Review paper
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PRELIMINARY POMOLOGICAL AND BIOCHEMICAL CHARACTERIZATION OF FIG (*Ficus Carica* L) GERMPLASM COLLECTED IN HERZEGOVINA

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Abstract

Inventory and sampling of 24 fig accessions were conducted in the region of Trebinje and Mostar during 2013. The trees were found in the gardens, boundaries as well as in derelict areas. The following characters of riped fruits were determined: the mass and fruit size, soluble solids content, total phenols content and antioxidant activity. The average fruit mass ranged from smallest fruit accession Zimica (29.08 g) to the biggest Mostarska (72.85 g). The biggest average fruit length was recorded in the variety Butunka (70.55 mm) and the smallest in Termenjača (37.02 mm). The highest average fruit width measured at variety Mostarka (55.83 mm) and the lowest at Zimica (37,01 mm). Soluble solids content ranged from 11.27% Brix in the acc. Vodenjača to 26.4% Brix in the acc. Zimica. The highest total phenol compounds were found in acc. Crnica (536.44 mg GAE / 100 g fresh fruit), which in addition to the acc. Zlatulja (39.01 mg of fresh fruits/mL) showed the best antioxidant activity (EC50: 40.45 mg of fresh fruits/mL).
Initial characterization of the tested fig accessions showed significant genotypic diversity. It is necessary to perform further detailed research on characterization and evaluation to assist in the preservation of the existing diversity to prevent the disappearance of the existing gene pool of fig.

Key words: *fruit mass, soluble solids, total phenols, antioxidant activities.*

Introduction

Fig (*Ficus carica* L.) is a deciduous tree belonging to the Moraceae family, and as one of the oldest cultivated fruit trees is an important crop, for both dry and fresh consumption, as well as for processing. Fig fruit is commonly consumed as fresh or dried. Fresh fig fruits are rich in amino acids, proteins, carbohydrates, fibers, minerals (Mawa et al., 2013). Fig fruit has importance in food industry for processing into preserved fruits, jam, juice, etc. Figs are an important constituent of the Mediterranean diet, one of the healthiest which is associated with longevity (Çalişkan and Polat, 2011). Fig also contains flavone, rutin and quercetin as medical products used for cardiovacsular disease (Gozlekci, 2011). Antioxidant compounds, such as phenolics, organic acids, vitamin E, and carotenoids scavenge free radicals, thus inhibiting the oxidative mechanisms that may lead to degenerative illnesses (Gaaliche et al., 2012a; Puoci et al., 2011; Gozlekci, 2011). Phenolic compounds are common plant secondary metabolites which not only have physiological functions in plants but also positive effects for human health, because they can act as antioxidants (Joseph and Raj, 2011; Pande, 2009). Research of biochemical properties of fig fruits from the Mediterranean region show that figs of all colors have antioxidant capacity, but it was the highest in dark skinned fig fruits. It was also found that the antioxidant capacity is highly significantly correlated with the content of polyphenols and anthocyanins (Çalişkan and Polat, 2011). Crisosto et al. (2010) investigated the antioxidant capacity of figs in conditions of California and found that most components that

have antioxidant activity, such as polyphenols, anthocyanins and flavonoids, are found in fruit skin. Fig is very interesting species because of its positive biochemical properties and significant diversity of germplasm (Çalişkan and Polat, 2011; Gozlekci, 2011; Gaaliche et al. 2012a, 2012b). Growing figs in Herzegovina region is a tradition, but today generally has extensive character, as individual trees are grown in the gardens around the houses. Smaller orchards were planted recently, but still it does not have the character of significant production. More research on growing importance and pomological properties of figs were done in the area of Herzegovina, Montenegro and Dalmatia (Tabain, 1978; Kulina et al., 2002; Čizmović, et al., 2005; Bucić-Kojić et al. 2011; Vego et al. 2008). These studies point to significant richness of germpazme that needs to be characterized and saved adequately for breeding programs and future generations. The fig tree also has special characteristics of the buds and fruit setting (Djuric and Micic, 1992; Vego et al. 2008) that should be kept in mind when selecting genotypes with positive characteristics for reproduction and further growing.
The aim of this study is to analyze the most important biochemical properties of fruits and pomological characteristics of 24 fig accessions collected from the wider Herzegovina region of Mostar and Trebinje.

Material and methods

Through coolaboration of two universities (Genetic resources Institute of the University of Banja Luka - GRIUBL and Faculty of Agriculture and Food technology, University of Mostar - FAFTMO) inventory and sampling of 24 fig accessions were conducted in the region of municipalities of Trebinje and Mostar during 2013. The trees for sampling were found in the gardens, boundaries as well as in derelict areas. The accession names were taken from the owner of these trees or guide who pointed to them.
The following characters of riped fruits were determined: the mass and fruit size, soluble solids content, total phenolics content and antioxidant activity.
Determination of fruit mass and size as well as the soluble solids content in the cell juice of fruit flesh was carried out on 15 fig accessions, while the determination of total phenolics and antioxidant activity was done on all 24 accessions. Length and width of the fruits were determined by a digital caliper, fruit mass on a digital scale type KERN EMB 600-2 and soluble solids content with digital refractometer type Atago. Total phenols content was determined by Folin-Ciocalteau (FC) spectrophotometric method based on the oxidation of the phenolic group by the FC reagent. Results are expressed as mg of gallic acid equivalents (GAE) per 100 grams of fresh weight (FW) (mg GAE/100 g FW). The antioxidant activity of the sample was determined by the method of quenching the free stable 2,2-diphenyl-1-picryl-hidrazil (DPPH) radicals. The EC50 value is defined as the concentration of sample required for 50% scavenging of DPPH radicals and is a parameter widely used to measure the free radical scavenging activity. The inhibition of free radicals by anti-oxidants was monitored spectrophotometrically.

Chemicals and Reagents

The used DPPH (2,2-Diphenyl-1-picrylhydrazil) is produced by Sigma-Aldrich (Germany). Methanol optigrade for HPLC was from Promochem (Wesel, Germany). Folin–Ciocalteu phenol reagent was product of Switzerland (Sigma-Aldrich). Gallic acid 98% was from Acros Organic (CN, Belgium). Sodium carbonate was from Lach-ner (Czech Republic).

Results and discussion

The determined pomological characteristics of fig accessions collected by GRIUBL are shown in Table 1. The average fruit mass ranged from smallest fruit accession Zimica (29.08 g) to the biggest Mostarska (72.85 g). The biggest average fruit length was recorded in the variety Butunka (70.55 mm) and the smallest in Termenjača (37.02 mm). The biggest average fruit width was measured in varieties Mostarska (55.83 mm) and Dužica (50.25 mm) and the

smallest at Zimica (37.08 mm; 35.39 mm)). The soluble solids content ranged from 11.27 % Brix in the accession Dužica to 26.04 % Brix in the accession Zimica.

Table 1. - Pomological characteristics of fig accessions collected by GRIUBL

Accession name (Location)		Mass (g)	Lenght (*mm*)	Width 1 (*mm*)	Width 2 (*mm*)	Solids (% Brix)
Bijela tenica (Mostar)	Xsr	40.71	45.78	46.40	45.96	16.34
	±*Sx*	*1.85*	*0.84*	*0.72*	*0.74*	*0.63*
Butunka (Mostar)	Xsr	60.71	70.55	44.34	42.90	21.48
	±*Sx*	*2.61*	*1.54*	*0.96*	*0.74*	*1.16*
Dužica (Trebinje)	Xsr	71.15	60.18	50.43	50.25	11.27
	±*Sx*	*2.47*	*1.54*	*1.21*	*0.89*	*0.89*
Zimica (Trebinje)	Xsr	29.08	40.24	37.08	35.39	26.04
	±*Sx*	*1.34*	*0.85*	*0.86*	*0.68*	*1.90*
Klapavica (Trebinje)	Xsr	69.81	52.49	52.19	49.95	11.6
	±*Sx*	*3.02*	*1.29*	*1.59*	*1.45*	*0.95*
Mostarska (Mostar)	Xsr	72.85	56.54	55.83	49.80	16.52
	±*Sx*	*3.75*	*2.36*	*1.07*	*0.94*	*1.17*
Petrovača bijela (Mostar)	Xsr	46.0	38.10	47.73	44.26	17.43
	±*Sx*	*1.38*	*0.55*	*0.65*	*0.59*	*0.95*
Petrovača bijela (Trebinje)	Xsr	43.79	44.49	46.11	44.54	19.58
	±*Sx*	*3.1*	*1.21*	*1.09*	*1.01*	*0.76*
Sušilica (Trebinje)	Xsr	33.79	43.39	39.07	37.75	22.28
	±*Sx*	*1.17*	*1.15*	*0.67*	*0.58*	*1.84*
Tenica (Mostar)	Xsr	34.33	47.58	39.27	37.85	18.49
	±*Sx*	*1.33*	*0.78*	*0.55*	*0.46*	*0.90*
Termenjača (Mostar)	Xsr	34,64	37.02	39.13	37.61	23.42
	±*Sx*	*1.43*	*0.76*	*0.65*	*0.78*	*1.39*
Crnica (Mostar)	Xsr	41.0	39.71	44.49	43.01	18.56
	±*Sx*	*1.24*	*0.54*	*0.49*	*0.58*	*0.83*
Crnica 1 (Trebinje)	Xsr	45.88	42.59	45.48	44.36	17.33
	±*Sx*	*1.46*	*2.08*	*0.86*	*0.62*	*1.63*
Džokovica (Trebinje)	Xsr	36.83	47.86	41.87	38.66	18.08
	±*Sx*	*1.93*	*1.19*	*1.39*	*1.09*	*1.05*
Šaragulja Trebinje	Xsr	36.13	47.27	40.84	37.74	20.97
	±*Sx*	*1.36*	*1.16*	*1.49*	*1.26*	*1.16*
Šipanka (Trebinje)	Xsr	44.54	50.11	45.64	45.27	13.21
	±*Sx*	*2.19*	*0.97*	*0.99*	*0.91*	*1.03*

GRIUBL - Genetic Resources Institute of the University of Banja Luka

The determined biochemical characteristics of fig accessions collected by GRIUBL are shown in Table 2. The highest total phenolic compounds were present in accession Zimica (533.14 mg GAE/100 g fresh fruit), which in addition to the accessions Tenica and Termenjača has the best antioxidant activity (EC50: 46.04; 41.91; 43.66 mg of fresh fruits/mL, respectively).

Table 2. - Total phenolic compounds and antioxidant activity of fig accessions collected by GRIUBL

Accession	Total phenolic compounds (mg GAE/100 g fresh fruits)		EC50 (Antioxidative activities (mg fresh fruits/mL)
	Xsr	±*Sx*	
Bijela tenica Mostar	277.70	±30.39	73.69
Butunka Mostar	285.27	±27.97	62.65
Dužica Trebinje	271.85	±14.08	119.38
Zimica Trebinje	533.14	±40.55	46.04
Klapavica Trebinje	93.13	±6.23	152.57
Mostarska Mostar	268.21	±22.74	70.71
Petrovača bijela Mostar	242.23	±30.74	80.86
Petrovača bijela Trebinje	301.43	±33.13	90.00
Tenica Mostar	352.14	±36.58	41.91
Termenjača Mostar	413.39	±41.96	43.66
Crnica Mostar	230.72	±12.04	63.26
Crnica 1 Trebinje	207.89	±21.51	95.82
Džokovica Trebinje	195.51	±9.01	201.60
Šipanka Trebinje	443.01	±35.81	65.64
Šaragulja Trebinje	225.71	±13.05	87.56

The determined biochemical characteristics of fig accessions collected by FAFTMO are shown in Table 3. The highest total phenolic compounds were present in accession Crnica (536.4 mg GAE/100 g fresh fruit), which in addition to the accessions Zlatulja and Talijanka has the best antioxidant activity (EC50: 40.45; 39.01; 46.30 mg of fresh fruits/mL respectively).

Table 3. - Total phenolic compounds and antioxidant activity of fig accessions collected by FAFTMO

Accession	Total phenolic compounds (mg GAE/100 g fresh fruits)		EC50 (Antioxidative activities (mg fresh fruits/mL)
	Xsr	±*Sx*	
Crnica (tunel, Ulog Varda)	536.4	±46.42	40.45
Zlatulja-(Zubac)	410.84	± 28.41	39.01
Talijanka (Ilići Vrelo)	439.76	± 37.26	46.30
Bjelica (Ilići Vrelo)	194.37	± 23.64	68.99
Morka (Sovići)	282.95	± 27.67	112.49
Termenjača (Sovići)	235.32	± 14.92	55.17
Vodenjača (Balinovac)	312.32	± 24.68	72.40
Crnica (Sovići)	405.65	± 38.34	58.26

FAFTMO - Faculty of Agriculture and Food technology, University of Mostar

Fig genotypes collected in the Herzegovina region, when compared to other research, show exceptionally good pomological and biochemical characteristics. Antioxidative activity of most genotypes is better than dark fig varieties from east mediterranean part of Turkey for which Çalişkan and Polat (2011) state to have average antioxidant activity of 118.9 GAE/100 g FW. Dry matter content in picked genotypes is very good and within limits indicated in literature. Gozleck (2011) states that average dry matter content in fig fruits collected from western part of Turkey ranges from 13 to 29 % Brix.

Conclusions

Initial characterization of the tested fig accessions from Herzegovina region showed significant genotypic diversity. It is necessary to perform further detailed research on characterization and evaluation to help with the preservation of the existing diversity and to prevent disappearance of the existing fig gene pool. Bearing in mind the richness of fig germplasm in Herzegovina, and favorable agro-ecological conditions, the fig tree may have a significant role in the revitalization of rural areas of Herzegovina. Prior to the introduction of new varieties, it is necessary to do the inventory of existing fig germplasm, as well as its characterization and evaluation. It is also necessary to determine the limiting factors in the cultivation and try to find technical measures which shall reduce or eliminate these obstacles. Only then, it will be possible to make recommendations for growing of existing genotypes or propose the introduction of new ones. Regardless of all else, it is important to evaluate existing gene pool and keep it from losing for the future.

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