PAPER

QUALITY OF AUTOCHTHONOUS SICILIAN PLUMS

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ABSTRACT

Thirty four plum local varieties and accessions obtained from different growing area of the Sicilian island were analyzed for their qualitative and nutraceutical properties and three commercial cultivar were used as references. These properties included the fruit fresh weight (g), the pulp firmness (FFF), the total soluble solids (TSS), the titratable acidity (TA), the total anthocyanins, the phenolics content and the antioxidant activity.

This preliminary study showed significantly differeces among the plums; Zuccarato giallo and Prunu Niuru presented TSS higher than the commercial cultivars (24.9 and 21.6 °Brix respectively) and interesting data obtained on the nutraceutical compounds values suggested these local cultivars as sources of polyphenols (Zuccarato giallo with 663 mg GA/100 gFW) and natural antioxidants (Pruno Regina with 47.46 Fe^{2+}/100 gFW). The characterization of these plums could represent also an important resource for the international activity in the genetic improving and the collection of the more interesting quality traits could be useful for improving the *Prunus* database actually in use.

- Keywords: agrobiodiversity, plum, quality, nutraceutical compounds -

1. INTRODUCTION

The varietal diversity is one of the agricultural biodiversity (HEYWOOD, 1999) and the management by farmers at the local community level is one of the factors involved to preserve it. The International Treaty on Plant Genetic Resources for Food and Agriculture approved in 2001 has assigned to all joined Nations the duty to take specific local actions in terms of preservation of genetic resources, particularly those that are directly related with the food and agriculture, ie. agrobiodiversity. Since that, many national initiatives have been set up aiming at the recovery and characterization of the genetic autochthonous resources as well as the enhancement in both nutritional and nutraceuticals traits.

The need to maintain, to protect and to manage agobiodiversity is increasing; the identification of the composition of locally cultivated food as sources of nutraceutical compounds is essential to promote a more food-base approach to nutrition and health (SCOONES, 1992). Plums are the most taxonomically diverse of stone fruits (DAS *et al.*, 2011) and the varietal diversity is strongly related to the high percentage of self-incompatibility that led over the centuries to various cross-pollinations with recombinations of characters (SOTTILE *et al.*, 2010a). The management in situ is one of the commonly recommended germplasm conservation approaches (MAXTED *et al.*, 2010) and in Sicily plum fruits were cultivated since the sixteenth and seveteenth centuries as reported in literature (CUPANI, 1696; NICOSIA, 1735) due the propitious pedoclimatic conditions of the territory for their development and genetic diversification (IMPALLARI *et al.*, 2010). The most representative areas for the diffusion of plum trees are described by these authors as the Palermo and Trapani Province which today have an important rule to improve and to diffuse the cultivation of the specie by using its natural and favorable climatic conditions. The characterization and identification of plum varieties usually is performed on morphological data (SOTTILE *et al.*, 2010b), phenototic traits (HORVATH *et al.*, 2011) and more recently on some molecular markers (GREGOR *et al.*, 1994; ORTIZ *et al.*, 1997; GHARB *et al.*, 2014), but the study of the nutraceutical compounds (SOTTILE *et al.*, 2010b), represent today an important tool to improve the collected data and to describe better the varietal diversity (VASANTHA RUPASINGHE *et al.*, 2006; DÍAZ-MULA *et al.*, 2009). The replacement of local cultivars with the new one introduced by genetic improvement programs, due to a higher productivity, as well as resistance or tolerance to pests and diseases, or to abiotic stress, has caused a strong genetic erosion of the indigenous fruit tree species germplasm (IMPALLARI *et al.*, 2010). As a consequence of the globalization process, the homologation involved the fruit consumption and deeply contributed in the loss of the unique taste of these fruits.

Many studies have showed that the locally available cultivars, varieties and wild underutilized ecotypes; JABLONSKA-RYS *et al.*, 2009; PETRUCCELLI *et al.*, 2013;) are in many cases more rich in nutrients than similar commercially foods, confirming the old ecotypes as genetic resources of fruit nutritional traits.

Plums have the potential to contribute greatly to human nutrition because of their richness in fiber and antioxidants (STACEWICZ-SAPUNTZAKIS *et al.*, 2001; SOTTILE *et al.*, 2010b). In many cases the genetic resources with a higher relevance in terms of nutraceutical facts are related to old varieties and reported with a high risk of erosion. To limit the loss of biodiversity and to adopt collaborative conservation strategies it is necessary to improve the knowledge of the genetic resources and their horticultural aspects. The reduction in the genetic variability is increasing from the past century so as established by international approaches to biodiversity preservation protocols, each Country is responsible for its own genetic resources (DAS *et al.*, 2011). No detailed study concerning physical and nutritional properties of old Sicilian plum ecotypes have been performed up to now, so the aim of this study was to determine some qualitative and nutritional traits of plum fruits belonging to some local cultivars identified in the Sicily island.

2. MATERIALS AND METHODS

2.1 Plant material and collection of data

One hundred forty-three georeferenced plum cultivars and accessions were identified in the Sicilian island from existing bibliography and a territorial investigation but in this preliminary study only thirty-seven varieties are considered. In the Table 1 the total 37 local cultivars and accessions of plums used for the qualitative and nutraceutical analysis on fruits are reported. These included 34 plum trees from different locations in the Sicily region and 3 commercial varieties respectively of *Prunus domestica* L. (cv. Stanley) and *Prunus salicina* Lindl. (cv. Shiro and cv. Angeleno), as references. The investigated area is located both in the West and in the Eastern part of Sicily. For each local cultivars and accession 30 fruits randomly collected from the entire production were used.

The plants of the Sicilian germplasm were maintained on site in their natural habitat where they are routinely grown by local farmers. In all cases minimal cultural techniques have been applied, without any fruit thinning. All cultivars produce primarily on spurs and pruning is not commonly carried out. An integrated pest management approach is ordinary adopted by

Table 1 - List of cultivars and accessions plums collected from the local germplasm of Sicily and sampling locations.

	Authoctonous cultivars and accession name	Location*
1	69SUS005P	Messina (ME)
2	Lazzarino	Palermo (PA)
3	Sanacore Tardivo	Palermo (PA)
4	Zuccarino Rosa	Messina (ME)
5	Prunu Nucidda	Messina (ME)
6	Cuore di Bue	Catania (CT)
7	Pruno Regina	Catania (CT)
8	107SUS009E	Trapani (TP)
9	107SUS008B	Trapani (TP)
10	107SUS007B	Trapani (TP)
11	Rapparinu Russu	Trapani (TP)
12	Sanacore	Palermo (PA)
13	Prunu Niuru	Catania (CT)
14	Ariddo di Core	Palermo (PA)
15	Occhio di Bue	Catania (CT)
16	Ranco' Nero	Catania (CT)
17	Don Ciccino	Catania (CT)
18	Cugghiuni di Mulu	Catania (CT)
19	Papale	Catania (CT)
20	71SUS028B	Catania (CT)
21	President	Catania (CT)
22	Pruna di S. Antonio	Messina (ME)
23	Susine Nere	Messina (ME)
24	Nivuru Purmintia	Messina (ME)
25	Nivuru	Messina (ME)
26	Pruna i Sceccu	Messina (ME)
27	Santu Vitu	Messina (ME)
28	66SUS052P	Messina (ME)
29	Prunu Ciraseddu	Catania (CT)
30	Prugnolo rosso	Messina (ME)
31	Pruno Rosa	Palermo (PA)
32	Primintio	Palermo (PA)
33	Prunu Nivuru Codulusu	Trapani (TP)
34	Zuccarato Giallo	Messina (ME)
35	Shiro	Palermo (PA)
36	Stanley	Palermo (PA)
37	Angeleno	Palermo (PA)

*Data on geographical position (latitude and longitude) are available for all plums.

growers by following the regional governmental rules for plum.

The fruits were picked by hand at the ripe stage (Table 2). The fruits damaged were removed, were graded for color and size uniformity and they were immediately transported to the pomological laboratory for analysis.

2.2 Fruit quality traits

The weight was obtained measuring individually 30 fruits per each local cultivars and accessions. The data were expressed as the mean ± SE. Fruit weight (g) was performed using an electronic balance (SE622, WVR, USA) with an accuracy of 0.01 g.

The fresh fruit firmness (FFF) was measured using an Effegi hand-held penetrometer (Turoni, Italy) with a 5-mm-diameter plunger in accordance with standard industry practice. The skin of the fruits was partially removed before measuring. Two measurements (30 fruits) were made on opposite sides of the central zone of the fruits and then averaged to yield a mean value for the fruit. The measurements were reported in kg force (kgf) cm^{-2}.

After the firmness measurements for the total soluble solids (TSS) and the titratable acidity (TA) determination, the same fruits were completely hand-peeled and skin and pulp were cut in small pieces to obtain homogeneous samples. For TSS and TA determination 10 g of pulp samples were squeezed using a commercial blender and the extracted juice was later sieved and centrifuged at 8,000 × g for 20 min (Sigma 3-18 K, Osterode and Harz, Germany). An aliquot of this supernatant was used to determine TSS with a digital pocket refractometer Atago PAL-1 (Atago Co. Ltd., Japan) calibrated at 20°C to 0% with distilled water, and expressed as per-

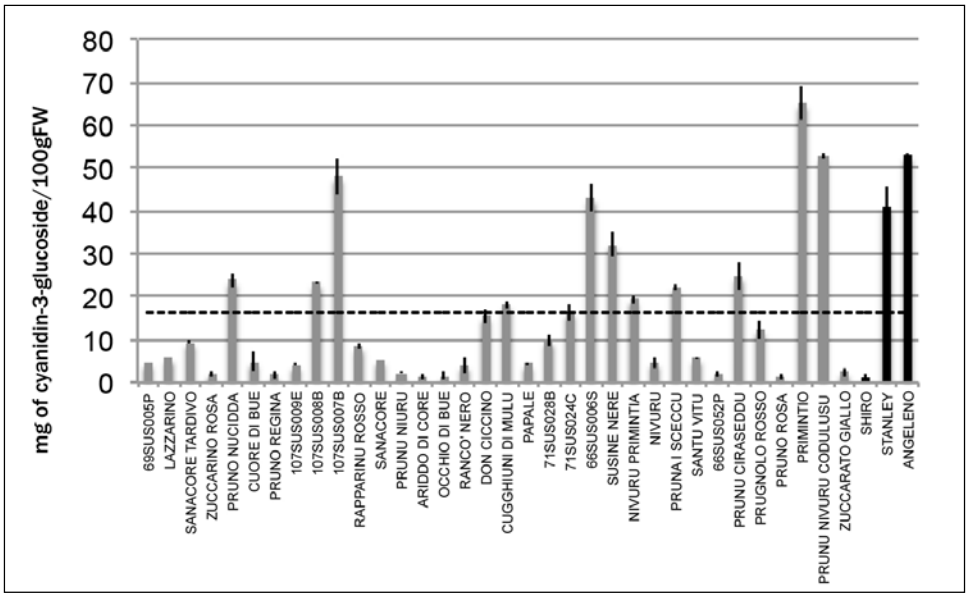

Fig. 1 - Total anthocyanins of local Sicilian plums

Table 2 - Harvesting dates for the authochtonous Sicilian plums.

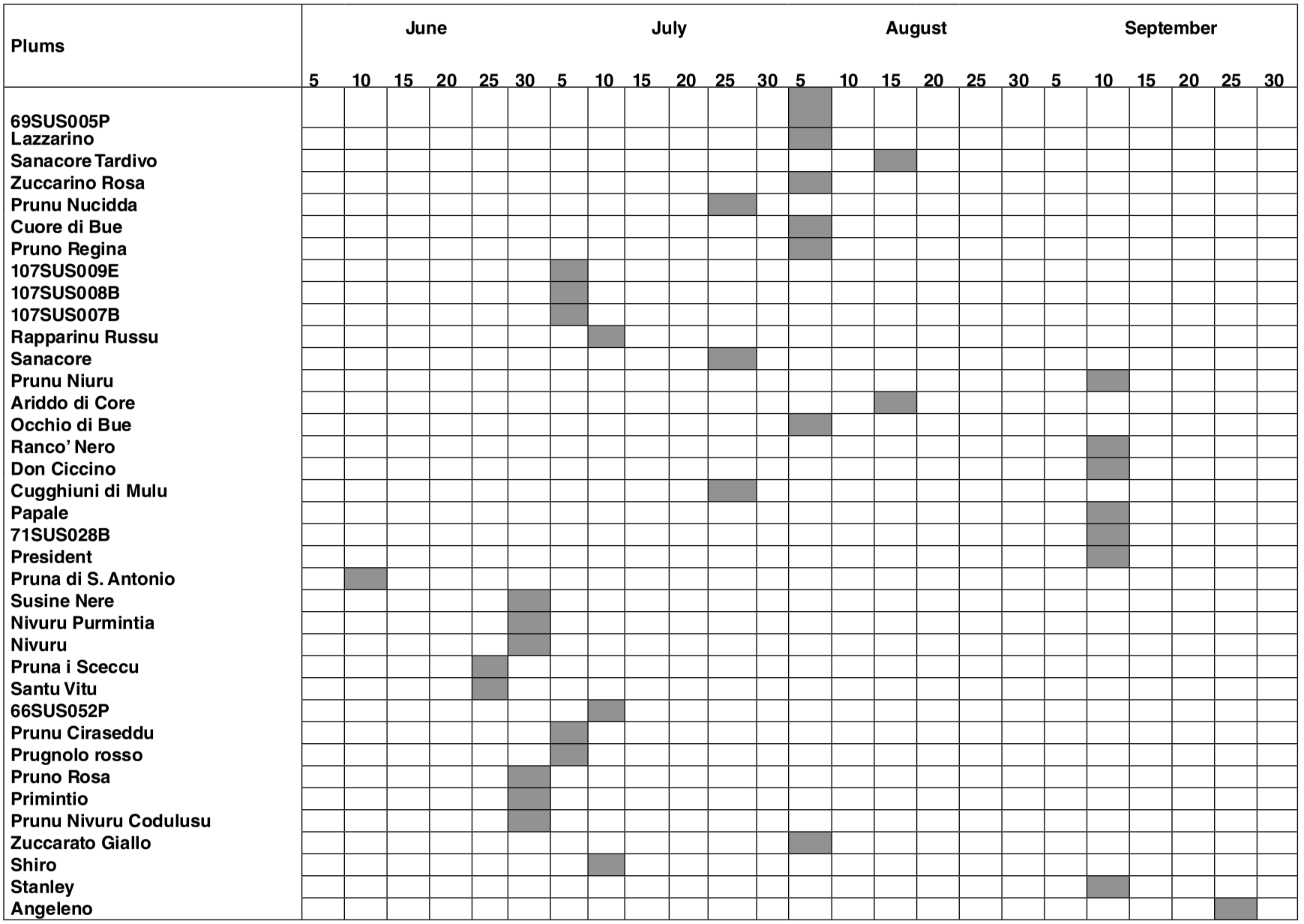

Table 3 - Fruit quality traits of 37 authochtonous Sicilian plums.

	Fruit weight (g)		FFF kgf cm^{-2}		TSS °Brix		TA g malic acid L^{-1}		MI
Plums									
69SUS005P	34.20±4.51	G-I	0.88±0.21	D-I	19.6±0.21	B-E	7.76±1.74	G-O	2.5
LAZZARINO	16.77±2.90	O-S	0.58±0.26	L-R	16.5±1.47	F-I	6.28±0.41	I-Q	2.6
SANACORE TARDIVO	28.98±7.13	L-M	0.80±0.22	G-N	15.3±0.06	H-N	7.72±0.26	G-P	2.0
ZUCCARINO ROSA	13.67±1.99	R-U	0.31±0.12	S-U	15.1±0.70	H-N	9.02±0.14	F-L	1.7
PRUNO NUCIDDA	12.06±4.32	S-U	1.14±0.36	D	21.2±0.28	B-C	9.00±0.13	F-L	2.4
CUORE DI BUE	83.79±9.02	A	0.76±0.21	H-O	13.3±0.21	L-P	12.21±1.22	C-E	1.1
PRUNO REGINA	33.62±3.58	H-I	0.76±0.22	H-O	18.4±0.21	C-G	7.95±0.09	G-N	2.3
107SUS009E	21.07±7.06	N-O	0.63±0.20	I-Q	11.5±0.21	O-Q	16.56±0.57	B	0.7
107SUS008B	14.26±2.44	Q-U	0.40±0.12	Q-T	12.8±0.00	M-P	11.97±1.02	C-E	1.1
107SUS007B	14.93±3.43	P-U	0.40±0.11	Q-T	15.5±0.42	G-N	10.56±0.15	E-H	1.5
RAPPARINU ROSSO	13.75±2.25	Q-U	0.58±0.21	L-R	15.7±1.91	G-N	4.27±0.75	M-Q	3.7
SANACORE	19.26±5.86	O-Q	0.93±0.30	D-H	16.0±1.06	F-L	7.98±0.43	G-M	2.0
PRUNU NIURU	26.36±4.44	L-N	0.69±0.15	G-P	21.6±1.49	B	4.93±0.25	M-Q	4.4
ARIDDO DI CORE	16.75±3.19	O-S	1.07±0.35	D-F	20.1±2.03	B-D	6.13±0.76	I-Q	3.3
OCCHIO DI BUE	41.76±8.28	E-F	0.55±0.10	N-S	15.6±0.28	G-N	4.86±0.08	M-Q	3.2
RANCO' NERO	44.13±5.39	E	0.60±0.10	L-R	16.6±0.07	E-I	7.29±0.09	H-P	2.3
DON CICCINO	37.22±5.92	F-H	0.47±0.06	P-S	19.1±0.28	B-F	10.12±0.21	E-I	1.9
CUGGHIUNI DI MULU	61.53±8.92	C	0.56±0.13	M-S	14.6±0.06	I-O	8.24±0.39	G-M	1.8
PAPALE	45.19±6.46	D-E	0.57±0.17	M-R	15.4±0.10	G-N	9.60±1.17	E-I	1.6
71SUS028B	49.99±8.77	D	0.55±0.07	N-S	16.7±0.15	E-I	7.67±0.24	G-P	2.2
71SUS024C	66.52±12.77	B-C	0.87±0.27	E-I	13.7±0.06	I-P	12.78±0.33	C-E	1.1
66SUS006S	16.16±4.37	O-T	0.65±0.17	I-Q	14.8±0.07	H-N	9.43±0.91	E-I	1.6
SUSINE NERE	9.48±1.69	U	0.52±0.05	O-S	14.2±0.07	I-O	11.83±0.99	C-E	1.2
NIVURU PRIMINTIA	40.70±7.23	E-F	0.82±0.17	F-M	14.5±0.96	I-O	10.84±0.26	E-G	1.3
NIVURU	15.21±2.91	P-T	0.69±0.26	H-P	14.9±0.07	H-N	9.65±1.26	E-I	1.5
PRUNA I SCECCU	39.79±7.30	E-G	0.83±0.31	F-L	11.0±0.28	P-Q	22.62±0.59	A	0.5
SANTU VITU	20.41±2.48	O-P	0.52±0.25	O-S	14.0±3.02	I-P	4.45±0.45	P-Q	3.1
66SUS052P	65.64±10.75	B-C	1.04±0.64	D-G	12.8±0.35	N-Q	14.56±0.47	B-C	0.9
PRUNU CIRASEDDU	14.21±2.05	Q-U	0.35±0.04	R-U	10.1±0.14	Q	3.60±0.18	Q	2.8
PRUGNOLO ROSSO	18.45±2.07	O-R	1.10±0.27	D-E	17.7±0.78	D-H	6.76±0.42	I-P	2.6
PRUNO ROSA	17.90±3.32	O-R	0.55±0.26	N-S	16.2±0.74	F-L	8.66±1.07	G-L	1.9
PRIMINTIO	21.09±5.33	N-O	0.46±0.17	P-S	15.7±1.44	G-N	10.94±2.15	D-G	1.4
PRUNU NIVURU CODULUSU	10.78±1.68	TU	0.12±0.04	U	16.7±0.07	E-I	14.23±0.40	B-D	1.2
ZUCCARATO GIALLO	13.57±2.89	R-U	0.16±0.05	T-U	25.0±0.35	A	5.86±0.27	L-Q	4.3
SHIRO	36.62±5.16	F-H	1.57±0.09	C	15.0±0.40	G-M	10.63±0.81	E-H	1.4
STANLEY	40.10±3.35	E-F	2.46±0.10	B	15.9±0.36	G-M	5.23±0.20	L-Q	3.0
ANGELENO	67.70±9.80	B	4.33±0.39	A	21.2±1.28	B-C	4.64±0.61	P-Q	4.6

Data are means ± SD. Values with the same letter at the column level are not statistically different with the Tukey's test (0.05).

centage (°Brix). TA was determined in 1 mL of the above supernatant diluted in 25 mL of distilled water by titration with 0.1 N NaOH up to pH 8.1, using an automatic titration device (484 Titrino plus, Metrohm, Switzerland) and results expressed as grams of malic acid L^{-1}. Three replicates per measurement were used and the data reported are the mean ± SE.

The TSS:TA ratio was calculated for individual fruit from the TSS and TA results and it expressed the maturity index (MI).

2.3 Total anthocyanins, phenolic content and antioxidant activity

To determine the total anthocyanin content, the total phenolic content and the total antioxidant capacity, fruit extract was obtained using 10 g of fruit added to 25 ml of extraction buffer (500 ml methanol, 23.8 ml deionized water and 1.4 ml hydrochloric acid 37%). After 1 h in the dark at room temperature, the samples were thoroughly homogenized for a few minutes with an ultra turrax (IKA, Staufen, Germany) and centrifuged for 15 min at 3,000 rpm. The clear supernatant fluid was collected and stored at -20 °C until analysis.

The total anthocyanin content was quantified according to the pH differential method of CHENG and BREEN (1991). Anthocyanins were estimated by their difference of absorbance at 510 and 700 nm in a buffer at pH 1.0 and pH 4.5, where $A_{tot} = (A_{515} - A_{700})$ pH 1.0 - $(A_{515} - A_{700})$ pH 4.5. The results are expressed as milligrams of cyanidin-3-glucoside (C3G) equivalent per 100 g of fresh weight (fw).

The total phenolics content was measured using a Folin-Ciocalteu reagent with gallic acid

as a standard at 765 nm following the method of SLINKARD and SINGLETON (1977). The results are expressed as milligrams of gallic acid equivalents (GAE) per 100 g of fresh weight (fw).

The antioxidant activity was determined using the FRAP (Ferric Reducing Antioxidant Power) assay, according to BENZIE and STRAIN (1996) method modified by PELLEGRINI *et al.* (2003). The antioxidant capacity of the dilute fruits extract was determined by its ability to reduce ferric iron to ferrous iron in a solution of 2,4,6-tris(2-pyridyl)-s-tri-azine (TPTZ) prepared in sodium acetate at pH 3.6. The reduction of iron in the TPTZ–ferric chloride solution (FRAP reagent) results in the formation of a blue-coloured product (ferrous tripyridyltriazine complex), the absorbance of which was read spectrophotometrically at 595 nm 4 min after the addition of appropriately diluted fruits extracts or antioxidant standards to the FRAP reagent. The results were expressed as mmol Fe^{2+} equivalents per kilogram of fresh fruits.

All of these analyses were performed using a UV-Vis spectrophotometer 1600-VWR. Three replicates per measurement were used.

2.4 Statistical analysis

The data obtained were treated with one-way analysis of variance (ANOVA) using SPSS for Windows version 20.0 and the means were separated using the Tuckey test ($P \leq 0.05$).

3. RESULTS

3.1. Quality parameters

In the Table 3 the qualitative traits studied for the different plums are reported.

As already reported, fruit size is an important quality parameter to evaluate the economic value for the consumption of fresh fruits (PETRUCCELLI *et al.*, 2013) and to determine the category of the ranges of marketability of many fruits. It is affected by a number of variables, including source–sink relationship (SNELGAR *et al.*, 1998), water availability (INTRIGLIOLO and CASTEL, 2006) as well as temperature and growing conditions in general. In our study a great variability on fruit weight has been reported among the different plums suggesting a different fruit surface/volume (EIFERT *et al.*, 2006), a fruit size distribution into different classes and a different correlation to physical-chemical parameters, such TSS and TA. Fruits with greater weight would have a greater proportion of edible flesh (FRANCO-MORA *et al.*, 2009). The fresh weight of all plums analysed revealed a mean value of 30.91 g ranging from 83.79 to 9.48 g; the maximum value was observed for the Cuore di Bue cultivar while the lowest was observed for the Susine Nere plums. Less than half of the plums (sixteen) showed higher values than the mean value. The Don Ciccino cultivar was the only one to show the weight (37.22 g) similar to the values of the commercial cv. Shiro (36.62 g) while Nivuru Primintia and Occhio di Bue with respectively 40.70 and 41.76 g showed similar weight to the commercial cv. Stanley (40.10 g). All plums showed statistically differences from the commercial cv. Angeleno which weight was of 67.70 g.

Flesh firmness is a key quality parameter, since it is directly related to fruit ripeness, and is often a good indicator of shelf-life potential (VALERO *et al.*, 2007). The highest pulp firmness was observed for all the three commercial cultivars, the cv. Angeleno with 4.33 (kgf) cm^{-2} was the higher value followed by the cv. Stanley with 2.46 (kgf) cm^{-2} and the cv. Shiro with 1.57 (kgf) cm^{-2}. All autochthonous plums (34) showed statistically differences from these last and only 11% of them showed FFF value major than 1(kgf) cm^{-2}. The mean value was of 0.82 (kgf) cm^{-2}, the lowest value was reached by the Prunu Nivuru Codulusu probably due to the low weight (10.78 g), while the highest was observed for the Pruno Nucidda (1.14) (kgf) cm^{-2}.

The physical-chemical parameters, such TSS and TA, strongly influence the consumer preference for stone fruit quality and the aromatic profile for the plums consumption (CRISOSTO *et al.*, 2007).

The Zuccarato giallo and the Prunu Niuru showed the highest TSS content (25.0 and 21.6 °Brix, respectively) while the lowest TSS value (10.1 °Brix) was scored by the Prunu Ciraseddu cultivar. Observing the Table 2 there is a tendency for late season plums to have higher TSS than early season plums.

Less than half of the plums (43%) showed the TSS content greater than the mean value (16.6°Brix). The 69SUS005P, Pruno Nucidda, Pruno Regina, Prunu Niuru, Ariddo di Core and Don Ciccino authoctonous plums showed similar values to the commercial cv. Angeleno (21.2 °Brix) and no statistically significant differences were observed between these fruits. The 66% of the plums showed value not statistically different from the commercial cv. Shiro and Stanley which scored 15.0 and 16.0 °Brix respectively. The TSS values measured in the local cultivars and accession are quite high when compared to the value find in the literature; in fact TSS between 14% and 16% (WESTWOOD, 1978) or 10 and 15% (DÍAZ-MULA *et al.*, 2009) could suggest edible fruit ready for consumption.

The TA mean value was of 9.10 g malic acid L^{-1} and the 58% of the local plums showed TA values inferior to the average. The lowest acidity was for the Prunu Ciraseddu (3.60 g malic acid L^{-1}) while the highest value was for the Pruna i Sceccu (22.62 g malic acid L^{-1}).

The variations observed in TSS and TA affected the values of the maturity index (MI). Great

differences were observed among values which ranged from a minimum of 0.5 in the case of the Pruna i Sceccu to a maximum of 4.6 for the commercial cv. Angeleno. The Prunu Niuru and the Zuccarato giallo with the MI of 4.4 and 4.3 showed TSS/TA ratio similar to the cv. Angeleno while Primintio (1.4) and Santu Vitu (3.0) were similar to the cv. Shiro and the cv. Stanley respectively.

3.2 Total anthocyanins, phenolic content, and antioxidant activity

The evaluation of the total anthocyanins content (Fig. 1), in general, has shown that this component does not assume, in percentage terms, a high importance in the context of polyphenolic compounds (Fig. 4). The Primintio accession had significantly more total anthocyanins content (65.22 mg of cyanidin-3-glucoside /100 g FW) than other fruits, although it is only 34.5% of the total polyphenols (Fig. 4). The lowest value was for Ariddo di Core (1.22 mg of cyanidin-3-glucoside/100 g FW) which content was similar to the commercial cv. Shiro and the fraction measured on the total content of the total polyphenols was of 0.3 %. Although the anthocyanin fraction mean value was of the 5.8% of the total polyphenol content it was observed that the absolute values detected in some local cultivars and accessions such as Primintio, 107SUS007B and Pruna di S. Antonio were higher than values previously reported for other varieties (TOMÁS-BARBERÁN *et al.*, 2001; CEVALLOS-CASALS *et al.*, 2006; USENIK *et al.*, 2009).

Polyphenols represent the largest group of water-soluble phytochemicals. They have been known to be chemotaxonomic markers for classification purposes in plum fruits (TREUTTER *et al.*, 2012) and their content could contribute strongly to the antioxidant activity in fresh fruits. Generally the polyphenol composition is related to the cultural practices and abiotic factors such as the outside air temperature and the rainfall rate (SALGADO *et al.*, 2008; MILETIC *et al.*, 2012). Strong variations in the total polyphenol content were observed among the plums of the study (Fig. 2) whose mean value was of 301.67 mg GA/100 g FW. The minimum value of 104.87 mg GA/100 g FW was observed for the Sanacore Tardivo while the maximum value of 663.99 mg GA/100 g FW was observed for the Zuccarato giallo. The total phenolic content in the commercial cultivars used as references was lower than that reported by CEVALLOS-CAVALS *et al.*, 2006 (298 to 563 mg/100 g FW) for *Prunus salicina* cv. Shiro (191.17 mg GA/100 g FW) and cv. Angeleno (242.01 mg GA/100 g FW) while according to LOS *et al.*, (2000) it was in the range for *Prunus domestica* (160-300 mg/100 g) (cv. Stanley 211.23 mg GA/100 g FW). The 58% of the local plums included a total polyphenol content major than cv. Angeleno. Previous studies showed as the averages of the total phenolic content of plums were significantly higher than the content in other fruits such as apples (LEE AND SMITH, 2000; PROTEGGENTE *et al.*, 2002) and our data confirmed that.

The total antioxidant capacity of fresh fruits (Fig. 3), expressed as mmol Fe^{2+} per kg of fresh fruits ranged from a maximum value of 47.46 measured for Pruno Regina and a minimum value of 4.14 for the Rapparinu Russu accessions. No statistically significantly differences were ob-

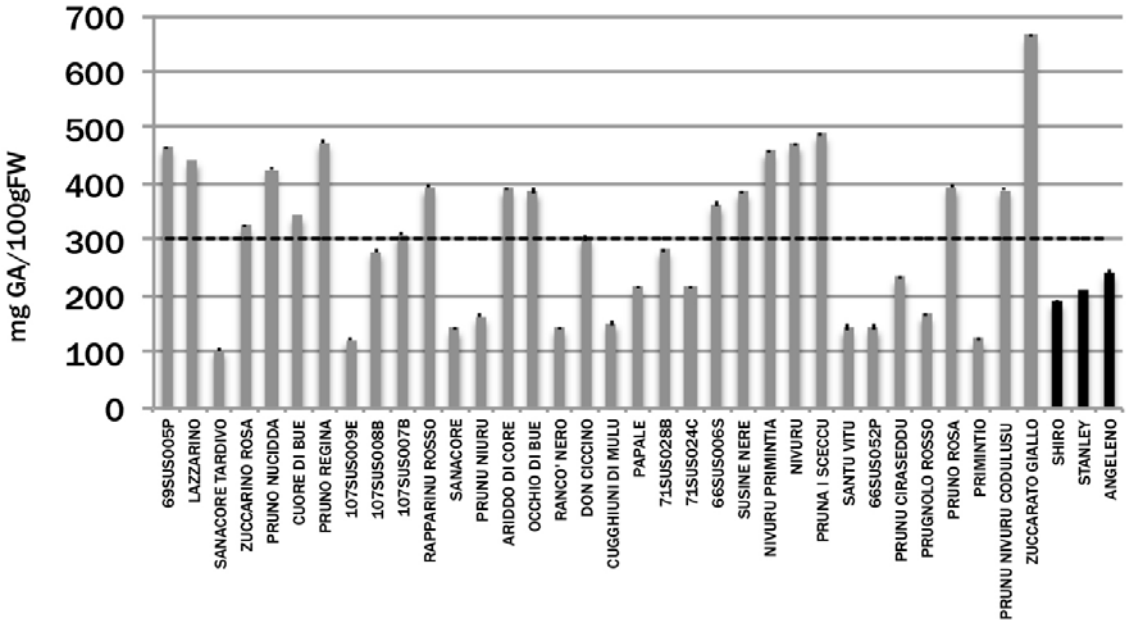

Fig. 2 - Total phenolics content of local Sicilian plums

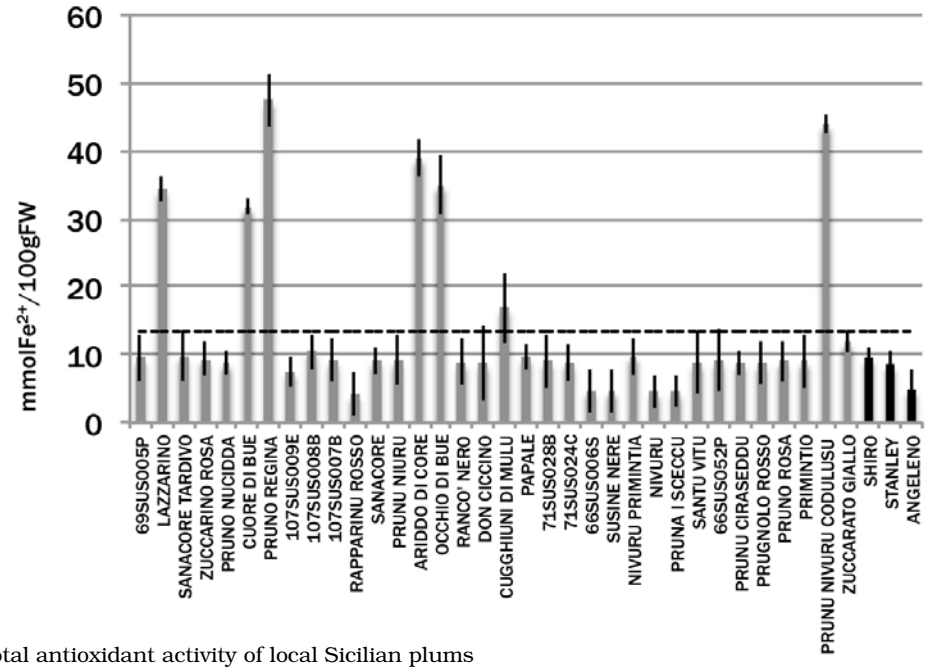

Fig. 3 - Total antioxidant activity of local Sicilian plums

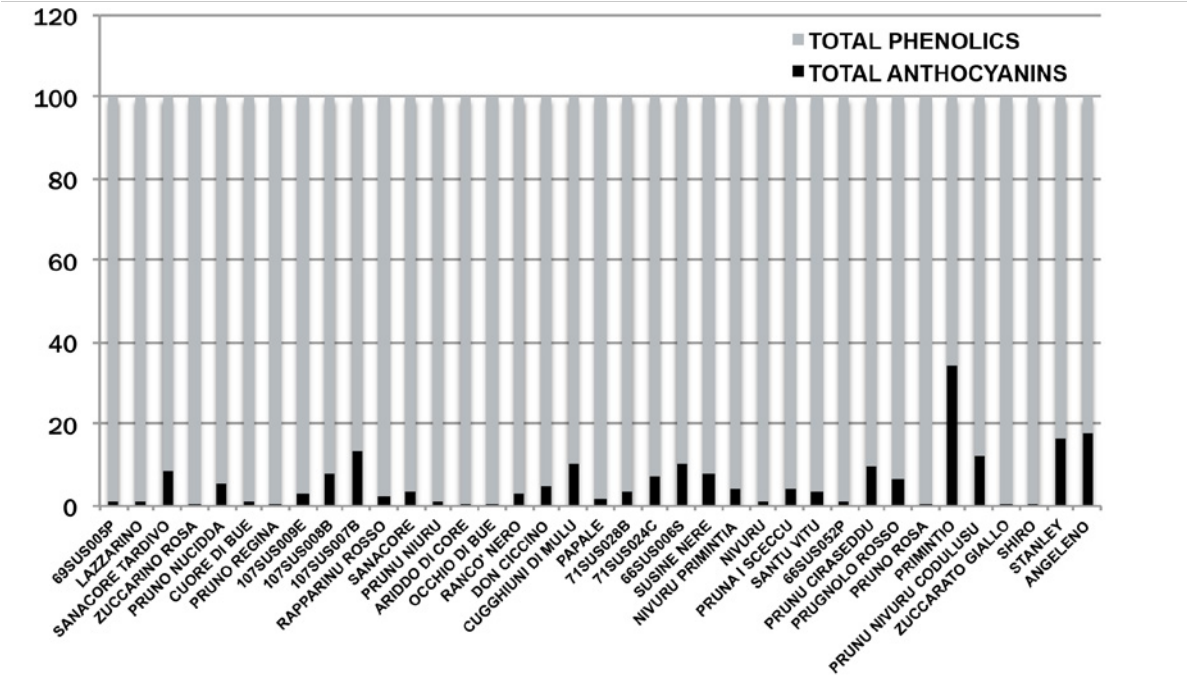

Fig. 4 - Total anthocyanins and phenolics distribution (%) in authochtonous Sicilian plums.

served among the cv. Shiro, Stanley and Angeleno which values ranged between 4.86 and 9.59 mmol Fe^{2+}/100 g FW and the 20% of the fruits showed values major than the average (13.45 mmol Fe^{2+}/100 g FW). As described by FRANKEL and MAYER (2000), the measure of fruit antioxidant capacity is influenced by the analytical method used and this could represent a limit for the evaluation. According to MILETIC *et al.*, (2012), fruits containing the highest total phenols do not necessarily exhibit the highest antioxidant capacity. In fact the highest value observed for the Pruno Regina accession is related to the relative high phenolic content but the same correlation wasn't observed for the Zuccarato giallo which corresponded the highest phenolic content (663.99 mg GA/100 g FW) but the low total antioxidant activity of 11.86 mmol Fe^{2+}/100 g FW.

Comparing the total antioxidant activity of the studied plums to the total FRAP of other fruits reported in previous work (GUO *et al.*, 2003) it is interesting to observe the high values find that could suggest interesting uptake of plums for the human diet.

4. CONCLUSIONS

This study provides important data for qualitative and nutraceutical properties of the fruits.

The results obtained by this preliminary study reveals that the authocthonous Sicilan plums contains important amounts of anthocyanins and phenols; often their concentrations is higher than found not only in the commercial cultivars but also in fruits that are reported in literature to have high content of nutraceutical compounds. Considerable and significantly different among the plums were observed and the environmental conditions and the activity of propagation and exchange of genetic material results of the local farmers could be both responsible for the differentiation of the germplasm collected in the investigated areas of the Sicilian territory.

The maintaining of local genetic materials is important for the biodiversity and the action of localization and characterization of old fruits cultivar and accessions is fundamental to improve the management of the European *Prunus* Database for Plum (EPDP) making them available for research and genetic improvement.

The knowledge of the qualitative traits of fruits represent a good opportunity not only for the health advantages but also for the general consumption; in fact the enhancement and the safeguarding of these fruits can be thought as an opportunity of new marketing channel but more studies need to be undertaken about the evolution of the qualitative and nutraceutical compounds during storage to answer the consumer's demands and expectations.

ACKNOWLEDGEMENTS

This work is part of the activity funded by the Sicilian Regional Government with the project "Risorse Genetiche Vegetali Sicilia' – Scientific Coordinator Francesco Sottile, University of Palermo.

REFERENCES

Benzie I.F.F. and Strain J.J. 1996. The ferric reducing ability of plasma (FRAP) as a measure of 'Antioxidant Power': the FRAP assay. Anal. Biochem. 239: 70.

Cevallos-Casals B.A., Byrne D., Okie W. R. and Cisneros-Zevallos L. 2006. Selecting new peach and plum genotypes rich in phenolic compounds and enhanced functional properties. Food Chem. 96: 273.

Cheng G.W. and Breen P.J. 1991. Activity of phenylalanine ammonia-lyase (PAL) and concentrations of anthocyanins and phenolics in developing strawberry fruit. J. Am. Soc. Hortic. Sci. 116: 865.

Crisosto G.M., Crisosto C.H., Echeverria G. and Puy J. 2007. Segregation of plum and pluot cultivars according to their organoleptic characteristics. Postharvest Biol. Technol. 44: 271.

Cupani F., 1696. Hortus Catholicus, 2nd Ed. Benzi, Napoli.

Das B., Ahmed N. and Singh P. 2011. Prunus diversity. Eearly and present development: A review. Intern. J. of Biodiversity and Conservation 3: 721.

Díaz-Mula H.M., Zapata P.J., Guillen F., Martinez-Romero D., Castillo S., Serrano M. and Valero D. 2009. Changes in hydrophilic and lipophilic antioxidant activity and related bio-active compounds during postharvest storage of yellow and purple plum cultivars. Postharvest Biol. Technol. 51: 354.

Eifert J. D., Sanglay G. C., Lee D.J., Sumner S. S. and Pierson M. D. 2006. Prediction of raw produce surface area from weight measurement. J. Food Eng. 74: 552.

Franco-Mora V.H., Franco-Mora O., Lopez-Sandoval J.A., de Jesus Perez-Lopez D. and Balbuena-Melgarejo A. 2009. Characterization of wild plum (*Ximenia americana* L. var. americana; Olacaceae) fruit growing at Tepexi de Rodriguez, Puebla, Mexico. Genet. Resour. Crop. Evol. 56: 719.

Frankel E. N. and Meyer A. S. 2000. The problems of using one-dimensional methods to evaluate multifunctional food and biological antioxidants. J. Sci. Food Agric. 80: 1925.

Gharb O., Wünsch A. and Rodrigo J. 2014. Characterization of accessions of 'Reine Claude Verte' plum using Prunus SRR and phenotypic traits. Sci. Hortic. 169: 57.

Gregor D., Hartman W. and Stosser R. 1994. Cultivar identification in *Prunus domestica* using random amplified polymorphic DNA markers. Acta Hortic. 359: 33.

Heywood V.H. 1999. Trends in agricultural biodiversity. In: "Perspectives on new Crops and new Uses". Janick J. (Ed.), ASHS Press, Alexandria, VA., p.151.

Guo C., Yang J., Wei J., Li Y., Xu J. and Jiang Y. 2003. Antioxidant activities of peel, pulp and seed fractions of common fruits as determined by FRAP assay. Nutrition Research. 23: 1719.

Horvath A., Balsemin E., Barbot J.C., Christmann H., Manzano G., Reynet P., Laigret F. and Mariette S., 2011. Phenotypic variability and genetic structure in plum (*Prunus domestica* L.), cherry plum (*P. cerasifera* Ehrh.) and sloe (*P. spinosa* L.). Sci. Hortic. 129: 283.

Impallari F.M., Monte M., Girgenti V., Del Signore M.B. and Sottile F. 2010. Biodiversity of Sicilian fruit trees: Studies on Plum. Acta Hortic. 874: 37.

Intrigliolo D.S. and Castel J.R. 2006. Performance of various water stress indicators for prediction of fruit size response to deficit irrigation in plum. Agri. Water Manage. 83: 173.

Los J., Wilska J.J. and Pawlak M. 2000. Polyphenolic compounds of plums (*Prunus domestica*). Pol. J. Food Nutr. Sci. 50: 35.

Jablonska-Rys E., Zalewska-Korona M. and Kalbarczyk J. 2009. Antioxidant capacity, ascorbic acid and phenolics content in wild edible fruits. J. of Fruit and Ornamental Plant Research 17: 115.

Lee C. Y. and Smith N. L. 2000. Apples: an important source of antioxidants in the American diet. New York Fruit Quarterly. 8:15.

Maxted N., Kell S., Toledo Á., Dulloo E., Heywood V., Hodgkin T., Hunter D., Guarino L., Jarvis A. and Ford-Lloyd B. 2010. A global approach to crop wild relative conservation: securing the gene pool for food and agriculture. Kew Bulletin 65: 561.

Miletic N., Popović B., Mitrović O. and Kandic M. 2012. Phenolic content and antioxidant capacity of fruits of plum cv. 'Stanley' (*Prunus domestica* L.) as influenced by maturity stage and on-tree ripening. AJCS 6: 681.

Nicosia F. 1735 Il podere fruttifero e dilettevole, ed. Felicella, Palermo.

Ortiz A., Renaud R., Calzada I. and Titter E. 1997. Analysis of plum cultivars with RAPD markers. J. Hortic. Sci. 72: 1.

Pellegrini N., Serafini M., Colombi B., Del Rio D., Salvatora S. and Bianchi M. 2003. Total antioxidant capacity of plant foods, beverages and oils consumed in Italy by three different in vitro assays. J. Nutr. 133: 2812.

Petruccelli R., Ganino T., Ciaccheri L., Maselli F. and Mariotti P. 2013. Phenotypic diversity of traditional cherry accessions present in the Tuscan region. Sci. Hortic. 150: 334.

Proteggente A. R., Pannala A. S., Paganga G., Van Buren L., Wagner E., Wiseman S., van de Put F., Dacombe C. and Rice-Evans C. A. 2002. The antioxidant activity of regularly consumed fruit and vegetables reflects their phe-

nolic and vitamin C composition. Free Radical Research 36: 217.

Salgado P.R., Favarin J.L., Leandro R.A. and de Lima Filho O.F. 2008. Total phenol concentrations in coffee tree leaves during fruit development. Sci Agric. 65: 354.

Scoones I., Melnyk M. and Pretty J.N. 1992. The Hidden Harvest: Wild Foods and Agricultural Systems, a Literature Review and Annotated Bibliography. International Institute for Environment and Development, London. p.260.

Slinkard K. and Singleton V.L. 1977. Total phenol analysis: Automation and comparison with manual methods. Am. J. Enol.Vitic. 28: 49.

Snelgar W.P., Hopkirk G., Seelye R.J., Martin P.J., Manson P.J. 1998. Relationship between canopy density and fruit quality of kiwifruit. N.Z.J. Crop Hortic. Sci. 26: 223.

Sottile F., E. Bellini, V. Nencetti, Peano C., Palara U., Pirazzini P., B. Mezzetti, F. Capocasa, Mennone C., Catalano L. 2010a. Plum production in Italy, state of the art and perspectives. Acta Hortic. 874: 25.

Sottile F., Impallari M., Peano C., Giuggioli N., 2010b. Antioxidant compounds and qualitative traits in European (*Prunus domestica* L.) and Japanese (*P. triflora*) plum fruits as affected by cold storage. Acta Hortic. 877: 1145.

Stacewicz-Sapuntzakis M., Bowen P.E., Hussain E.A., Damayanti-Wood B.I. and Farnsworth N.R. 2001. Chemical composition and potential health effects of prunes: a functional food? Crit. Rev. Food Sci. Nutr.41: 251.

Tomás-Barberán F. A., Gil M. I., Cremin P., Waterhouse A. L., Hess-Pierce B. and Kader A. A. 2001. HPLC-DAD-ESIMS analysis of phenolic compounds in nectarines, peaches and plums. J. Agric. Food Chem. 49: 4748.

Treutter D., Wang D., Farag M. A., Argueta Baires G. D., Rühmann S. and Neumüller M. 2012. Diversity of phenolic profiles in the fruit skin of *Prunus domestica* plums and related species. J. Agric. Food Chem. 60: 12011.

Usenik V., Štampar F. and Veberic R. 2009. Anthocyanins and fruit colour in plums (*Prunus domestica* L.) during ripening. Food Chem. 114: 529.

Valero C., Crisosto C.H. and Slaughter D. 2007. Relationship between nondestructive firmness measurements and commercially important ripening fruit stages for peaches, nectarines and plums. Postharvest Biol. Technol. 44: 248.

Vasantha Rupasinghe H.P., Jayasankar S. and Lay W. 2006. Variation in total phenolics and antioxidant capacity among European plum genotypes. Sci. Hortic. 108: 243.

Westwood M.N. 1978. Temperate-Zone-Pomology (Postharvest, Storage and Nutritional Value), New York: W.N. Freeman and Company, p. 428.

Paper Received June 26, 2014 Accepted September 26, 2014