Croatian Review of Economic, Business and Social Statistics (CREBSS)
UDK: 33;519,2; DOI: 10.1515/crebss; ISSN 1849-8531 (Print); ISSN 2459-5616 (Online)
Vol. 3, No. 2, 2017, pp. 1-9

DE GRUYTER
OPEN

Morphological and genetic characterization of vine grape cultivars of Herzegovina

Zrinka Knezović
Faculty of Agriculture and Food Technology, University of Mostar, Bosnia and Herzegovina
zrinka.knezovic@sve-mo.ba

Ana Mandić
Faculty of Agriculture and Food Technology, University of Mostar, Bosnia and Herzegovina
ana.sabljo@sve-mo.ba

Nikica Perić
Faculty of Agriculture and Food Technology, University of Mostar, Bosnia and Herzegovina
nikica.peric@gmail.com

Jure Beljo
Faculty of Agriculture and Food Technology, University of Mostar, Bosnia and Herzegovina
jure.beljo@sve-mo.ba

Maja Žulj Mihaljević
Faculty of Agriculture, University of Zagreb, Croatia
mzulj@agr.hr

Abstract
In Herzegovina, different genotypes of grapevine are called the same, and the origin of these cultivars is mainly unexplored. Two groups of autochthonous cultivars are grown. The first group consists of more widespread Žilavka and Blatina, and accompanying Bena, Krkošija, Dobrogostina and Trnjak, and the second one of less common cultivars that should be preserved from extinction. Considering the small number of studies on the comparison of different methods used for analyses of similarities and relatedness of grapevine germplasm, it was interesting to assess the use of morphological characterization with molecular markers in identification of cultivars in Herzegovina. The results indicate that a similarity coefficient had a broad value range for both methods. Both methods successfully in different ways differentiated all analysed varieties, and for complete and comprehensive identification of grapevine varieties should be use.

Keywords: ampelography, cultivar, similarity coefficient, SSR markers.
JEL classification: Q19.
DOI: 10.1515/crebss-2017-0005
Received: May 05, 2017
Accepted: June 25, 2017

Introduction

Grapevine (lat. *Vitis vinifera)* is one of the oldest cultivated plants (Olmo, 1995). According to material evidence, its cultivation is dated to around 5,400 BC in the areas of northern Iran (McGovern, 2003). According to the majority of scientists, it originates from the wild Eurasian grape *Vitis sylvestris*, and is grown primarily in the moderate climate zone. In Herzegovina grapevine is one of the most significant agricultural crop and is grown on an area of about 3,500 ha (Suhadolnik, 2015). In the area of Herzegovina, it was grown in the time of Daorsi, members of the ancient Illyrians. Although it has been cultivated since ancient times, there is no documented description of the most important cultivars of Herzegovina, especially those less common (Bulić, 1949, Mirošević, Turković, 2003). Different genotypes are called the same, and the origin of these cultivars is mainly unexplored. The tendency of growing autochthonous cultivars in ambient conditions ensures expression of typical characteristics. Two groups of autochthonous cultivars are grown. The first group consists of more commercial Žilavka and Blatina (Tomić, 2009), and accompanying Bena, Krkošija, Dobrogostina and Trnjak, and the second one of less common cultivars that should be preserved from extinction. Cultivar identification is important, but it comes with certain problems. Identification is based on the determination of morphological characteristics and/or determination of the genetic profile of a specific cultivar. The existence of synonyms or different nomenclature of the same cultivar, as well as homonyms, or the occurrence of the same nomenclature of different varieties complicates identification. That is why research must be detailed and includes ampelographic and genetic identification (Dettweiler et al., 2000). The research objectives of this paper were ampelographically to describe the most important Herzegovinian cultivars, to do genotyping with SSR markers, and to compare these two methods for testing similarities of grapevine germplasm.

For identification of grapevine cultivars, the International Organization of Vine and Wine (OIV) has developed the ampelographic scheme based on OIV descriptors (OIV, 2009). Leaf morphology observation is one of the most important methods in cultivar determination. Leaf is described in stages from the beginning of development of leaf until the end of vegetation. Those descriptions may be reliable and time saving but also influenced by environmental factors and subjective approach of the ampelographer. Molecular markers, like microsatellite (SSR) markers (Maletić, Karoglan Kontić, Pejić, 2008), are increasingly applied to increase the reliability of varietal identification. Leko et al. (2012) investigated interrelations of some autochthonous Herzegovinian cultivars based on the analysis of genetic markers, and showed clustering in according to the common origin.

The aim of this research was to characterise autochthonous Herzegovinian cultivars using SSR molecular markers and classical ampelographic descriptors, for the quick and reliable identification. A further aim was to compare phenotypic matrix with genetic matrix using Mantel test.

Materials and methods

The following ten Herzegovinian cultivars were studied: Žilavka, Bena, Krkošija, Dobrogostina, Pošip bijeli, Zložder, Blatina, Trnjak, Pošip crni and Šljiva crna.

Individual characteristics were observed and described using ampelographic methods, while ampelometric methods were used for measuring the characteristics of leaf (phyllometry) and bunch (uvometry) using OIV descriptors. Every characteristic is marked by an OIV code, and their reading by a number. Primary descriptors consisted of morphological descriptors, used for identification of

genotypes, and these are divided into ampelographic and ampelometric ones. Table 1 lists 16 primary OIV descriptors that were used to describe shoot tip, leaf, bunch and berry. Time and number of observation, and the evaluated part of vine, were also recorded.

Table 1 List of used OIV descriptors

OIV code	Variable
OIV 003	Young shoot: intensity of anthocyanin coloration on hairs of the shoot tip
OIV 004	Young shoot: density of hairs on the shoot tip
OIV 051	Young leaf: color of upper side of blade
OIV 053	Young leaf: density of hairs between main veins on the lower side of blade
OIV 067	Mature leaf: shape of blade
OIV 068	Mature leaf: number of lobes
OIV 079	Mature leaf: Degree of opening and overlapping
OIV 080	Mature leaf: shape of base of petiole sinus
OIV 094	Depth of lateral sinuses
OIV 202	Bunch: length of bunch
OIV 204	Bunch: density of bunch
OIV 208	Bunch: shape of bunch
OIV 220	Berry: length of berry
OIV 221	Berry: width of berry
OIV 223	Berry: shape of berry
OIV 225	Berry: berry skin color

Source: OIV, 2009.

Samples for the description of shoot and leaf were taken in the period from berry formation to ripening, and nine parameters were described (003; 004; 051; 053; 067; 068; 079; 080; 094). Samples for the description of bunches and berries were taken during harvest, specifically 10 biggest bunches from 10 shoots, and for berries 30 undeformed berries of normal size taken from the central part of 20 bunches. Three parameters (202; 204; 208) were described for bunch, and four parameters (220; 221; 223; 225) for berry.

Phenotipic distance matrix based on 16 OIV descriptors was computed by NTSYSpc version 2.10s software (Rohlf, 2000) using DICE coefficient of similarity (Nei, 1978, Li et al., 2009). The distance matrix was then processed using the UPGMA algorithm, which was then visualized as the dendrogram by the same software.

Microsatellite (SSR) molecular markers were used for reliable identification of chosen varieties. They are based on DNA polymorphism in microsatellite regions, and are inherited without the environmental influence. Young grapevine leaves were lyophilized and total genomic DNA was extracted using PeqGOLDPlant DNA Mini Kita (Peqlab). Nine microsatellite loci were analyzed: VVS2 (Thomas, Scott, 1993), VVMD5, VVMD7, VVMD25, VVMD27, VVMD28, VVMD32 (Bowers et al., 1996, 1999), as well as VrZAG62 and VrZAG79 (Sefc et al., 1999, 2000) as proposed by the GrapeGen06 consortium and by the European Vitis Database. Fluorescently labelled primers were used. PCR amplifications were carried out in a Veriti thermal cycler (Applied Biosystems) as previously described (Žulj Mihaljević et al., 2013). Amplified products were separated on an ABI3130 Genetic Analyzer (Applied Biosystems) with a GeneScan-500 LIZ size standard (Thermo Fisher Scientific). The fragments (alleles) of the studied cultivars were sized with GeneMapper 4.0 software (Applied Biosystems) and with the reference set of cultivars proposed by This et al. (2004), which were coded according to the GrapeGen06 method (European Commission, 2017). The cluster analysis was performed in order to test grouping of accessions across their origin (Blei, Lafferty, 2009). Genetic distance matrix was computed by NTSYSpc

version 2.10s software (Rohlf, 2000) based on DICE coefficient of similarity (Nei,1978, Li et al., 2009). The distance matrix was then processed using the UPGMA algorithm which was then visualized as dendrogram by the same software.

Phenotipic matrix was then correlated with genetic matrix using Mantel test by XLSTAT.

Results and discussion

Ampelographic description based on 16 OIV descriptors is given in Table 2.

Table 2 Ampelographic description of ten grapevine cultivars from Herzegovina on 16 OIV descriptors

Variety/ OIV code	3	4	51	53	67	68	79	80	94	202	204	208	220	221	223	225
Žilavka	1	5	2	5	4	3	7	2	5	5	7	3	5	5	2	1
Krkošija	1	5	2	5	2	3	5	1	5	3	7	2	5	3	2	1
Dobrogostina	1	3	3	5	3	2	5	3	3	5	7	2	3	3	1	1
Blatina	5	1	2	1	4	4	5	2	5	7	7	2	5	5	2	6
Trnjak	2	3	1	5	2	3	5	2	5	3	7	2	1	3	2	6
Pošip_bijeli	1	4	3	5	3	3	7	2	3	7	5	1	5	3	4	1
Pošip_crni	3	5	4	5	4	3	7	3	5	5	9	1	3	1	3	2
Šljiva_crna	1	3	2	2	3	4	3	3	5	4	5	3	5	5	3	5
Zložder	2	3	3	5	2	2	3	1	5	3	9	2	5	5	1	1

Source: Authors' creation.

For anthocyanin, coloration of the shoot tips all white cultivars and the red cultivar Šljiva crna were with very low intensity, while other cultivars were of low or medium intensity. Density of hairs on the shoot tip, varied from very rare hairs to medium density hairs. We determined green color, green color with bronze spots, yellow color, and yellow color with bronze spots on upper part of blade. Hairs between veins on the lower side of blade were of medium density for most cultivars, and rare hairs and very rare hairs for some cultivars, while the cultivar Blatina was hairless on the lower side of blade. The cultivars had circular, wedge and pentagonal shape of leaf. For the character number of lobes, it was established that cultivars had three, five or seven lobes. Degree of opening and overlapping of petiole sinus was presented with partly overlapping lobes, overlapping lobes, half-open, and closed petiole sinus. Sinus could be brace-shaped, U-shaped, V-shaped and key-shaped. Most cultivars had medium depth of lateral sinuses, and some have shallow sinuses. Length of bunch was from short bunch through medium long to long. In most varieties, it was established that bunch was dense, and some had medium dense or very dense bunch. It was expected since there were mostly cultivars for wine production. Cultivars had conical shape of bunch, pyramidal shape and cylindrical. Analyzed berries were versatile from very short to long ones. Very narrow berries, narrow and medium wide berries were established. According to shape of berry, they were divided into cultivars with: spherical shape, ovate, rounded-spherical, rounded, and wide elliptical shape. The following colours of berry cuticle were registered: yellow-green, blue-black colour; red colour of cuticle, and dark red colour.

Coefficients of similarity for 16 OIV descriptors are given in table 3.

Table 3 Distance matrix for 16 OIV descriptors based on DICE coefficient

	Žilavka	Bena	Krkošija	Dobrogos.	Blatina	Trnjak	Pošip_b	Pošip_c	Šljiva_c	Zložder
Žilavka	1.000	*								
Bena	0.438	1.000								
Krkošija	0.625	0.375	1.000							
Dobrogos.	0.313	0.438	0.438	1.000						
Blatina	0.500	0.438	0.438	0.188	1.000					
Trnjak	0.375	0.188	0.625	0.375	0.438	1.000				
Pošip_b	0.438	0.188	0.375	0.438	0.188	0.250	1.000			
Pošip_c	0.438	0.188	0.250	0.250	0.125	0.188	0.250	1.000		
Šljiva_c	0.375	0.438	0.250	0.250	0.313	0.125	0.250	0.188	1.000	
Zložder	0.375	0.313	0.563	0.375	0.313	0.500	0.250	0.188	0.313	1.000

* Values range from 0-1; 0= min, 1=max.
Source: Authors' creation.

Between cultivars a broad range of morphological similarity coefficients was determined. The lowest similarity coefficient 0.125 was determined between Šljiva crna and Trnjak which suggests that on morphological level these were the most different varieties. The highest similarity coefficient 0.625 was determined for combination Žilavka and Krkošija and Trnjak and Krkošija, which means that these varieties were most similar given the obtained morphological data.

Coefficients of similarity for 9 SSR markers are given in table 4.

Table 4 Distance matrix for 9 SSR markers based on DICE coefficient

	Žilavka	Bena	Krkošija	Dobrogos.	Blatina	Trnjak	Pošip_b	Pošip_c	Šljiva_c	Zložder
Žilavka	1.000									
Bena	0.313	1.000								
Krkošija	0.714	0.313	1.000							
Dobrogos.	0.643	0.313	0.714	1.000						
Blatina	0.323	0.457	0.258	0.258	1.000					
Trnjak	0.438	0.556	0.438	0.563	0.400	1.000				
Pošip_b	0.429	0.563	0.357	0.286	0.452	0.563	1.000			
Pošip_c	0.483	0.485	0.483	0.483	0.375	0.606	0.621	1.000		
Šljiva_c	0.414	0.485	0.276	0.345	0.500	0.485	0.483	0.400	1.000	
Zložder	0.200	0.588	0.133	0.200	0.364	0.529	0.333	0.258	0.258	1.000

* Values range from 0-1; 0= min, 1=max.
Source: Authors' creation.

Also, broad range of genetic similarity coefficients was determined between the analyzed varieties. The lowest similarity coefficient 0.133 was determined for varieties Zložder and Krkošija which suggests that, based on chosen set of nine SSR markers, these varieties genetically differed the most. The highest similarity coefficient 0.714 was determined for combination Žilavka and Krkošija and Dobrogostina and Krkošija, which means that these varieties were most similar given the obtained genetic data.

Cluster analysis based on DICE similarity coefficients resulted in dendrograms presented for morphological data (Fig.1) and for genetic data (Figure 2).

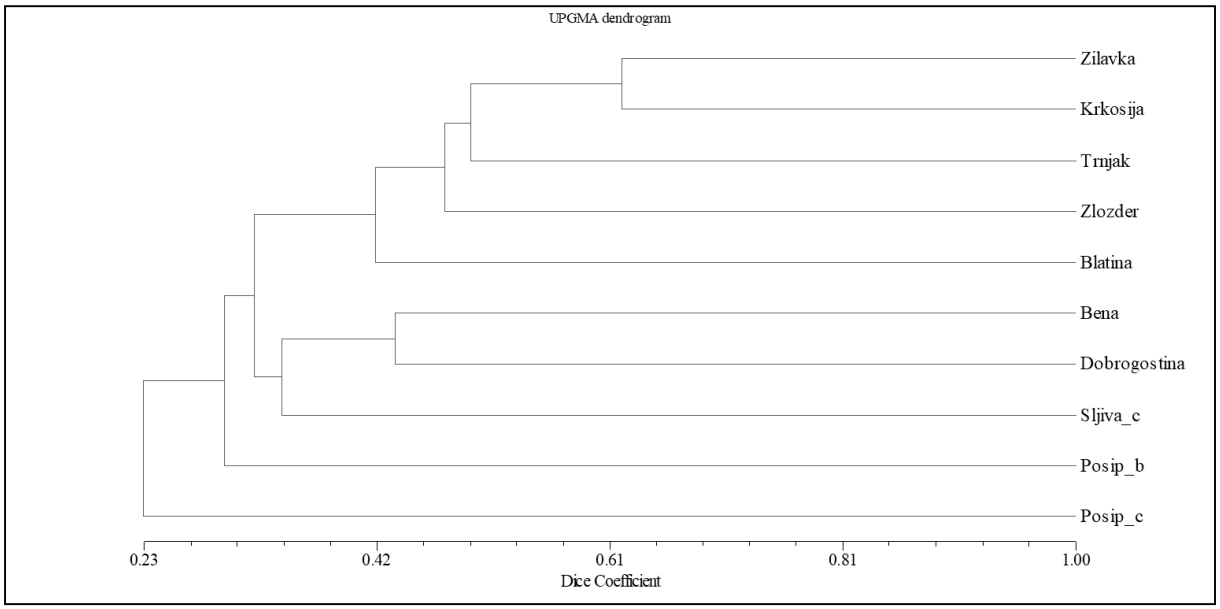

Figure 1 UPGMA dendrogram based on morphological data
Source: Authors' creation.

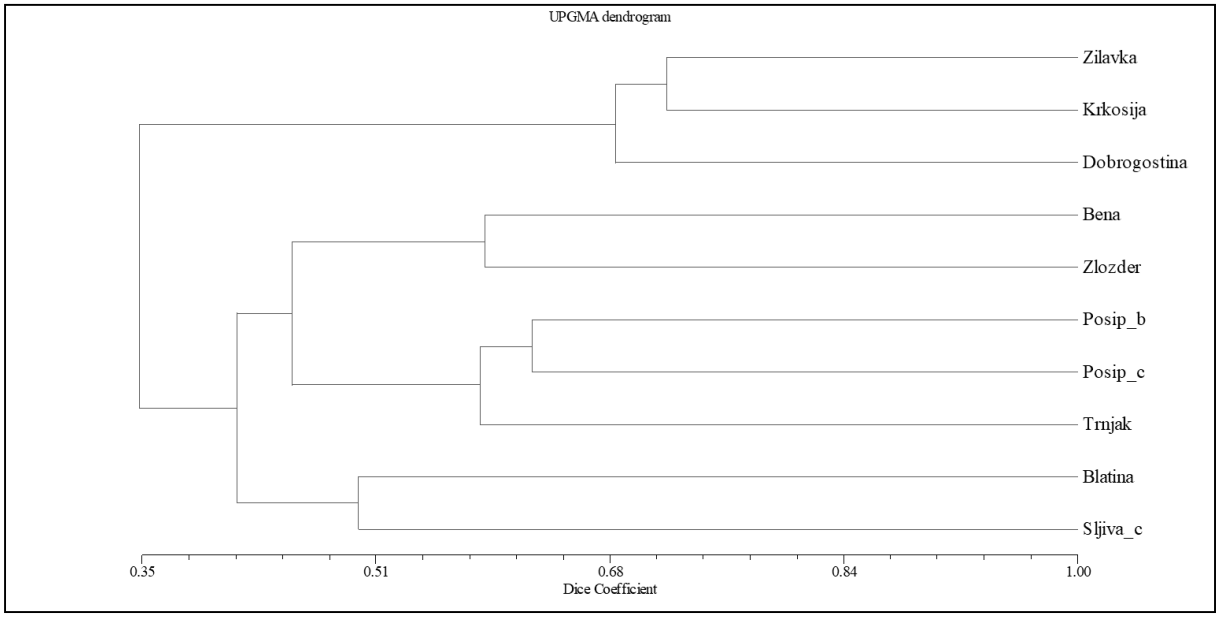

Figure 2 UPGMA dendrogram based on genetic data
Source: Authors' creation.

The only two groupings that are common to both dendrograms are those of Žilavka and Krkošija, which are in the same time the closest groupings. This strongly suggests that this two varieties are somehow related, parent-offspring relationship excluded. Overview of alleles of these two varieties found per SSR locus showed that on eight of nine loci these two varieties shared at least one common allele (data not shown). Žilavka and Dobrogostina whose genetic similarity was 0.643 share at least one common allele on each analyzed locus so they could be in parent-offspring relationship although their morphological similarity is quite low (0.313). Pošip bijeli and Pošip crni also grouped closely, having common alleles on eight of nine loci. Pošip bijeli is Dalmatian variety, and its similarity with Pošip crni suggest the influence of Dalmatian assortment to the formation of Herzegovinian cultivars, due to Dalmatia's

proximity (similar agro-ecological conditions), which can also be noticed from naming of some varieties and morphological resemblance. It is likely that after the introduction of Dalmatian varieties, autochthonous Herzegovinian varieties formed through spontaneous hybridization and adaptation to Herzegovinian ecological conditions.

Correlation of morphological and genetic matrix of similarity using Mantel test significantly showed that there was no correlation between those two matrices (r=-0.076**) which means that morphological data were not in correlation with genetic data. Although both methods successfully differentiated all analyzed varieties, they didn't do it in a similar way. This is in concordance with other research like Martinez et al. (2003) who did not find significant correlation between AFLP and 53 morhpological characters and also with findings of Zdunić (2005) and Zdunić et al. (2008) who found only weak correlation between morphological and genetic data.

Conclusions

Morphological characterization of 16 OIV descriptors and genetic identification on nine SSR markers were used for characterization of ten grapevine varieties from Herzegovina. Based on obtained morphologic and genetic data coefficients of similarity were calculated and compared, and UPGMA dendrograms were presented. Similarity coefficient had a broad value range for both methods. The most similar varieties for both morphological and genetic data were Žilavka and Krkošija, and this grouping can also be seen on both dendrograms. Analyses showed Žilavka's and Dobrogostina's possible parent-offspring relationship. Influence of Dalmatian grapevine varieties on formation of Herzegovinian assortment was confirmed through close genetic grouping of varieties Pošip bijeli and Pošip crni. Correlation of morphological and genetic matrix of similarity showed no correlation between those two matrices which means that morphological data were not in correlation with genetic data. Although both methods successfully differentiated all analyzed varieties, they didn't do it in a similar way. For complete and comprehensive identification of grapevine varieties, both ampelographic and genetic evaluation should be used.

References

1. Blei, D., Lafferty, J. (2009). Topic models. In *Text Mining: Classification, Clustering, and Applications*, Srivastava, A., Sahami, M. (Eds.), Tylor & Francis Group, Boca Raton, pp. 71-94.
2. Bowers, J. E., Dangel, G. S., Meredith, C. P. (1999). Development and characterization of additional microsatellite DNA markers for grape. *American Journal of Enology and Viticulture*, Vol. 50, No. 3, pp. 243-246.
3. Bowers, J. E., Dangel, G. S., Vignani, R., Meredith, C. P. (1996). Isolation and characterization of new polymorphic simple sequence repeat in loci in grape (*Vitis vinifera* L.). *Genome*, Vol. 39, No. 4, pp. 628-633.
4. Bulić, S. (1949). *Dalmatinska ampelografija*. Poljoprivredni nakladni zavod, Zagreb.
5. Dettweiler, E., Jung, A., Zyprian, E., Töpfer, R. (2000). Grapevine cultivar Muller-Thurgau and its true to type descent. *Vitis*, Vol. 39, No. 2, pp. 63-65.
6. European Commission (2017). *Agriculture and rural development, Agriculture and the environment*. Available at http://www1.montpellier.inra.fr/grapegen06/ [10 June 2017].
7. Leko, M., Žulj Mihaljević, M., Beljo, J., Šimon, S., Sabljo, A., Pejić, I. (2012). Genetic relationship among autochthonous grapevine cultivars in Bosnia and Herzegovina. *The Journal of Edge University Faculty of Agriculture*, Vol. 2, No. special issue, pp. 479-482.

8. Li, P., Cheng, L., Gao, H., Jiang, C., Peng, T. (2009). Heterogeneous behavior of PSII in soybean (Glycine max) leaves with identical PSII photochemistry efficiency under different high temperature treatments. *Journal* of *Plant Physiology*, Vol. 166, No. 15, pp. 1607-1615.
9. Maletić, E., Karoglan Kontić, J., Pejić, I. (2008). *Vinova loza – ampelografija, ekologija, oplemenjivanje*. Školska knjiga, Zagreb.
10. Martinez, L., Cavagnaro, P., Masuelli, R. and Rodriguez, J. (2003). Evaluation of diversity among Argentine grapevine (*Vitis vinifera* L.) varieties using morphological data and AFLP markers. *Electronic Journal of Biotechnology*, Vol. 6, No. 3, pp. 1-10.
11. McGovern, E. P. (2003). *Ancient Wine*. Princeton University Press, Princeton.
12. Mirošević, N., Turković, J. (2003). *Ampelografski atlas*. Golden marketing, Tehnička knjiga, Zagreb.
13. Nei, M. (1978). Estimation of average heterozygosity and genetic distance from a small number of individuals. *Genetics*, Vol. 89, No. 3, pp. 583-590.
14. OIV (2009). Code des caracteres descriptifis des varietes et especes de vitis. Paris.
15. Olmo, H. P. (1995). The origine and domestication of the Vitis grape. In *The origins and ancient history of wine*, McGovern, U. P. E. (Ed.), Gordon and Breach, Amsterdam, pp. 31-34.
16. Rohlf, F. J. (2000). *NTSYSpc - Numerical taxonomy and multivariate analysis*. Exeter Software, Setauket.
17. Sefc, K. M., Lopes, M. S., Lefort, F., Botta, R., Roubelakis-Angelakis, K. A., Ibáñez, J., Pejić, I., Wagner, H. W., Glössl, J., Steinkellner, H. (2000). Microsatellite variability in grapevine cultivars from different European regions and evaluation of assignment testing to assess the geographic origin of cultivars. *Theoretical and Applied Genetics*, Vol. 100, No. 3, pp. 498-505.
18. Sefc, K. M., Regner, F., Turetschek, E., Glössl, J., Steinkellner, H. (1999). Identification of microsatellite sequences in Vitis riparia and their applicability for genotyping of different Vitis species. *Genome*, Vol. 42, No. 3, pp. 1-7.
19. Suhadolnik, Ž. (2015). *Naši vinski susjedi: Bosna i Hercegovina: Žilavka, Blatina, Vranac*. Available at https://suhiucasi.wordpress.com/2015/03/23/nasi-vinski-susjedi-bosna-i-hercegovinazilavka-blatina-vranac/ [16 January 2016].
20. This, P., Jung, A., Boccacci, P., Borrego, J., Botta, R., Costantini, L., Crespan, M., Dangl, G. S., Eisenheld, C., Ferreira-Monteiro, F.,Grando, S., Ibáñez, J., Lacombe, T., Laucou, V., Magalhães, R., Meredith, C. P., Milani, N., Peterlunger, E., Regner, F., Zulini, L., Maul, E. (2004). Development of a standard set of microsatellite references alleles for identification of grape cultivars. *Theoretical and Applied Genetics*, Vol. 109, No. 7, pp.1448-1058.
21. Thomas, M. R., Scott, N. S. (1993). Microsatellite repeats in grapevine reveal DNA polymorphism when analysed as sequence-tagged sites (STSs). *Theoretical and Applied Genetics*, Vol. 86, No. 8, pp. 985-990.
22. Tomić, L. (2009). *Genetic characterization of the grapevine variety Žilavka (Vitis vinifera L.) with DNA markers*. Master thesis, University of Ljubljana, Biotechnical Faculty, Ljubljana.
23. Zdunić, G. (2005). *Ampelographic and genetic evaluation of autochthonous varieties of grapevine (Vitis vinifera L.) in the area of Kaštela*. Master thesis, Faculty of Agriculture Zagreb, Zagreb.
24. Zdunić, G., Pejić, I., Karoglan Kontić, J., Vukićević, D., Vokurka, A., Pezo, I., Maletić E. (2008). *Comparison of genetic and morphological data for inferring similarity among native Dalmatian (Croatia) grapevine cultivars (Vitis vinifera L.)*. *Journal of Food, Agriculture & Environment*, Vol. 6, No. 2, pp. 333-336.
25. Žulj Mihaljević, M., Simon, S., Pejic, I., Carka, F., Sevo, R., Kojic, A., Gasi, F., Tomic, L., Jovanovic Cvetkovic, T., Maletic, E., Preiner, D., Bozinovic, Z., Savin, G., Cornea, V., Maras, V., Tomic Mugosa, M., Botu, M., Popa, A., Beleski, K. (2013). Molecular characterization of old local grapevine varieties from South East European countries. *Vitis*, Vol. 52, No. 2, pp. 69-76.

About the authors

Zrinka Knezović is employed at Faculty of Agriculture and Food Technology University of Mostar since 1998. In 2004 she gained a doctoral degree at Faculty of Agriculture, University of Zagreb, Croatia. At the same Faculty she gained her master's degree in 2001. She is also external expert for accreditation of study programs (ESABIH); HERE expert (Higher Education Reform Expert in Bosnia and Herzegovina) as representative of the University of Mostar (Ministry of Education, Science, Culture and Sports of the West Herzegovina District); Expert for evaluation of action plans and studies on environmental impact assessment in the process of issuing environmental permits (Federal Ministry of Environment and Tourism). Scientific interests include genotype x environment interaction and experimental design and efficiency. Since 2006 she is member of the International Association for Research on Plant Breeding (EUCARPIA) and a Croatian Biometric Society. She worked as coordinator or associate at several domestic and international projects. She can be contacted at *zrinka.knezovic@sve-mo.ba*.

Ana Mandić works at Faculty of Agriculture and Food Technology University of Mostar. She works at modules: Plant breeding, breeding fruit crops, Biostatistics. She worked on several domestic and international projects. Scientific interest: plant breeding, genetics, molecular markers. She was one of the authors on two books and published several scientific papers. She can be contacted at *ana.sabljo@sve-mo.ba*.

Nikica Perić holds a master's degree diploma in Agriculture from Faculty of Agriculture and Food Technology University of Mostar. He had worked on grapevine ampelography for his master thesis. He works at municipality of Stolac, Bosnia and Herzegovina. He can be contacted at *nikica.peric@gmail.com*.

Jure Beljo is Full Professor at the Faculty of Agriculture and Food Technology University of Mostar since its foundation in 1994. He was scientific expert at Tobacco institute Zagreb till retirement. He was coordinator of modules: Plant breeding, Breeding fruit and grape crops, Tobacco production and processing. Correspondent of the *Tobacco Journal International* since 1982 and associate at *Tobacco Encyclopaedia*. He also created hybrids and varieties of tobacco. Beljo published over 70 scientific and professional papers and seven books. He was coordinator of many scientific and expert projects in the area of agriculture. He works on promotion of agriculture and agricultural history and tradition of Herzegovina. Author can be contacted at *jure.beljo@sve-mo.ba*.

Maja Žulj Mihaljević works at Faculty of Agriculture, University of Zagreb, as a Young Researcher at Department of Plant breeding, genetics and biometrics. Scientific area: genetics, plant breeding, molecular markers, genetic identification of fruit and grape crops, parental analyses of crops. She was one of the authors at three books and published several scientific papers. She is laureate of L'OREAL-UNESCO for women in science award for 2017. She can be contacted at *mzulj@agr.hr*.