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RESEARCH ARTICLE

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

Helena Gómez-Martínez, Almudena Bermejo, María L. Badenes and Elena Zuriaga

Citriculture and Crop Production Center, Instituto Valenciano de Investigaciones Agrarias (IVIA), CV-315, Km. 10.7, Moncada, 46113 Valencia, Spain

Abstract

Aim of study: In a social context of increasing concern about healthy diets, the development of new varieties with enhanced content in nutraceutical compounds is an important objective of the fruit breeding programs currently developed. In this sense, apricot is a fruit crop very appreciated by consumers worldwide due to its organoleptic characteristics, but also plays an important role in human nutrition due to its content of phytocompounds as sugars, organic acids, vitamins and polyphenols.

Area of study: The identification of sources of variation for these traits could be useful for apricot breeding worldwide.

Material and methods: New selections from the apricot breeding program carried out at the Instituto Valenciano de Investigaciones Agrarias (IVIA, Spain) and traditional varieties have been analysed aimed at identifying sources of genetic variation for fruit quality. For this purpose, sugar content, organic acids and ascorbic acid were studied during three crop years.

Main results: Results revealed sucrose and glucose as the major sugars, malic and citric acid as the main organic acids, and diverse ascorbic acid content among the cultivars studied.

Research highlights: Some accessions point as potential sources to increase fruit quality. In addition, the study showed that apricot peel is an excellent source of nutraceutical compounds. Moreover, this study opens up new possibilities to study the genetic control of these traits in apricot in the future.

Additional key words: sugars; ascorbic acids; organic acids.

Abbreviations used: DW (dry weight); FW (fresh weight); PPV (Plum Pox Virus); SI (sweetness index); TSI (total sweetness index)

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Correspondence should be addressed to Elena Zuriaga: garcia_zur@gva.es

Introduction

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

Apricot (*Prunus armeniaca* L.) is a stone fruit crop species with a large tradition in the Mediterranean basin countries. World apricot production reached 4.08 million tonnes in 2019, being Turkey, Uzbekistan, Iran, Italy, Algeria and Spain as main producers (http://www.fao.org/faostat/). Despite its wide geographical spread, each

region usually grows locally adapted apricot cultivars because this species has very specific ecological requirements. In this sense, significant breeding efforts have been undertaken (Zhebentyayeva *et al.*, 2012), leading to a rich diversity apricot germplasm in terms of fruit morphology, harvest season or biotic and abiotic stresses. Apricots are consumed in multiple and diverse ways, including fresh or processed fruits (as dried, canned, jam, juice or even liquors), and the apricot kernel oil is also used for medicinal purposes (Zhebentyayeva *et al.*, 2012). Apricots are an important source of sugars, fiber, proteins, minerals and vitamins (Sochor *et al.*, 2010; Moustafa & Cross, 2019). However, pomological and nutraceutical properties depend on varieties, cultivation systems, fruit storage conditions or developmental stages (Ruiz *et al.*, 2005).

In terms of fruit consumption, organoleptic characteristics are one of the main factors for consumers' decision. 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 flesh 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; Osorio *et al.*, 2013; Seymour *et al.*, 2013; Karlova *et al.*, 2014). In this sense, García-Gómez *et al.* (2021) reviewed current knowledge of the molecular bases of fruit ripening process in *Prunus* species due to its importance for breeding. 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 phytocompounds 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, Spain) 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 (Polo-Oltra *et al.*, 2020). 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 one North-American, three Spanish (Valencian Community) and nine 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) during three cropping seasons.

Material and methods

Plant material

Thirteen apricot genotypes were used, including three well-known cultivars from the Mediterranean Basin ('Canino', 'Mitger' and 'Tadeo'), one North-American ('Goldrich'), and nine selections from the IVIA's breeding program resistant to PPV ('Dama Rosa', 'Dama Taronja', 'GG9310', 'GG979', 'GP9817', 'HG9821', 'HG9850', 'HM964' and 'SEOP934'). Pedigree information can be checked at Polo-Oltra *et al.* (2020). All of them are kept at the collection of the IVIA in Moncada (Valencia, Spain). Five fruits per tree were harvested at the ripening stage during 3 growing seasons (2016, 2017 and 2019) and used for pomological and nutraceutical analyses. For each fruit, the peel was separated from the flesh with a peeler. A mix of 5 fruits (peel or flesh, respectively) was frozen with liquid nitrogen and kept at -80ºC until processing. Peel samples were freeze-dried and powdered. Tissue homogenization was carried out using a Polytrom 3100 (Kinematica AG, Switzerland) and a vortex for the flesh and peel samples, respectively.

Sample processing and HPLC analysis

For sample processing, 1 g of flesh or 10-20 mg of freeze-dried peel were mixed with 1.5 mL of 5% metaphosphoric acid solution, 1 mL of water of LC-MS grade

and 1 mL of 0.1% H2SO4 solution for ascorbic acid, sugars and organic acids extraction, respectively. Then the sample was homogenized and centrifuged at 4ºC for 20 min at 8.050×g.

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

Ascorbic acid

Total ascorbic acid was extracted according to the method previously described by Cano & Bermejo (2011) adapted to a microliter format (Sdiri *et al.*, 2012) and using *DL*-dithiothreitol (DTT) as reducing reagent of dehydroascorbic acid to ascorbic acid. After centrifugation, 1 mL of supernatant was mixed with 200 µL of DTT (20 mg/mL) and maintained for 2 h in the dark, then filtered through 0.45 µm filter. It was analysed by HPLC-DAD in an Alliance liquid chromatographic system (Waters, Barcelona, Spain) equipped with a 2695 separation module coupled to a 2996 photodiode array detector, and a reverse-phase C_{18} column Tracer Excel 5 µm 120 OSDB (250 mm × 4.6 mm) (Teknokroma, Barcelona) with an isocratic mobile phase of methanol:0.6% acetic acid (5:95) at a flow rate of 1 mL/min; the injection volume was 5 µL. The quantification was performed at 245 nm.

Sugars

Sucrose, glucose, and fructose were extracted as described by Sdiri *et al.* (2012). After centrifugation, samples were filtered through a 0.45 µm nylon filter and analysed by an HPLC system equipped with a Waters 515 HPLC pump, a Waters 2414 refractive index detector, a 5-µm Tracer Carbohydr column (250 mm × 4.5 mm) (Teknokroma, Barcelona, Spain), and a 20-µL loop Rheodyne injector were used for the sugar analysis. The mobile phase was composed of acetonitrile and water (75:25) at a flow rate of 1.0 mL/min.

Organic acids

Citric, malic, succinic and fumaric acids were extracted as described by Sdiri *et al.* (2012). After centrifugation, the supernatant was filtered through a 0.45 µm filter, analysed by HPLC-DAD and confirmed by HPLC-MS under electrospray ion negative conditions using a ZQ2000 mass detector. The sample temperature was 5ºC and column temperature was 35ºC. Capillary voltage was 3.0 kV, cone voltage was 23 V, source temperature was 100ºC, desolvation temperature was 200ºC and desolvation gas flow was 400 L/h. Full data acquisition was performed by scanning from 100 to 400 uma in the centroid mode. An ICSep ICE-COREGEL 87H3 column (Transgenomic, UK), an ICSep ICE-COREGEL 87H guard kit, and an automatic injector were used for chromatographic separation. The solvent system was an isocratic mobile phase of 0.1% H_2SO_4 solution. The total run time was 20 min at 0.6 mL/min, and the injection volume was 5 µL.

Pomological characterization

Ten fruit variables were studied according to the apricot descriptor guidelines published by the International Union for the Protection of the Obtained Vegetables (UPOV, 2008). A digital calibrator Mahr 16 EX was used for length measures. Fruit weight was measured in a precision scale COBOS (max 12 kg, d = 1g). Firmness was measured using an EZ-L Test (Shimadzu, Kyoto, Japan) with an 8 mm cylindrical plunger. Colour related traits were determined by visual inspection and codified as qualitative traits following the UPOV descriptor.

Data analysis

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

Sweetness index (SI) and total sweetness index (TSI)

In order to determine the sweetness perception of fruits, both indexes were calculated according to Magwaza & Opara (2015) following the equations:

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

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

Results

Pomological and metabolic data obtained here were submitted to statistical analysis in order to check the presence of significant differences between genotypes and/or years. In all cases, data showed no normality and homoscedasticity according to the Shapiro-Wilk and Bartlett test, respectively, violating ANOVA assumptions. For this reason, the non-parametric Kruskal-Wallis test was used to check differences between years and/or genotypes in all cases.

Sugars

Fructose, glucose and sucrose content in peel and flesh showed significant differences ($p \leq 0.05$) between the accessions analysed (Fig. 1, Table S1 [suppl]). Regarding total sugar content in flesh, 'SEOP934' showed the highest value (12.34 g/100 g FW) and 'HG9850' the lowest one (5.75 g/100 g FW). 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 all the sugars analysed (α=0.05). According to the Spearman correlation analysis, 13 significant correlations were observed between the analysed sugars (Fig. 2, Table S2 [suppl]). Mainly, fructose and glucose appear positively correlated between tissues and also between years, while in peel fructose 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. In fact, this cultivar consistently showed the lowest sucrose contents (12.41, 4.63 and 17.80 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 3.65-26.60 % of total sugar measured, glucose between 18.03-49.09% and sucrose between 19.57-72.70%. As a measure of sweetness, SI and TSI index were calculated (Table S3 [suppl]). According to these indexes, fruits with identical total sugar content but with relatively more fructose or sucrose will

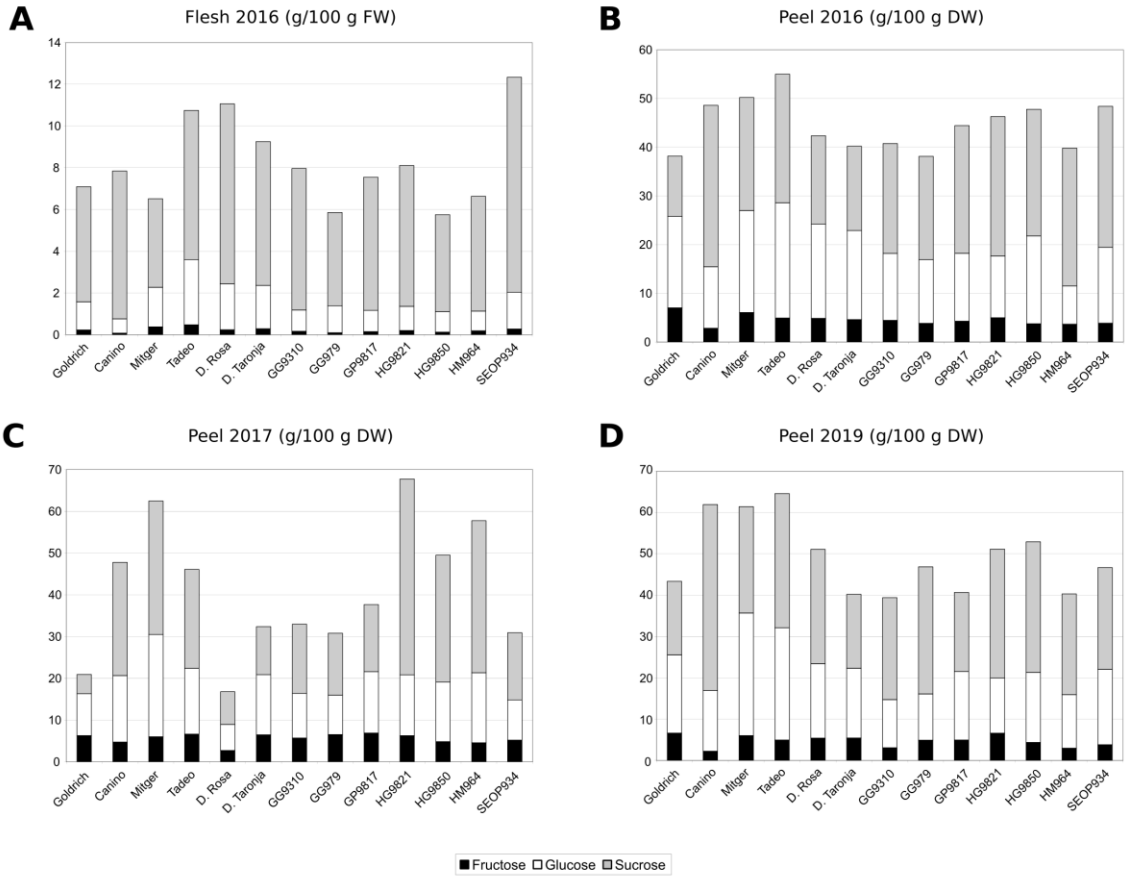

Figure 1. Profiles of sugar content in flesh (g/100 g fresh weight (FW)) and peel (g /100 g dry weight (DW)) during 2016, 2017 and 2019.

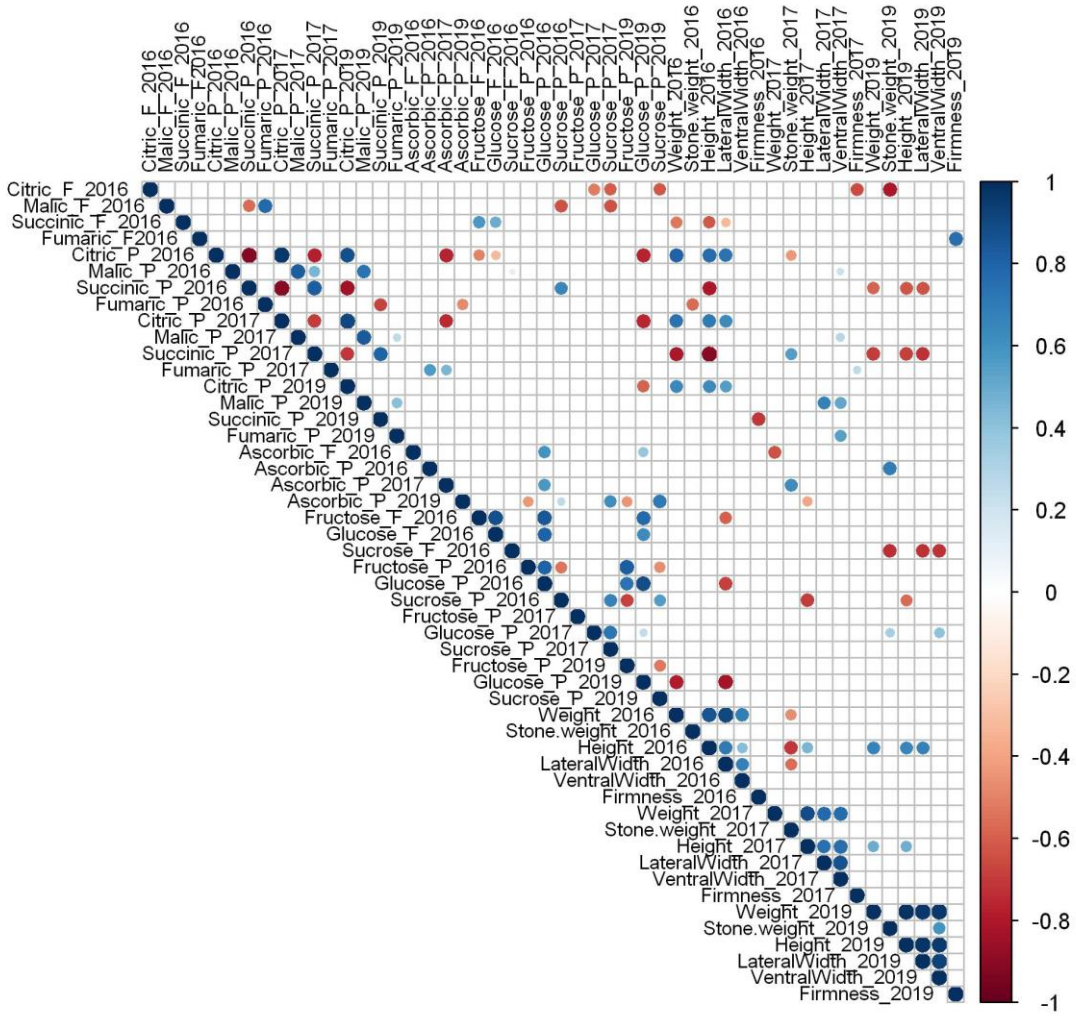

Figure 2. Significant correlations between variables analysed (α=0.05)

taste sweeter. Overall, the Spanish cultivar 'Tadeo' and the selection of the breeding program 'HG9821' had the sweetest peel, while 'SEOP934' showed the sweetest flesh. Contrary, the selections 'Dama Rosa' and 'GG979' have the lower values in peel and 'HG9850' in flesh.

Organic acids

Significant differences among the apricot accessions were observed for citric, malic, succinic and fumaric acids content (Fig. 3, Table S4 [suppl]). In this case, 21 significant correlations were detected between the organics analyzed, being the most notorious the negative correlation between succinic and citric acids in peel (Fig. 2, Table S2 [suppl]). In flesh, citric acid was the main organic acid in all cases, ranging from 47-80.8%. Malic acid was the second one, ranging from 4.5-45%, except for 'Tadeo' (~22.2%), which showed more succinic content (22.9%). Succinic represented between 7.1-22.93% 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) (Fig. 3, Table S4 [suppl]). As in the case of sugars, an effect of crop year was observed over the peel content in all the organic acids analysed (α=0.05). The content of fumaric was especially low in 2019, which was confirmed by repeating the analyses. Regarding peel content, citric acid was the main organic acid in all cases except for 'SEOP934' (6%), 'Mitger' (12.5%) and 'Tadeo' (23.4%), which consistently showed a higher content of malic acid (77.8%, 68.6% and 56.1%, respectively) and also succinic acid (with mean values of 15.3%, 17% and 18.60%, respectively), except 'Tadeo' in 2019. Regarding the total content in peel, 'Goldrich' showed the highest values (20.7, 31.7 and 42.6 g /100 g DW), and 'Tadeo' the lower ones (9.6, 11.3 and 10.8 g/100 g DW) during the three years analysed.

Ascorbic acid

Results of ascorbic acid content in peel and flesh of the genotypes studied in the 3 crop years are in Fig. 4

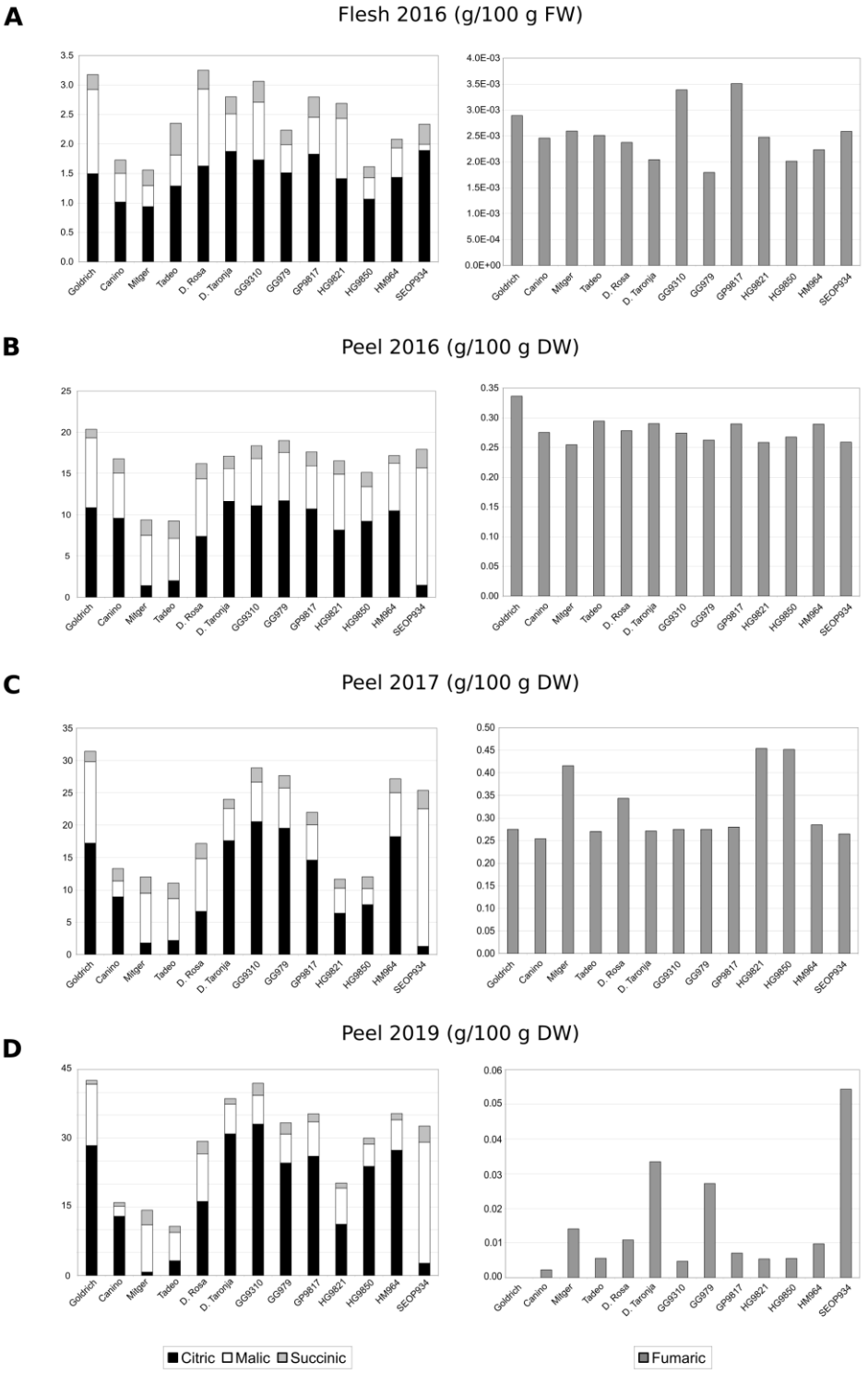

Figure 3. Profiles of organic acids content in flesh (g/100 g FW) and peel (g /100 g DW) during 2016, 2017 and 2019.

and Table S5 [suppl]. Significant differences were found among crop years (α=0.05). In flesh, values ranged from 9.11 mg/100 g FW ('SEOP934') and 13.08 mg/100 g FW ('HG9821'). Regarding peel content, 'Mitger', 'HG9850' and 'HM964' showed the highest values in 2016 (185.02 mg/100 g DW), 2017 (192.82 mg/100 g DW) and 2019 (165.16 mg/100 g DW), respectively.

Pomological traits

Ten fruit traits, mainly related with size, firmness and colour, were studied in the 3 crop years and significant differences were found among crop years and genotypes (α=0.05) (Table S6 [suppl]). 'Dama Taronja' in 2016 and 2019 and 'HG9821' in 2017 showed the highest weight,

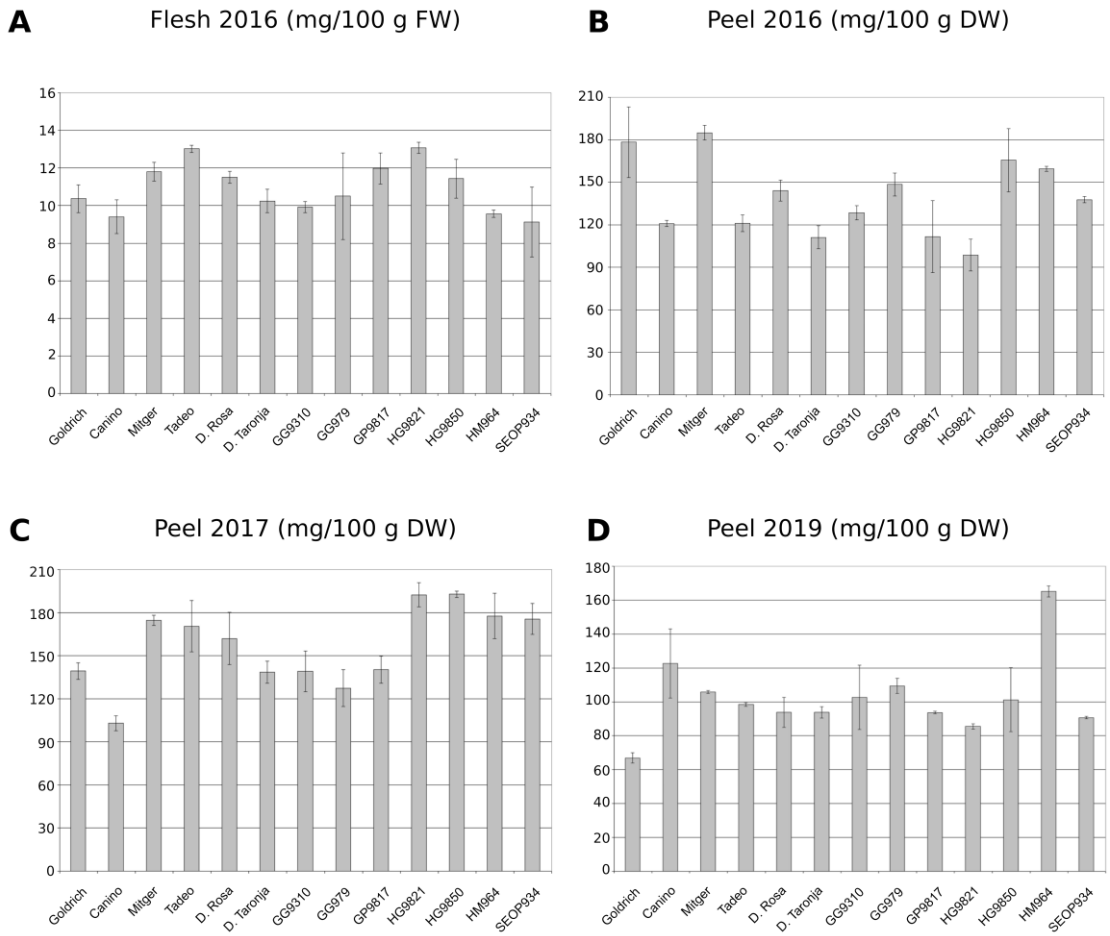

Figure 4. Ascorbic acid content in flesh (mg/100 g FW) and peel (mg /100 g DW) during 2016, 2017 and 2019.

almost 3 times higher than the lowest one in all cases. Fruit color was also influenced by the environment, with slight variations observed every year. Anyway, 'Dama Taronja', 'HM964' and 'SEOP934' showed medium to dark orange flesh colour, which could point them as good carotenoid sources. Regarding firmness, another trait highly affected during the ripening process, significant differences were also observed between the analysed accession, showing in general higher values the traditional cultivars, like 'Goldrich', 'Canino', 'Mitger' and 'Tadeo'.

Correlations and principal component analysis

As consumer preferences are highly influenced by the balance of sugar and organic acids content, relations between all the analysed compounds were also studied (Fig. 2, Table S2 [suppl]). As 'HG9821' and 'HM964' had some pomological data missing, these accessions were eliminated from the analysis. Emphasizing just the strongest correlations (-0.8>x>0.8), malic content in flesh was highly and positively correlated with fumaric content in peel, while citric content in peel was highly and negatively correlated with succinic, ascorbic acid and glucose content. Glucose and fructose showed positive correlations in both tissues. Regarding pomological traits, fruit weight and height showed positive correlations with citric content but negatively with succinic and glucose content.

In order to explore the variability observed in the accessions, the pomological and nutraceutical data for each year were submitted to PCA. As results with each independent data sets were quite similar, just the PCA for 2017 is shown (Fig. 5). First three principal components (PC1, PC2 and PC3) accounted for 73.8% of the total variance (31.06%, 27.29% and 15.45%, respectively). PC1 was positively correlated mainly with sugar content and firmness, and negatively with malic content and fruit size traits. PC2 showed a positive correlation mainly with succinic, fumaric, ascorbic acids, sucrose, stone weight and firmness, and negatively with citric acid and fructose content. PC3 showed a positive correlation with succinic, malic and stone weight, but in this case a negative one with firmness and fumaric. Accessions appear distributed in the space of the three first components without a clear substructure. 'Goldrich' and 'Dama Taronja' appeared close to each other, but the other 'Goldrich' descendants appear more separated by the PC3. 'Canino' and 'GP9817' appeared also close to each other, while 'Tadeo' appears clearly separated from the rest.

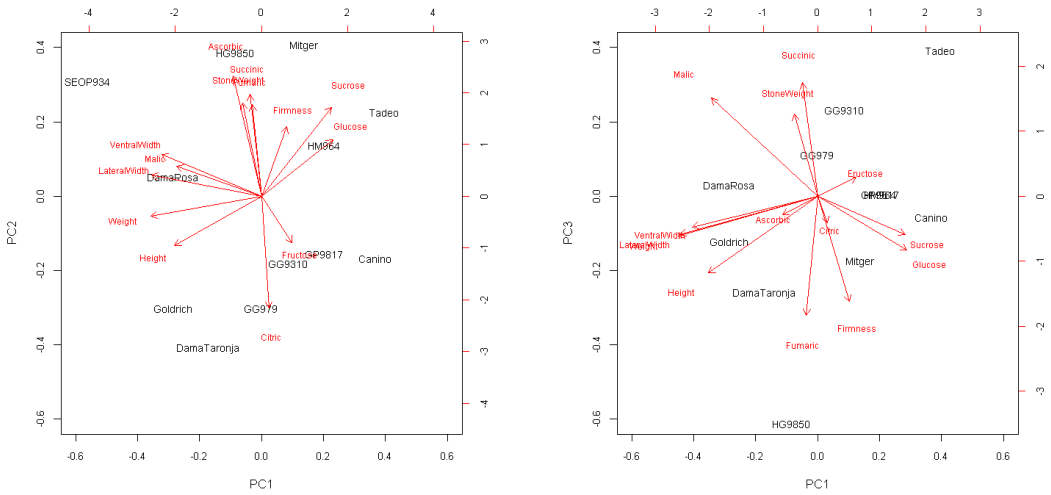

Figure 5. Principal component analysis for 2017 data. Left: first and second components; right: first and third components.

Discussion

Traditionally, plant breeding goals have been focused on yield, stress resistance and external quality traits as appearance and shelf-life. However, consumers are increasingly demanding high quality food. As an example, huge efforts are in progress to recover the lost flavour in tomato cultivars (Tieman *et al.*, 2017). Nowadays, internal quality traits have been incorporated as objectives of almost any plant breeding program. Great efforts are being made in order to identify genes of interest involved in the control of these traits that could be useful to facilitate breeding programs (García-Gómez *et al.*, 2020; Zhang *et al.*, 2019). The IVIA's apricot breeding program started in 1993 and was initially focused on introgression of sharka resistance into locally grown cultivars (Martínez-Calvo *et al.*, 2009). However, just a handful of North American apricot PPV resistant cultivars, adapted to cold-growing conditions, have been identified (Martínez-Gómez *et al.*, 2000). Despite the crosses with those cultivars introduce also undesirable traits, the hybrids obtained in the breeding program represent a good opportunity to incorporate new breeding goals and to accelerate the development of new varieties better adapted to the Mediterranean basin conditions. In this sense, the characterization of the nutraceutical properties of these germplasm collection allows to identify putative promising accessions and to optimize the design of the future crosses. This study opens also future work to study the genetic control of these traits in apricot. In this work, we analysed 13 accessions of the IVIA's collection in order to identify the main source of variation for each phytocompound of interest: sugars (sucrose, fructose and glucose), organic acids (citric, malic, succinic and fumaric) and vitamin C (ascorbic acid).

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

Organic acids also have an important role, with sugars, on apricot taste (Xi *et al.*, 2016). All organic acids increase at first and then fall throughout fruit development and ripening process (Xi *et al.*, 2016). In agreement with the previous studies already cited, malic and citric acids were predominant in the apricot genotypes analysed. In terms of taste Dolenc-Sturm *et al.* (1999) pointed the stronger acidic taste of malic compared with citric acid, and concluded that the optimal ratio between malic and citric acid is near the value of 0.8. Interestingly, some accessions showed the malic:citric ratio around this value, like 'Dama Rosa' and 'HG9821', two accessions from the IVIA's breeding program, and also 'Goldrich'.

Interestingly, the PPV resistant 'Dama Rosa' cultivar has been already registered (Badenes *et al.*, 2018). Moreover, cultivars with high content in acids and low in sugars could be more appreciated, particularly those with higher citric acid concentration (Dolenc-Sturm *et al.*, 1999). Moreover, cultivars with high content of organic acids could be also used as source of these compounds, as they can be used to provide acidity and sour flavour as additive in food products. For instance, malic acid is used for elaboration of sweets and fumaric acid is used as acidulant and antioxidant in soft drinks and cake mixes (Moldes *et al.*, 2017). In this sense, several of the selections studied could be useful for the food-industry, like 'GG9310', 'GG979', and 'SEOP934' that appear as good candidates as they showed high contents of total organics acids.

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

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

In summary, a set of selections and genitors from the IVIA's apricot breeding collection has been characterized from a nutraceutical point of view and the main sources of variation of the group of genotypes have been identified, which can be considered as a previous step for further breeding. Our results confirm the diversity among the set of apricot studied regarding to sugars, organic acids and ascorbic acid content. These results pave the way for future studies in which the mapping of QTLs can be carried out using our segregating populations once the parents have been characterized. For this purpose, a higher number of fruits will be analysed per tree in order to address the genotype × environment interaction analysis.

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