1 **Title: Nutraceutical profiles of apricots (*Prunus armeniaca* L.) as a source of fruit quality traits for**
2 **breeding**

3

4 **Running title:** Nutraceutical properties of apricot fruits

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6 Helena Gómez-Martínez¹, Almudena Bermejo¹, María Luisa Badenes¹ and Elena Zuriaga^{1*}

7 ¹Citriculture and Crop Production Center, Instituto Valenciano de Investigaciones Agrarias (IVIA), CV-315, Km. 10.7,

8 Moncada, 46113 Valencia, Spain

9 *Corresponding author: garcia_zur@gva.es

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11 **Keywords**

12 Sucrose, glucose, fructose, ascorbic, citric, malic, succinic, fumaric, breeding

13 Summary

14 In a social context of increasingly concern about healthy diets, the development of new varieties with enhanced content
15 in nutraceutical compounds is an increasingly important objective of the fruit breeding programs currently developed.
16 In this sense, apricot is a fruit crop very appreciated by consumers due to its organoleptic characteristics, but also plays
17 an important role in human nutrition due to its contain of phytochemicals as sugars, organic acids, vitamins and
18 polyphenols. In this work, new selections from the apricot breeding program carried out at the Instituto Valenciano de
19 Investigaciones Agrarias (IVIA) and traditional varieties have been analysed aimed at identifying sources of genetic
20 variation for fruit quality. For this purpose, sugar content, organic acids and ascorbic acid were studied during two crop
21 years. Results revealed sucrose and glucose as the major sugars, malic and citric acid as the main organic acids, and
22 diverse ascorbic acid content among the cultivars studied. Results obtained pointed some accessions as potential sources
23 to increase fruit quality. In addition, the study showed that apricot peel is an excellent source of nutraceutical
24 compounds. Moreover, this study opens up new possibilities for future work to study the genetic control of these traits
25 in apricot.

26

27 1. Introduction

28 The increasing demand for safe, healthy and nutritious food by consumers, turn the internal quality of the fruit into one
29 of the main goals of the food industry. In this sense, plants and some fruits become a useful source of compounds with a
30 relevant role in improving health (Vieira da Silva *et al.*, 2016; Slavin and Lloyd, 2012). In fact, plant extracts and their
31 bioactive compounds are used by the industry to produce functional food (Azmir *et al.*, 2013). For this reason, those
32 fruits with high content of these compounds are of high interest for the industry. In this sense, nutraceutical profiles can
33 be used for promotion of fruit consumption as a natural functional food.

34 Apricot (*Prunus armeniaca* L.) is a stone fruit crop species with a large tradition in the Mediterranean basin countries.
35 World apricot production reached 3.84 million tonnes in 2018, being Turkey, Uzbekistan, Iran, Algeria, Italy and Spain
36 as main producers (<http://www.fao.org/faostat/>). Despite its wide geographical spread apricot has very specific
37 ecological requirements, so each region usually grows locally adapted cultivars. Significant breeding efforts have been
38 undertaken (Zhebentyayeva *et al.*, 2012), leading to a rich diversity apricot germplasm in terms of fruit morphology,
39 harvest season or biotic and abiotic resistances. Apricots are consumed in multiple and diverse ways, including fresh or
40 processed fruits (as dried, canned, jam, juice or even liquors), and also used the apricot kernel oil for medicinal
41 purposes (Zhebentyayeva *et al.*, 2012). Apricots are an important source of sugars, fiber, proteins, minerals and
42 vitamins (Sochor *et al.*, 2010; Moustafa and Cross, 2019). However, pomological and nutraceutical properties depend
43 on varieties, cultivation systems, fruit storage conditions or developmental stages (Ruiz *et al.*, 2005).

44 In terms of fruit consumption, organoleptic characteristics are one of the main factors for consumers decision.
45 Notwithstanding, nutraceutical compounds interact with each other and influence the quality properties making it

difficult to handle. For instance, the flavour is provided by sucrose, malic acid and volatiles (Xi *et al.*, 2016), being sugar and organic acid balance relevant for sweetness. From them, fructose and sucrose are the prominent contributors to sweetness, being the most important sensory quality for consumer satisfaction (Fan *et al.*, 2017). Similar results have been found in peach, whose sweetness depends on the overall sugar amount as well as in the specific relative amount of each individual sugar (Kroger *et al.*, 2006). Regarding the apricot nutraceutical profile, previous studies have also found glucose and sucrose as the major sugars in both pulp and peel (Xi *et al.*, 2016). Moreover, during the fruit ripening a high number of molecular and metabolic changes occur that have a relevant effect in fruit properties (D'Ambrosio *et al.*, 2013; Karlova *et al.*, 2014; Osorio *et al.*, 2013; Seymour *et al.*, 2013). For instance, organic acids increase during the early stages of fruit development and decrease when fruits were full-ripped, being malic the most important organic acid in apricot (Xi *et al.*, 2016). Additionally, fruits and vegetables constitute the main source of ascorbate in the human diet, so rising its content in highly consumed fruits would clearly have an impact on human nutrition (Fenech *et al.*, 2019). Moreover, ascorbate content has been also related with elevated stress tolerance (Fenech *et al.*, 2019). In fact, foliar application of ascorbic acid on peach trees resulted in improving the yield and fruit quality (Sajid *et al.*, 2017). Previous studies found that vitamin C content in apricot could reach up to 100 mg/100 g dry weight (Akin *et al.*, 2008), showing the potential of this species as a source of this vitamin.

In conclusion, apricot germplasm represent a diverse source of phytochemicals that can be exploited for breeding purposes in order to develop new varieties with higher content of these nutraceutical compounds. The apricot breeding program at the Instituto Valenciano de Investigaciones Agrarias (IVIA) has the purpose of obtaining new varieties, with high fruit quality, resistant to the Plum Pox virus (PPV), self-compatibles and well-adapted to the Southern European environment (Martínez-Calvo *et al.*, 2009). PPV is the main limiting factor for apricot production worldwide, hence, during the last decades, development of PPV resistant varieties has been the main objective of almost any apricot breeding program. However, for this purpose, just some North American cultivars not well-adapted to Mediterranean conditions were identified and used as resistance donors (Martínez-Gómez *et al.*, 2000). This represents a challenge especially in the current climate change scenario affecting the Mediterranean basin, with increasingly mild winters.

The objective of the present work is to assess the fruit quality characterization of 1 North-American, 3 Spanish (Valencian Community) and 9 accessions from the IVIA's apricot breeding program aimed at identifying the most convenient genotypes for increasing the fruit quality of apricot while keeping the adaptability to warm winters. In this study we analyse sugars (sucrose, fructose, and glucose), ascorbic acid, and organic acids (citric, malic, succinic and fumaric).

2. Material and Methods

76 2.1. Plant Material

77 Thirteen apricot genotypes were used , including 3 well-known cultivars from the Mediterranean Basin, 1 North-
 78 American, and 9 selections from the IVIA's breeding program resistant to PPV (Table 1). All of them are kept at the
 79 collection of the IVIA in Moncada (Valencia, Spain). Five fruits per tree were harvested at the ripening stage during 2
 80 growing seasons (2016-2017). For each fruit, the peel was separated from the flesh with a peeler. A mix of 5 fruits (peel
 81 or flesh, respectively) was frozen with liquid nitrogen and kept at -80°C until processing. Peel samples were freeze-
 82 dried and powdered. Tissue homogenization was carried out using a Polytron 3100 (Kinematic AG, Switzerland) and
 83 a vortex for the flesh and peel samples, respectively.

84 2.2. Sample processing and HPLC analysis

85 For sample processing, 1 g of flesh or 10-20 mg of freeze-dried peels were mixed with 1.5 mL of 5% metaphosphoric
 86 acid solution, , 1 mL of water of LC-MS grade and 1 mL of 0.1% H₂SO₄ solution for ascorbic acid, sugars and organic
 87 acids extraction, respectively. Then the sample was homogenized and centrifuged at 4°C for 20 min at 8.050xg.

88 Compounds were identified on the bases of comparing their retention times, UV-vis spectra and mass spectrum data
 89 with authentic standards obtained from Sigma-Aldrich using an external calibration curve. In addition, standards were
 90 run daily with samples for validation. All the solvents used were of LC-MS grade. Three samples per cultivar were
 91 analysed and all the samples were run in triplicate. The Empower 2 software (Waters, Spain) was used for data
 92 processing.

93 2.2.1. Ascorbic acid

94 Total ascorbic acid was extracted according to the method previously described by Cano *et al.* (2011) adapted to a
 95 microliter format (Sdiri *et al.*, 2012) and using *DL*-dithiothreitol (DTT) as reducing reagent of dehydroascorbic acid to
 96 ascorbic acid. After centrifugation, 1mL of supernatant was mixed with 200 µL of DTT (20 mg/mL) and maintained for
 97 2 h in the dark, then filtered through 0.45 µm filter. It was analysed by HPLC-DAD in an Alliance liquid
 98 chromatographic system (Waters, Barcelona, Spain) equipped with a 2695 separation module coupled to a 2996
 99 photodiode array detector, and a reverse-phase C₁₈ column Tracer Excel 5 µm 120 OSDB (250 mm x 4.6 mm)
 100 (Teknokroma, Barcelona, Spain) with an isocratic mobile phase of methanol:0.6% acetic acid (5:95) at a flow rate of 1
 101 mL/min, and injection volume was 5 µL. The quantification was performed at 245 nm.

102 2.2.2. Sugars

103 Sucrose, glucose, and fructose were extracted as described by Sdiri *et al.* (2012). After centrifugation, samples were
 104 filtered through a 0.45 µm nylon filter and analysed by an HPLC system equipped with a Waters 515 HPLC pump, a

105 Waters 2414 refractive index detector, a 5- μ m Tracer Carbohydr column (250 mm x 4.5 mm) (Teknokroma, Barcelona,
106 Spain), and a 20- μ L loop Rheodyne injector were used for the sugar analysis. The mobile phase was composed of
107 acetonitrile and water (75:25) at a flow rate of 1.0 mL/min.

108 2.2.3. Organic acids

109 Citric, malic, succinic and fumaric acids were extracted as described by Sdiri *et al.* (2012). After centrifugation, the
110 supernatant was filtered through a 0.45 μ m filter, analysed by HPLC-DAD and confirmed by HPLC-MS under
111 electrospray ion negative conditions using a ZQ2000 mass detector. The sample temperature was 5°C and column
112 temperature was 35°C. Capillary voltage was 3.0 kV, cone voltage was 23 V, source temperature was 100°C,
113 desolvation temperature was 200°C and desolvation gas flow was 400 L/h. Full data acquisition was performed by
114 scanning from 100 to 400 uma in the centroid mode. An ICsep ICE-COREGEL 87H3 column (Transgenomic, UK), an
115 ICsep ICE-COREGEL 87H guard kit, and an automatic injector were used for chromatographic separation. The solvent
116 system was an isocratic mobile phase of 0.1% H₂SO₄ solution. The total run time was 20 min at 0.6 mL/min, and the
117 injection volume was 5 μ L.

118 2.3 Data analysis

119 Data were analysed with R (R Core Team, 2012) using R-studio software (v.3.5.3) with *stats*, *ggbiplot*, *readxl*, *graphics*
120 and *grDevices* packages. Normality and homoscedasticity were checked using Shapiro-Wilk and Bartlett tests
121 respectively. Next, the non parametric Kruskal-Wallis test was used to make all samples comparisons. Correlation
122 coefficients among the variables were determined using the Spearman method. Principal component analysis (PCA),
123 using centered and scaled data, was conducted to visualize the relationships between accessions and variables.

124 2.3.1. Sweetness Index (SI) and Total Sweetness Index (TSI)

125 In order to determine the sweetness perception of fruits, both index were calculated according to Magwaza and Opara
126 (2015) following the equations:

$$127 \text{ SI} = (1.00 \times [\text{glucose}]) + (2.30 \times [\text{fructose}]) + (1.35 \times [\text{sucrose}])$$

$$128 \text{ TSI} = (1.00 \times [\text{sucrose}]) + (0.76 \times [\text{glucose}]) + (1.50 \times [\text{fructose}])$$

129

130 3. Results

131 3.1 Sugars

Fructose, glucose and sucrose content in peel and flesh showed significant differences ($p \leq 0.05$) between the accessions analysed (Figure 1, Table S1). Regarding total sugar content in flesh, SEOP934 showed the highest value (12.34 g/100 g FW) and HG9850 the lower one (5.75 g/100 g FW) (Figure 1A). In all cases sucrose was the predominant sugar, ranging from 65.1 to 90.3% of the total. For each sugar, Tadeo showed the highest content of fructose (0.48 g/100 g FW) and glucose (3.11 g/100 g FW), and SEOP934 showed the highest quantity of sucrose (10.3 g/100 g FW). Regarding peel content, Kruskal-Wallis test showed an effect of the crop year over the fructose and glucose content, but not over sucrose. According to the Spearman correlation analysis, seven significant correlations were observed between the analysed sugars (Figure 2, Table S2). Mainly, fructose and glucose appear positively correlated between tissues and also between years, while in peel fructose peel appeared negatively correlated with sucrose. The North American Goldrich cultivar showed the lower total sugar content in 2016 (38.19 g/100 g DW) and the second lowest in 2017 (23.68 g/100 g DW), mainly due to its low sucrose content (12.41 and 4.63 g/100 g DW, respectively). In general, the well-known cultivars from the Mediterranean Basin showed high sugar content and the accessions belonging to the IVIA's breeding program showed an intermediate content between them and Goldrich. For each sugar, fructose ranged between the 5.9-21.2 % of total sugar measured, glucose between 19.7-45.6% and sucrose between 35.5-71.1%. As a measure of sweetness, SI and TSI index were calculated (Table 2). According to these indexes, fruits with identical total sugar content but with relatively more fructose or sucrose will taste sweeter. Overall, the Spanish cultivar Tadeo and 2 of the selections of the breeding program, HG9821 and SEOP934, were the sweetest according to these indexes. Contrary, the selections Dama Rosa, GG979 and HG9850 have the lower values.

3.2. Organic acids

Significant differences among the apricot accessions were observed for citric, malic, succinic and fumaric acids content (Figure 3, Table S3). Citric acid was the main organic acid in flesh in all cases, ranging from 50-80.1%. Malic acid was the second one except for Tadeo and SEOP934. Succinic represents between 7-22.93% of the organic acids measured and fumaric just between 0.07 and 0.17%. Regarding total content in flesh, Dama Rosa showed the highest value (3.254 g/100 g FW) and Mitger the lower one (1.562 g/100 g FW) (Figure 3A). In this case, 8 significant correlations were detected between organics (Figure 2), being the most notorious the negative correlation between succinic and citric acids in peel. As in the case of sugars, an effect of crop year was observed in the fumaric acid peel content, with some accessions showing higher values in 2017 (Figure 3B and 3C). Citric acid was the main organic acid in peel in all cases except for Mitger (~14.5%) and Tadeo (~20%), which showed both years a higher content of malic acid (around 62% and 55%, respectively), and Dama Rosa with 46.6% in 2017. Succinic acid was the third one, except for Tadeo (~22.2%), which showed more content than malic (~20%). Regarding the total content in peel, Goldrich showed the highest values (20.7 and 31.7 g/100 g DW), and Tadeo the lower ones (9.6 and 11.3 g/100 g DW).

163 3.3 Ascorbic acid

164 Results of ascorbic acid content in peel and flesh of the genotypes studied in the two crop years are in Figure 4 and
165 Table S4. Significant differences were found among genotypes and crop years (p-value = 0,0026). In flesh, values
166 ranged from 9.11 mg/100 g FW (SEOP934) and 13.08 mg/100 g FW (HG9821). Regarding peel content, Mitger and
167 HG9850 showed the highest values in 2016 (185.02 mg/100 g DW) and 2017 (192.82 mg/100 g DW) respectively. In
168 general, the accessions belonging to the IVIA's breeding program showed equal or higher content than Canino, which
169 showed the lowest value from the Mediterranean cultivars.

170 3.4. Correlations and Principal Component Analysis

171 As consumer preferences are highly influenced by the balance of sugar and organic acids content, relations between all
172 the analysed compounds were also studied (Figure 2). For instance, citric content in flesh was negatively correlated with
173 glucose and sucrose peel content, while in peel was negatively correlated with fructose and glucose flesh content. Malic
174 content in flesh was positively correlated with fructose content and negatively with sucrose, both in peel. Succinic
175 content in flesh was positively correlated with fructose and glucose. Finally, fumaric acid showed positive correlation
176 with ascorbic acid content.

177 In order to explore the variability observed in the accessions, the nutraceutical compounds analysed each year were
178 submitted to principal component analyses (PCA). As results with each independent data sets were quite similar, just
179 the PCA for 2017 is shown (Figure 5). First 3 principal components (PC1, PC2 and PC3) accounted for 78.1% of the
180 total variance (36.5%, 27.4% and 14.2%, respectively). PC1 was positively correlated mainly with sucrose, fumaric acid
181 and ascorbic, while negatively with citric acid content. PC2 showed a positive correlation with citric acid and fructose,
182 and negatively with malic and succinic acids. The distribution of the accessions in the space of the 3 first components
183 showed one group of 6 accessions (Goldrich, GG979, GP9817, GG9310, Dama Taronja and Canino) situated at
184 negative values of PC1 and positive values of PC2. Rest of the accessions appear more distributed, and just two of them
185 were close to each other, HG9821 and HG9850, both descendants from the same cross.

186 4. Discussion

187 Traditionally, plant breeding goals have been focused on yield, stress resistance and external quality traits as appearance
188 and shelf-life. However, consumers are increasingly demanding high quality food. As an example, huge efforts are in
189 progress to recover the lost flavour in tomato cultivars (Tieman *et al.*, 2017). Nowadays, internal quality traits have
190 been incorporated as objectives of almost any plant breeding program. The IVIA's apricot breeding program started in
191 1993 and was initially focused on introgression of sharka resistance into locally grown cultivars (Martínez-Calvo *et al.*,
192 2009). However, just a handful of North American apricot PPV resistant cultivars, adapted to cold-growing conditions,

193 have been identified (Martínez-Gómez *et al.*, 2000). Despite the crosses with those cultivars introduce also undesirable
194 traits, the hybrids obtained in the breeding program represent a good opportunity to incorporate new breeding goals and
195 to accelerate the development of new varieties better adapted to the Mediterranean basin conditions. In this sense, the
196 characterization of the nutraceutical properties of these germplasm collection allows to identify putative promising
197 accessions and to optimize the design of the future crosses. This study opens also future work to study the genetic
198 control of these traits in apricot. In this work, we analysed 13 accessions of the IVIA's collection in order to identify the
199 main source of variation for each phytochemical of interest: sugars (sucrose, fructose and glucose), organic acids
200 (citric, malic, succinic and fumaric) and vitamin C (ascorbic acid).

201 Apricot fruits are a good source of sugars, fiber, proteins, minerals and vitamins (Moustafa and Cross, 2019). Fruit taste
202 is highly dependent of the soluble solids content, which is the sum of sugars, acids and other minor components,
203 however sugars represent the most important proportion. As described in apricot and other *Prunus* species, sucrose,
204 glucose and fructose are the main sugars present in fruits (Bassi and Selli, 1990; Cirilli *et al.*, 2016). For instance,
205 sucrose is the predominant sugar (40-85%) in peach, followed by fructose and glucose in variable ratios (Cirilli *et al.*,
206 2016), similarly to our data presented here. According to Bae *et al.* (2014), the content of glucose and fructose was
207 higher than sucrose and sorbitol during fruit growth, these authors also pointed that sucrose increase as major sugar in
208 apricot and plum at the end of maturity, that is in accordance with our results. Consumer perception of sweetness
209 intensity depends on the overall sugar amount but also the specific profile (Cirilli *et al.*, 2016). For this sweetness
210 estimation, the contribution of each carbohydrate is calculated, based on the fact that fructose and sucrose are sweeter
211 than glucose (Magwaza and Opara, 2015). Although comparisons with other previous works are complicated for this
212 type of traits, our values are similar to the ones obtained by Fan *et al.*, (2017) analyzing northwest Chinese apricots.
213 According to our study, SEOP934, HG9821 and HG9850 could be good candidates as sweetness source.

214 Organic acids also have an important role, with sugars, on apricot taste (Xi *et al.*, 2016). All organic acids increase at
215 first and then fall throughout fruit development and ripening process (Xi *et al.*, 2016). In agreement with the previous
216 studies already cited, malic and citric acids were predominant in the apricot genotypes analysed. In terms of taste
217 Dolenc-Sturm *et al.*, (1999) pointed the stronger acidic taste of malic compared with citric acid, and conclude that the
218 optimal ratio between malic and citric acid is near the value of 0.8. Interestingly, some accessions showed the
219 malic: citric ratio around this value, like Dama Rosa and HG9821, two accessions from the IVIA's breeding program,
220 and also Goldrich. Interestingly, the PPV resistant Dama Rosa cultivar has been already registered (Badenes *et al.*,
221 2018). Moreover, cultivars with high content in acids and low in sugars could be more appreciated, particularly those
222 with higher citric acid concentration (Dolenc-Sturm *et al.*, 1999). Moreover, cultivars with high content of organic acids
223 could be also used as source of these compounds, as they can be used to provide acidity and sour flavour as additive in

224 food products. For instance, malic acid is used for elaboration of sweets and fumaric acid is used as acidulant and
225 antioxidant in soft drinks and cake mixes (Moldes *et al.* 2017). In this sense, several of the selections studied could be
226 useful for the food-industry, like GG9310, GG979, and SEOP934 that appear as good candidates as they showed high
227 contents of total organics acids.

228 Finally, the ascorbic acid is one of the most important vitamin in fruits (Lee and Kader, 2000), because of its protective
229 activity as antioxidant (Rice-Evans *et al.*, 1997). We found significant differences in ascorbic acid contents between
230 crop years and among genotypes. Our results are in agreement with others studies on apricot varieties (Akin *et al.*,
231 2008; Gündogdu *et al.*, 2013), with values ranging from 98.70 to 192.82 mg/100g DW among varieties and crop year.
232 HG9850 and HM964 could be suggested as promising cultivars for ascorbic acid content improving due to their high
233 content and stable behaviour in both years.

234 The increasing demand of healthy products has raised the need of using alternative supplements and additives in food
235 and, fruit nutraceutical compounds can be a good choice since they can be extracted from natural sources and can
236 provide extra health benefits (Moldes *et al.*, 2017). Our results suggest that apricot peel is a good source of sugars,
237 vitamins and organic acids, being an interesting provider of nutraceutical compounds. Our results are in agreement with
238 other authors that pointed the apricot peel as an extraordinary source of nutraceutical compounds and an optimum tissue
239 for studying mechanisms of flavour quality formation in fruit (Xi *et al.*, 2016; Voo *et al.*, 2012). Similar results were
240 found in previous apricot studies (Ruiz *et al.*, 2005) and other fruits species like pear (Li *et al.*, 2014) or peach
241 (Campbell *et al.*, 2013).

242 **4. Conclusions**

243 A set of selections and genitors from the IVIA's apricot breeding collection has been characterized from a nutraceutical
244 point of view and the main sources of variation of the group of genotypes have been identified, which can be considered
245 as a previous step for further breeding. Our results confirmed the diversity among the set of apricot studied regarding to
246 sugars, organic acids and ascorbic acid content.

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252 **Declaration of Competing Interest**

253 The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection,
254 analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

255 **Author contributions**

256 Helena Gómez-Martínez: Data curation, Formal analysis, Writing - review & editing; Almudena Bermejo: Data
257 curation, Methodology; María Luisa Badenes: Conceptualization, Funding acquisition, Supervision, Writing - review &
258 editing; Elena Zuriaga: Conceptualization, Data curation, Formal analysis, Funding acquisition, Writing - original draft,
259 Writing - review & editing

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264 **Table 1: Apricot accessions analysed**

Genotype	Pedigree	Origin	Harvest date	
		Country	2016	2017
Goldrich	Sunglo x Perfection	USA	June 22nd	9th June
Canino	Unknown	Spain (Valencia)	June 3rd	31st May
Mitger	Unknown	Spain (Valencia)	June 3rd	25th May
Tadeo	Unknown	Spain (Valencia)	June 15th	9th June
Dama Rosa	Goldrich x Ginesta	Spain (IVIA)	June 6th	9th June
Dama Taronja	Goldrich x Katy	Spain (IVIA)	June 10th	9th June
GG9310	Goldrich x Ginesta	Spain (IVIA)	June 6th	9th June
GG979	Goldrich x Ginesta	Spain (IVIA)	June 13th	9th June
GP9817	Goldrich x Palau	Spain (IVIA)	June 13th	9th June
HG9821	Harcot x Ginesta	Spain (IVIA)	June 8th	25th June
HG9850	Harcot x Ginesta	Spain (IVIA)	June 3rd	25th June
HM964	Harcot x Mitger	Spain (IVIA)	June 1st	2nd June
SEOP934	SEO x Palau	Spain (IVIA)	June 8th	2nd June

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267 **Table 2: Sweetness estimation, SI and TSI were calculated according to Magwaza and Opara (2015).**

Genotype	SI			TSI		
	Flesh_2016	Peel_2016	Peel_2017	Flesh_2016	Peel_2016	Peel_2017
Goldrich	9,33	51,67	30,74	6,89	37,20	21,68
Canino	10,43	63,91	63,45	7,72	47,00	46,34
Mitger	8,50	66,22	81,48	6,25	48,22	59,60
Tadeo	13,88	70,66	63,02	10,24	51,79	45,63
Dama Rosa	14,40	55,04	23,08	10,66	40,15	16,66
Dama Taronja	12,04	52,27	44,83	8,90	38,13	32,17
GG9310	10,56	54,46	46,20	7,81	39,70	33,27
GG979	7,56	50,54	44,51	5,60	36,91	31,82
GP9817	9,98	59,19	52,29	7,38	43,24	37,61
HG9821	10,74	62,78	92,30	7,93	45,73	67,37
HG9850	7,55	61,78	66,43	5,58	45,34	48,50
HM964	8,82	54,53	76,46	6,51	39,79	56,03
SEOP934	16,30	63,58	43,30	12,05	46,60	31,20

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272 **Figure 1: Profiles of sugar content in flesh (g/100 g fresh weight (FW)) and peel (g /100 g dry weight (DW))**

273 **during 2016 and 2017.**

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277 **Figure 2: Significant correlations between variables analysed ($\alpha=0.05$)**

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280 **Figure 3: Profiles of organic acids content in flesh (g/100 g FW) and peel (g/100 g DW) during 2016 and 2017.**

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282

283 **Figure 4: Ascorbic acid content in flesh (mg/100 g FW) and peel (mg /100 g DW) during 2016 and 2017.**

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Figure 5: Principal Component Analysis for 2017 data. A: Representation of the accessions in the space defined by the first and second components; B: Representation of the accessions in the space defined by the first and third components.

Table S1: Profiles of sugar content in flesh (g/100 g fresh weight (FW)) and peel (g /100 g dry weight (DW)) during 2016 and 2017.

Table S2: Correlations between variables analysed.

Table S3: Profiles of organic acids content in flesh (g/100 g FW) and peel (g /100 g DW) during 2016 and 2017.

Table S4: Ascorbic acid content in flesh (mg/100 g FW) and peel (g /100 g DW) during 2016 and 2017.

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381

382 **ORCID:**

383 Helena Gómez-Martínez: <https://orcid.org/0000-0001-8714-5197>

384 Almudena Bermejo: <https://orcid.org/0000-0003-4030-6007>

385 María Luisa Badenes: <https://orcid.org/0000-0001-9722-6783>

386 Elena Zuriaga*: <https://orcid.org/0000-0001-5497-4941>

387 *Corresponding author: garcia_zur@gva.es

388 **Postal address:**

389 Citriculture and Crop Production Center, Instituto Valenciano de Investigaciones Agrarias (IVIA), CV-315, Km. 10.7,

390 Moncada, 46113 Valencia, Spain

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