

AGROBIOLOGICAL AND TECHNOLOGICAL CHARACTERISTICS OF SOME GRAPEVINE VARIETIES AND CLONES GROWN IN SERBIA

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In Serbia under the vineyards is about 22 149 hectares from that area 17482 hectares is under vine and 4667 hectares under table varieties. The most common wine varieties are Cabernet sauvignon (8.49%), Merlo (8.14%), Limberger (4.65%), Pinot noir (3.2%), Prokupac (3.33%), Italian riesling (13.94%), Riesling rhine (8.01%), Chardonnay (6.76%) and Sauvignon blanc (4.59%). Among table varieties Muscat hamburg with 52.83% is the most common, followed by Victoria (7.94%), Moldova (7%), Cardinal (5.92%) and others.

Over the past twenty years grapevine assortment has been significantly expanded through: introduction of other varieties and clones (mainly from France and Italy), with creation of new varieties at Faculty of Agriculture University of Belgrade and with clonal selection of Serbian origin varieties. Through big number of breeding programs, 23 table and 9 wine grape varieties were created, while 12 new clones of autochthonous Prokupac variety were recognized by the Genetic Resources Department of the Ministry of agriculture, forestry and water Management.

Keywords: variety, clone, introduction, testing

INTRODUCTION

Varietal structure in most Serbian vineyards in earlier years was mainly reduced to several introduced grape varieties (Cabernet sauvignon, Merlo, Pinot noir, Sauvignon blanc, Chardonnay, Rkaciteli ...) or to a less to autochthonous varieties Prokupac and Smederevka (Marković, 2012).

In the last twenty years grapevine assortment in Serbia has been significantly expanded through introduction of varieties and clones of international varieties, creation of new varieties and through clonal selection of autochthonous varieties. New varieties or clones were introduced from largest vineyard centers in Italy, France and Germany. The greatest contribution to creation of new varieties was given by Department of Viticulture Faculty of Agriculture University of Belgrade where is created 32 grape varieties (9 wine and 23 table varieties).

The autochthonous grape variety in Serbia has been reduced to several varieties which, according to earlier systematizations, consisted mainly of varieties for table and quality wines (Prokupac, Smederevka, Bagrina, Začinak, Tamjanika). Recent research has found that in Serbia there are numerous variations of these varieties with high technological potential, which would also be classified into the category of varieties for high quality wines (Živković et al., 2016).

In recent years, have been made efforts to test 42 clones of Prokupac variety in order to become, as an autochthonous variety, an appropriate place in Serbian variety. As a result of research on clonal selection, Genetic Resources Department of the Ministry of agriculture, forestry and water Management issued certificate on recognition of following Prokupac clones: PR 2, PR 6, PR 8, PR 9, PR 10, PR 11, PR 12, PR 13, PR 16, PR 17, PR 19 and

PR 20 (Markovic et al, 2013a, b, c). In addition to Prokupac, intensive research and clonal selection is also being done on Smederevka, Začinak and Bagrina varieties.

Introduced varieties and clones, as well as new created and recognized clones, have a test procedure related to follow parameters:

1. testing of resistance to low temperatures
2. phenology (BBCH identification key- *Biologische Bundesamt Bundessorten amt and Chemical industry*)
3. number of developed shoots
4. fertility (number and % of fertil and non-fertil shoots; number of inflorescence; fertility coefficient-potential, relativ and absolute)
5. mechanical composition of cluster and berries
6. mass of pruning shoots
7. content of sugar and total acids in must
8. anthocyan content in berry skin
9. yield

a) INTRODUCED VARIETIES AND CLONES

The biggest number of clones was tested for next wine varieties: Cabernet sauvignon: french clones-191, 337, 685, italian clones-R5, VCR 7, VCR 8, VCR 11, VCR 489; Cabernet franc: french clones-214, 326, 327, 330, 409, 623, 678, italian clones-VCR 10; Pinot noir: french clones-113, 114, 115, 165, 459, 667, 777, 779, 792, 828, 870, 871, 872, 927, 943, Italian clones-R4, VCR 9, VCR 18; Merlo: french clones-181, 184, 343, 347, 519, italian clones-R3, R12, R18, VCR1, VCR489; Sauvignon blanc: french clones-107, 108, 159, 161, 242, 316, 317, italian clones-ISV F3, ISV F5, R3, VCR 236, VCR 237; Chardonnay: italian clones-ISV 1, ISV 4, ISV 108, R8, VCR 4, VCR 10,

VCR 435, VCR 436, french clones-75, 76, 95, 96, 117, 121, 277, 548; Clairette de Gascogne: french clones-68, 208; Colombard: french clones-551, 552, 553, 625, 605, 606, 608, 609; Folle blanche: french clone-281; Marselan: french Clone-980; Muscat a petits grains: french clones-453, 454, 455; Ugni blanc: french clone-384 and Viognier: french clone-642.

Of table varieties Prima, Ora, Danlas, Lival and Victoria had a significant position (Markovic, 2003; Markovic & Przic, 2016).

Introduced varieties and clones are suitable for different agro-ecological conditions of Serbia and were high values in testing process of tested quantitative and qualitative parameters (Pržić, 2014; Marković et al., 2016, 2017) and in accordance with results of other authors who are examined part of introduced varieties in agroecological conditions of other countries (Jones & Davis, 2000; Kennedy et al., 2001; Matthews et al., 2005; Fregoni, 2010; Jones, 2010).

b) NEW CREATED VARIETIES

During the twenty-year period at Faculty of Agriculture University of Belgrade, it is worked intensively on creation of new varieties. Through a number of breeding programs, 9 wine varieties were created (Godominka, Kladovska bela, Jagodinaka, Srpski rubin, Krajinski bojadiser, Župski bojadiser, Negotinka, Vožd, Vladun) and 23 table varieties were created (Beogradska rana, Biserka rana, Demir kapija, Gročanka, Kosovska rana, Radmilovački muskat, Srbija, Opuzenska rana, Banatski muskat, Kavardarski drenak, Negotinski rubin, Smederevski muskat, Antigon, Povardarska pozna, Beogradska besemena, Evita, Kalina, Despina, Antonina, Kristina, Leontina, Simona, Valentina).

Table 1.

New created varieties at the Faculty of Agriculture, University of Belgrade

Varieties	Parents	Authors
Vine varieties		
Godominka	By Smederevka selfpollination	Avramov, L., Jovanović, M., Radovanović, V., Tadijanović, Đ., Polak, V., Jurčević, A., Marinković, A., Bjekić, S., Ružević, M.
Kladovska bela	Prokupac x Pinot noir	Avramov, L., Jovanović, M., Radovanović, V., Tadijanović, Đ., Polak, V.
Jagodinaka	Pinot noir x Prokupac	Avramov, L., Jovanović, M., Radovanović, V., Tadijanović, Đ., Polak, V.
Srpski rubin	Prokupac x Gamay	Avramov, L., Jovanović, M., Radovanović, V., Tadijanović, Đ., Polak, V.
Negotinka	Zaćinak x Pinot noir	Avramov, L., Sivčev, B., Gašić, N., Puljiz, M., Bjekić, S., Nenadović, Lj.
Krajinski bojadiser	Gamay x Gamay bojadiser	Avramov, L., Jovanović, M., Radovanović, V., Tadijanović, Đ., Polak, V.
Župski bojadiser	Alikant buše x Gamay bojadiser	Avramov, L., Jovanović, M., Radovanović, V., Tadijanović, Đ., Polak, V.
Table varieties		
Beogradska rana	Afuz ali x Buvijeova rana	Avramov, L.
Biserka rana	Čabski biser x Muscat otonel	Avramov, L., Tadijanović, Đ., Jovanović, M.
Demir kapija	Muscat otonel x Kraljica vinograda	Avramov, L., Tadijanović, Đ., Jovanović, M., Lović, R.
Gročanka	Čabski biser x Afuz ali	Avramov, L., Jovanović, M., Jovanović, Đ.
Kosovska rana	By Muscat hamburg selfpollination	Avramov, L., Jovanović, M.
Radmilovački muskat	Kraljica vinograda x Muscat hamburg	Avramov, L., Jelenković, G., Jovanović, M., Jovanović, Đ.
Srbija	By Alfons Lavale selfpollination	Avramov, L., Gašić, N., Jovanović, M., Ružević, M., Rudaković, R., Puljiz, M.
Opuzenska rana	Buvijeova rana x Muscat hamburg	Avramov, L., Jovanović, M.
Banatski muskat	Kraljica vinograda x Muscat hamburg	Avramov, L., Tadijanović, Đ., Jovanović, M., Lović, R.
Kavadarski drenak	Muscat hamburg x Afuz ali	Avramov, L., Jovanović, M., Jurčević, A.
Negotinski rubin	Muscat hamburg x Žilavka	Avramov, L., Tadijanović, Đ., Jovanović, M.
Smederevski	Muscat hamburg x	Avramov, L., Tadijanović, Đ.,

muskat	Žilavka	Jovanović, M., Jurčević, A.
Antigona	Muscat hamburg x Smederevka	Avramov, L., Jovanović, M., Jurčević, A.
Povardarska pozna	Muscat hamburg x Žilavka	Avramov, L., Jovanović, M., Jurčević, A.
Evita	Klinton x Prokupac x Muscat hamburg	Avramov, L., Tadijanović, Đ., Mijajlović, R., Ružević, M., Niketić-Aleksić, G., Puljiz, M., Gašić, N., Bjekić, S.
Beogradska besemena	Smederevka x (Sultanina, Sultanija and Muscat italija)	Avramov, L., Jovanović, M., Jurčević, A.

Table 2

Technological characteristics of newly created varieties

Varieties	Cluster mass (g)	Ripening epoch	Sugar content (%)	Total acid content (g/l)
Vine varieties				
Godominka	150-200	end of II beginning of III	20-24	5-7
Kladovska bela	130-200	III	18-22	8-10
Jagodinaka	100-150	III	18-22	7-8
Srpski rubin	180-300	III	18-20	5-9
Negotinka	150-180	II	21-22	6-8
Krajinski bojadiser	200-300	III	18-22	7-9
Župski bojadiser	120-190	III	18-21	8-11
Table varieties				
Beogradska rana	200-220	end of July	15-17	5-6
Biserka rana	100-110	with Julski muscat	14-16	5-6
Demir kapija	120-290	end of July	14-16	6-7
Gročanka	175-290	end of July	16-18	6-7
Kosovska rana	200-350	4-5 days before Queen of vineyards	15-17	6-7
Radmilovački muskat	170-280	2-3 days before Queen of vineyards	15-17	6-7
Srbija	150-400	3 decade of July	14-18	5-6
Opuzenska rana	100-160	very early	15-17	7-8
Banatski muskat	200-290	I	14-16	5-6
Kavadarski drenak	350-400	end of III beginning of IV	16-18	7-8
Negotinski rubin	300-350	end of III beginning of IV	16-18	5-6
Smederevski muskat	250-400	III	18-19	6-7
Antigona	260-400	IV	18-20	6-7
Povardarska pozna	300-400	IV	15-17	7-8
Evita	300-450	III	19-21	8-11
Beogradska besemena	300-500	III	19-20	6-7

During 2017 and 2018 year, eight varieties of grapevine were recognized by Genetic Resources Department of the Ministry of agriculture, forestry and water Management, including two wine and six table varieties. In table 3 it is show parental combinations of crossing, while table 4 it is show main technological

characteristics of new recognized varieties.

Table 3.

Recognized varieties at the Faculty of Agriculture in 2017 and 2018

	Cultivar	Purpose	Color	Year of recognition	Origin
1.	Vožd	wine	black	2017	Začinak x Prokupac
2.	Vladun	wine	black	2017	Merlot x Župski bojadiser
3.	Kalina	table	white	2017	Muscat Hamburg x SV 12375
4.	Despina	table	white	2017	SV 18315 x Muscat Hamburg
5.	Antonina	table	black	2017	Muscat Hamburg x Seedling108
6.	Kristina	table	black	2018	Muscat Hamburg x Seedling 108
7.	Leontina	table	black	2018	Muscat Hamburg x SV 12375
8.	Simona	table	black	2018	Seedling 113 x Muscat Hamburg

Table 4.

Technological characteristics of varieties recognized in 2017 and 2018 year

	Cultivar	Bunch weight (g)	Berry weight (g)	Sugar content in the must (%)	Total acid content in the must (g/l)	Resistance to <i>Plasmopara viticola</i> <i>Uncinula necator</i> <i>Botrytis cinerea</i>
1.	Vožd	175	1.56	20.5	6.5	-
2.	Vladun	168	1.45	22.5	6.0	-
3.	Kalina	280	3.60	17.9	6.1	+
4.	Despina	240	3.20	20.1	6.5	+
5.	Antonina	298	3.40	16.8	6.8	+
6.	Kristina	325	2.80	22.9	7.1	+
7.	Leontina	550	3.90	18.9	6.3	+
8.	Simona	340	3.10	18.1	6.1	+
9.	Valentina	346	3.50	17.1	6.9	+

a) CLONAL SELECTION

Prokupac is autochthonous red wine variety of Serbia with unspecified exact origin, but is assumed to spread from Prokuplje area and around Aleksandrovac Zupski (Zirojevic, 1964). According to some data, this variety was cultivated at the time, but also before Cara Lazar, to be suppressed in the last few decades by the introduced varieties, especially to Frankovka variety, which had to replace Prokupac, because had improved technological characteristics. Prokupac can find under synonyms: Kameničarka, Rekovacka crnka, Nikodimka, Rskavac, Prokupka and Niševka. It is characterized by medium to strong vigor and fertility manifested on both well and poor fertile soils. Prokupac shoots are developed and strong with upright growth and can be grown on low training systems. It is a high fertile variety, the lowest buds on shoot are very fertile. It is suitable short pruning were gives excellent yield. Some clones of this variety are characterized by increased resistance to Botritis cinerea. Prokupac wines are refreshing and suitable for making wines such as rose and strong colored wines (Avramov and Zunic, 2001; Zunic, 2010).

The significance of Prokupac is great, bearing in mind that this variety participated in crossbreeding of several parental combinations where as a result are created varieties Župljanka, Kladovka bela, Jagodinka, Serbian ruby and Evita. So far, 12 clones of the Prokupac variety have been recognized by the Ministry of Agriculture of the Department of Genetic Resources under the designations: PR 2, PR 6, PR 8, PR 9, PR 10, PR 11, PR 12, PR 13, PR 16, PR 17, PR 19, PR 20.

Most of tested clones were tested to presence of different viruses, 23 recognized and potentially recognized clones had "natural free virus status". Naturally virus-free clones can be used to further multiply and produce certified planting material, which would contribute to their rapid expansion into regular

winemaking (Markovic et al., 2012; Markovic et al., 2017).

Description of recognized Prokupac clones

PR 2

Authors: Marković Nebojša, Nakalamić Aleksandar, Jović Slobodan. Clone was recognized in 2010. It is characterized by large, medium-compacted cluster with mass up to 250.6 g. Berry is round, medium-sized. Participation of epidermis in berry is 4.29% and mesocarp 93.03%. Up to 22.6% of sugar and 6.7 g/l of total acids are accumulated in the must. Clone with big yield potential.

PR 6

Authors: Marković Nebojša, Nakalamić Aleksandar, Jović Slobodan. Clone was recognized in 2010. The average mass of cluster is 188.0 g, the length of cluster is 14.36 cm and width is 6.84 cm. Cluster is medium compact, with large lenticels on berries. Berry skin is abundantly sprinkled. It is characterized by a higher percent of seeds in berry-2.23% (3.28 seeds/berries) and with lower participation of skin in berry-3.50%. In must accumulated 22% of sugar and 6.22 g/l of total acids.

PR 8

Authors: Marković Nebojša, Nakalamić Aleksandar, Jović Slobodan, Cvetković Radoslav. Clone was recognized in 2010. Cluster is medium-sized, berry is round. In grape juice it accumulates 18.6% of sugar and 7 g/l of total acids.

PR 9

Authors: Marković Nebojša, Nakalamić Aleksandar, Jović Slobodan. Clone was recognized in 2010. Very yielding clone. It is characterized by a large cluster with average mass of 211.0 g. cluster is 13.38 cm long and 7.69 cm wide, medium compact, averaging 92.80 berries per cluster. Berry is large, with average mass of 2.77 g. It is characterized by big participation of epidermis in berry-5.42% and percent of

mesocarp 91.95%. Accumulated 19.32% of sugar and 8.02 g/l of total acids in must.

PR 10

Authors: Marković Nebojša, Nakalamić Aleksandar, Jović Slobodan, Žunić Dragoljub. Clone was recognized in 2010. It is characterized by compacted clusters with mass of 194 g. Berries are with large lenticels noticeable on the berries. Cluster is 12.7 cm long and 7.4 cm wide, contains in average 88.6 berries. Weight of the berry is 2.35 g. It is characterized by a high percentage of epidermis in berry-5.53% and seeds-2.98%. Accumulated 17% of sugar and 8.12 g/l of total acids in must. Yielding clone, had ripening time several days later than other clones.

PR 11

Authors: Marković Nebojša, Nakalamić Aleksandar. Clone was recognized in 2010. Cluster is compact, mass 170 g, medium-sized berries with noticeable tiny lenticels per cuticle. Participation of epidermis is 5.39%, of seeds 2.30 and mesocarp 92.3%. Length of cluster is 12.94 cm and width is 7.81 cm. In grape juice accumulate 19% of sugar and 6.43 g/l of total acids.

PR 12

Authors: Marković Nebojša, Nakalamić Aleksandar. Clone was recognized in 2010. Cluster is medium compact, with large lenticels clearly visible on berries. Mass of cluster is 217 g, length is 13.24 cm and its width 6.40 cm. It is characterized by a high content of berries in cluster (99.76%), as well as mesocarp in berry (93.76%), which indicates a higher juice yield. In grape juice it accumulate 21.38% of sugar and 6.79 g/l of total acids.

PR 13

Authors: Marković Nebojša, Nakalamić Aleksandar, Cvetković Radoslav. Clone was recognized in 2010. It is characterized by a compact cluster, mass 170 g, berries are small and different in size. Epidermis is thin. In

must accumulated 19.4% of sugar and 8.2 g/l of acid.

PR 16

Authors: Marković Nebojša, Pržić Zoran, Zorica Ranković Vasić, Saša Matijašević. Clone was recognized in 2015. It has a very large cluster of 245 g. Berry is round, medium-sized (2.17 g), with thick cuticles. Berry has in average 1.27 seeds, participation of epidermis in berry is 4.59% and mesocarp 93.30%. In must accumulated 22.4% of sugar and 6.5 g/l of total acids.

PR 17

Authors: Marković Nebojša, Pržić Zoran, Zorica Ranković-Vasić, Saša Matijašević. Clone was recognized in 2015. Mass of cluster is 202 g, length of cluster is 12.24 cm and width is 6.93 cm. Berry is round, medium-sized. Cluster has a high content of berries- 96,22%. Participation of epidermis is 5.41%, seeds 2.7% and mesocarp 91.89%. Weight of one berry is 2.22 g. In must accumulated 18.38% of sugar and 7.5 g/l of total acids.

PR 19

Authors: Marković Nebojša, Pržić Zoran, Zorica Ranković-Vasić, Saša Matijašević. Clone was recognized in 2015. Cluster is compact, berries are round with clear lenticels. Mass of the cluster is 188 grams, length 14.36 and width 6.84 cm. Clone is characterized by a higher seed participation in berry-2.23% (3.28 seeds / berry). Percent of mesocarp in berry is 94.27%. It is characterized by a high degree of sugar accumulation in must 22.05%, and it accumulate 6.22 g/l of total acids.

PR 20

Authors: Marković Nebojša, Pržić Zoran, Zorica Ranković Vasić, Sasa Matijašević. Clone was recognized in 2015. It is characterized by large cluster (220 g). Cluster is 14.8 cm long and 8.2 cm wide. Berry is round, large with a high percent of epidermis (4.76%). Percent of berries in cluster is high (97.27%). In must accumulate 19% of sugar and 6.42 g/l of total acids.

CONCLUSION

Changing varietal composition with introduction of new varieties and clones significantly completes offer in Serbian variety list, as well as in other countries in region that show interest in new varieties and clones. Especially since need for autochthonous assortment is often mentioned in professional circles, as interest on autochthonous assortment as well as on newly created grapevine varieties at agricultural faculties in Belgrade and Novi Sad, has increased on world vine market.

It is necessary to ensure implementation of new created varieties

and recognized clones in Serbian viticulture in coming period through scientific and professional approach. Considering agroecological conditions and economic and technological characteristics viewed through biological and chemical composition of grapes and wines, adequate reonization of new varieties and clones in Serbian vineyards is completed. This creates an appropriate basis for production of wines with a protected geographical origin of autochthonous and newly created varieties.

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