejo and Salazar, 2003). Besides, several physiopathies lead to deteriorate fruit appearance. PG fruit is considered a functional product of great benefit as it contains several groups of substances that are useful in disease risk reduction (Çam *et al*., 2009). The beneficial health qualities of PG have been attributed to the exceptionally high antioxidant capacity of the fruit juice (Gil *et al*., 2000). Commercial PG juices have shown an antioxidant capacity three times higher than red wine and green tea (Gil *et al*., 2000). Therefore, it can be considered that juices are a great option for the PG fruits with low appearance but high organoleptic quality. The main aim of this study was to evaluate the potential of sour-sweet PG fruits, cultivar C25, in the juice industry compared with juices currently marketed in Spain. Parameters under study were organic acids, sugars, antioxidant capacity, sensory profile and overall liking of a consumer panel.

II – Material and methods

1. Plant material

Two freshly squeezed and two commercial PG juices were studied. Commercial juices, from sweet cultivar (*Mollar de Elche*), were obtained (from a private company, Granadas de Elche SLU). Fresh juices were prepared by manually extracting the arils from the fruits (removing all carpellar membranes) and using a pilot-plant press. Fruits from a sour-sweet PG cultivar (C25) were obtained from an experimental farm of UMH facilities (Table 1).

Table 1. PG juices under study

Category	Cultivar	Nomenclature	Abbreviation
Commercial	Mollar de Elche	Grana vida 100% PG juice	PPCJ
Commercial	Mollar de Elche	Grana Ké PG nectar	CPN
Fresh	C25	100% PG juice	c-SSPJ
Fresh	C25	100% PG juice + 5% sucrose	s-SSPJ

2. Analysis of organic acids and sugars

Fresh and dried samples were extracted with ultra pure water and phosphoric acid 0.1%, homogenized and then centrifuged. One milliliter of the centrifuged supernatant was filtered and injected into a HPLC. Organic acids and sugars were quantified using a diode-array detector and a refractive index detector, respectively.

3. Antioxidant capacity

Total antioxidant activity (TAA) was quantified in both hydrophilic (H-TAA) and lipophilic (L-TAA) compounds in the same extraction. Juices were homogenized and then centrifuged. TAA was determined using the enzymatic system composed of the chromophore 2,2'-azino-bis-(3-ethylbenzothiazoline-6-sulfonic acid) diammonium salt (ABTS), horse radish peroxidase enzyme (HRP) and its oxidant substrate (hydrogen peroxide). The decrease in absorbance was measured at 730 nm after adding the juice extracts.

4. Sensory evaluation with expert and consumer panels

Sensory evaluation with a trained panel was used to describe PG juices. 8 panellists were trained in descriptive evaluation of juices, including PG juices. Panellists were asked to evaluate the intensity of the following attributes: color, fresh PG odor, caramel odor, sweetness, sourness, fresh PG flavor, caramel flavour and astringency. The individual products were scored for the intensity of the different attributes on a scale of 0 to 10, where; 0 = Non perceptible intensity and; 10 = extremely high intensity. A sensory evaluation with a consumer panel was carried out with 50 consumers with the main requirement for their recruitment of being consumers of fruit juices at least twice a week. Consumers were asked about the overall liking of the samples. A hedonic 11 point scale was used.

III – Results and discussion

1. Organic acid and sugar contents

The organic acids profile could be an important source of information about the sensory properties of PG juices because each acid grants different organoleptic attributes to the final product. Malic and citric acid were the main organic acids in all juices under study. These results agree with previous data reported in the literature (Melgarejo *et al*., 2000; Ozgen *et al*., 2008).

The malic acid content was slightly higher than the citric acid content in the commercial samples because of the PG variety used, *Mollar de Elche*. The composition of organic acid found in the commercial samples agreed with those from previous studies carried out by Mirdehghan *et al*. (2007) in fruits from the Indian cultivar *Malas Yazdi*. On the other hand in fresh sour-sweet PG juices, citric acid predominated over malic acid as reported previously by Melgarejo *et al.* (2000) for several Spanish sour-sweet and sour cultivars. Three other organic acids were also detected but occurred at much lower concentrations: oxalic, tartaric and ascorbic acid (Table 2). Finally, the total concentration of organic acids was significantly (p<0.01) lower in the commercial nectar than in all other juices under study.

Table 2: Organic acids and sugars of PG juices (g/100 ml)

Juices	Oxalic	Citric	Tartaric	Malic	Ascorbic
PPCJ	0.05 ± 0.02 a	0.68 ± 0.11 c	0.02 ± 0.01 b	0.72 ± 0.10 c	0.15 ± 0.03 b
CPN	0.03 ± 0.02 a	0.33 ± 0.03 d	0.08 ± 0.01 b	0.61 ± 0.04 c	0.10 ± 0.02 b
c-SSPJ	0.10 ± 0.04 a	1.54 ± 0.10 b	0.17 ± 0.04 a	1.24 ± 0.16 a	0.23 ± 0.02 a
s-SSPJ	0.13 ± 0.01 a	1.89 ± 0.01 a	0.16 ± 0.01 a	0.96 ± 0.02 b	0.22 ± 0.01 a
ANOVA	N.S.	***	**	***	**
Juices	**Fructose**	**Glucose**	**Sucrose**		
PPCJ	8.58 ± 0.29 c	6.54 ± 0.22 c	0 c		
CPN	2.52 ± 0.02 d	2.42 ± 0.02 d	0 c		
c-SSPJ	11.1 ± 0.03 b	9.05 ± 0.02 b	1.15 ± 0.01 b		
s-SSPJ	17.6 ± 0.07 a	13.8 ± 0.01 a	1.60 ± 0.01 a		
ANOVA	***	***	***		

Fructose and glucose were the main sugars found in the PG juices under study (Table 2). In the current study, fructose values were higher than glucose contents, as previous studies reported (Melgarejo *et al*., 2000; Tezcan *et al*., 2009); although differences were not always statistically significant (p>0.05). However, other studies have reported that glucose was slightly higher than fructose (Miguel *et al*., 2004; Ozgen *et al*., 2008). These differences could be related to, for example, fruit cultivar, climatic conditions and irrigation management, among other factors.

Sugar analysis also revealed the presence of sucrose in low but significant levels in juices from sour-sweet fruits; no sucrose was detected in the commercial juices. Besides, as shown in Table 2, a significant portion of the added sucrose to the juice s-SSPH was hydrolyzed and converted into fructose and glucose; therefore, increasing the contents of these two sugars in s-SSPJ compared to the control samples (c-SSPJ).

Finally, the total concentration of sugars was significantly (p<0.001) lower in the commercial nectar than in all other juices under study. However, the label of the PG nectar indicates that sweetener was added to improve the sweetness of the product.

2. Antioxidant capacity (AOC) of PG juices

The total antioxidant capacity was measured separately as H-TAA and L-TAA fractions by ABTS analytic method. H-TAA (mean of 3.02 ± 0.11 TEAC for all juices under study) was significantly higher (p<0.001) than L-TAA (mean of 0.58 ± 0.03 TEAC), showing that the major contributors to antioxidant activity of PG juices were hydrophilic compounds. The highest value of AOC in the hydrophilic extract was obtained in the control sour-sweet juice, 3.24 ± 0.09 TEAC; even though there were statistically significant differences (p<0.05) among the antioxidant activities of the four PG juices under study, the differences only represented a maximum value of 14 % (0.55 TEAC). In the present study, H-TAA represented about 84 % of the total antioxidant activity of PG juices. The initial total AOC of freshly squeezed juices from Mollar de Elche fruits was 4.1 TEAC. It is interesting to point out that even though commercial juices had a thermal treatment (98 ºC for 20 s) the antioxidant activity was only slightly reduced down to 3.52 TEAC.

3. Sensory evaluation

The descriptive sensory analysis of juices showed that commercial samples were characterised by significantly higher (p<0.001) intensities of caramel odour and flavour than freshly squeezed juices; these caramel notes could be originated during the soft pasteurisation of juices. Besides, commercial juices from *Mollar de Elche* fruits were characterised by high intensities of sweetness, astringency and low levels of sourness. Sensory results from the trained panel proved that fresh juices prepared using Spanish sour-sweet PG fruits (c-SSPJ) led very good sensory results and that these juices were characterized by *high intensities* of colour (8.8, intense garnet colour), fresh PG odour (5.8), fresh PG flavour (7.0) and sourness (7.0), *medium intensity* of sweetness (3.6) and astringency (3.3) and *low scores* of caramel odour (1.0) and caramel flavour (1.3). The addition of sucrose to the juice of sour-sweet fruits resulted in higher intensities of sweetness but at the same time in lower intensities of colour and fresh PG odour and flavour, finally leading to slightly lower but not statistically significant overall liking by consumers. The *overall liking* of the consumer panel regarding sour-sweet fresh PG juices (c-SSPJ) was 7.6 in a 0 to 10 scale. Fresh PG juice with sucrose addition (s-SSPJ) was the sample with the second overall liking score (6.8). In general, Spanish and USA consumers are not willing to consume juices from sour or sour-sweet varieties (Vázquez-Araújo *et al*., 2011); however, fresh juices from selected sour-sweet cultivars of high quality (such as C25) have proved to be useful for the manufacturing of commercial PG juices. The level of sourness of C25 fruits was useful in improving the typical freshness, colour, odour and flavour of PG juices but it was low enough not to cause rejection by consumers.

IV – Conclusions

Spanish sour-sweet PGs have proved to be useful for juice manufacturing because they presented high levels of antioxidant activity, high intensities of positive sensory attributes and high overall liking by consumers. The sourness of the sour-sweet PG juices could also be useful in reducing the sometimes excessive sweetness of the most cultivated sweet Spanish PG cultivar, *Mollar de Elche*.

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