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INHERITANCE OF THE COLOUR OF BERRY JUICE IN HYBRID COMBINATIONS BETWEEN SEEDED AND SEEDLESS VINE CULTIVARS (*VITIS VINIFERA* L.)

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Abstract

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Inheritance of the trait colour of berry juice in hybrid combinations between seeded and seedless vine cultivars has been studied. It has been found that the white and red colours of berry juice in F_1 progeny are in a ratio from 2.3:1 to 6.0:1. The theoretical ratios 4:1 and 3:1 between seedlings with white juice and those with red juice have a high degree of reliability of the zero hypotheses for the majority of the investigated crosses. When parent cultivars with red berry skin are crossed, the seeded seedlings have white and red colour of berry juice, while seedless plants are with red colour only. When the parthenocarpic parents are with white berry skin, the seedless seedlings have white and red colour of berry juice. The ratios between the two colours in the seeded and seedless plants differ significantly. Because of this research, seedless plants with red berry juice have been developed for the first time, which provide rich and varied initial material for further breeding procedures and selection of elite forms and cultivars.

Key words: inheritance, colour of berry juice and berry skin, seedlessness, hybrid combinations between seeded and seedless vine cultivars

Introduction

The colours of berry skin and berry juice in vine are commercially significant traits, which have been the subject of various ampelographic and breeding-genetic studies. The majority of publications on inheritance of the colour of berry skin suggest that it is determined by genetic interactions, as stated in the complementary or epistasis hypotheses (Hedrick and Antony, 1915; Rasmuson, 1916; Negrul, 1936; Lu Ji-Jan, 1962; Barritt and Einset, 1969; Bojinova-Boneva, 1974; Golodriga et al., 1975; Valchev, 1990; Klimenko and Troshin, 1994; Klimenko et al., 1997; Kulidjanov, 2001). Relatively less data is available on inheritance of the colour of berry juice. When red wine cultivars with white berry juice are crossed with ones with red berry juice the ratio between seedlings in F_1 progeny based on the colour of the juice is proportionate or almost proportionate – 1:1 and 1.5:1 (Kozma, 1974). In the identical type of crosses between a white table cultivar (Chaush) and a red tinctorial wine cultivar (Alicante Bouschet), 96.12% of the seedlings in F_1 progeny possess red berry skin, 56.31% of them having coloured juice and 39.81% - white (colourless) juice (Matevska, 1971). Milutinovic et al. (2000) establish monohybrid inheritance of the colour of berry skin and berry juice in F_1 progeny of the cross Evita x Beogradska Besemena, but the expected full combining of the desired traits – seedlessness, coloured juice, high yield and quality of grapes – was not obtained in any of the seedlings.

An in-depth analysis of the characteristics and peculiarities of the inheritance of the colour of skins and juice in hybrid combinations between seeded and seedless vine cultivars is not known to have been made so far. These breeding-genetic investigations are particularly interesting and important since they increase the possibilities for more efficient development of seedless vine cultivars with coloured berry juice, which will have a greater commercial value. The purpose of this study is to determine the type of inheritance of the trait colour of berry juice in F_1 progeny of hybrid combinations between seeded and seedless vine cultivars.

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Material and Methods

The investigation includes 20 hybrid combinations between the seeded cultivars Alicante Bouschet and Grand noir – with black berry skin and red berry juice, and the seedless cultivars having white juice – Beauty seedless, Kondarev 10, Roussalka 3 and Korintsko black (with black berry skin) and Roussalka 1, Kondarev 6, Roussalka and Nedelchev VI-4 (with white skin). The wine cultivars Mavrud and Evmolpiya – with black berry skin and white juice, crossed separately with the first two tinctorial cultivars, have been used as analyzers. The tinctorial red wine cultivars Alicante Bouschet and Grand noir have been used as donors of the trait coloured berry juice. The seedless cultivars are of stenospermocarpic type, with the exception of Korintsko black, which is characterized by a simulative type of parthenocarpy. According to the objectives of the study, the crosses were divided into five groups representing the diversity in the colour of berry skin and juice. The colour of berry skin and juice has been determined visually, and the seededness or seedlessness of berries has been established organoleptically for each plant in F_1 progeny of the specified crosses. The seedlings in whose berries no seed rudiments or only slight traces of seed rudiments were felt during the tasting were defined as seedless. Within the breeding-genetic analysis, the ratios 3:1 and 4:1 have been established as probable theoretical ratios between the two manifested colours of berry juice for the purpose of verification of the zero hypothesis, through the criterion χ^2. These rations have been chosen on the basis of the obtained experimental data and the assessment of the certainty of differences in the alternative variation (Snedecor, 1957; Genchev et al., 1975; Lidanski, 1988; Lakin, 1990). The coefficient K has been determined, which shows the percentage ratio between the two traits (K=W%/R%), where W represents seedlings with white berry juice, and R – seedlings with red berry juice. This coefficient makes it possible to determine the equivalent function of genotype factors in the course of the inheriting of the trait colour of berry juice in the seeded and seedless plants from the separate hybrid combinations.

Results and Discussion

Group I includes the hybrid combinations of Alicante Bouschet – with black skin and red berry juice – with the seedless cultivars Beauty seedless, Kondarev 10, Roussalka 3 and Korintsko black – with black berry skin and white juice. The results from the phenotype decomposition of the colour of berry juice in F_1 progeny show that the percentage values of seedlings with white (W) and red (R) juice are within the range 71.7%/28.3% - 92.6%/7.4% at a ratio of 2.5:1 – 12.5:1 and the total is 82.7%/17.3% at a ratio of 4.8:1 (Table 1). Only in the cross Alicante Bouschet x Kondarev 10 the theoretical ratio 3:1 has high reliability at $P_{0.70}$, whereas in the other crosses with 4:1 – at $P_{0.24}$ to $P_{0.64}$. A significant deviation has been observed in Alicante Bouschet x Korintsko black. High proven homogeneity among separate crosses has been reported at both theoretical ratios – $P_{0.20}$ and $P_{0.17}$.

In Group II Alicante Bouschet has been crossed with the seedless cultivars Roussalka 1, Kondarev 6, Roussalka and Nedelchev VI-4 – having white berry skin and white juice. The obtained percentage values among seedlings for the two traits are within the limits of 70.0%/30.0% - 86.2%/13.8% in a ratio 2.3:1 – 6.3:1, and totally – 76.9%/23.1% at a ratio 3.3:1. High reliability of the theoretical ratio 3:1 is established in Alicante Bouschet x Kondarev 6 at $P_{0.75}$ and Alicante Bouschet x Roussalka at $P_{0.47}$, and also for the theoretical ratio 4:1 in Alicante Bouschet x Roussalka 1 at $P_{0.90}$ and Alicante Bouschet x Nedelchev VI-4 at $P_{0.43}$. The hybrid combinations are characterized by a high degree of homogeneity at both ratios – $P_{0.45}$ and $P_{0.99}$. For the total result from Group I and Group II the percentage level is 79.7%/20.3% at a ratio of 3.9:1 with reliability $P_{0.90}$ at 4:1.

In Group III Grand noir – with black berry skin and red juice – has been crossed with the seedless cultivars from Group I. The percentage values of these hybrid combinations in F_1 progeny for the analyzed traits are 83.7%/16.3% - 85.7%/14.3% with a ratio varying from 5.1:1 to 6.0:1 – a total of 84.3%/15.7% and a ratio of 5.4:1. The decomposition of the colour of berry juice in the crosses from this group is characterized by high reliability at 4:1 with $P_{0.56}$ – $P_{0.75}$ and high homogeneity – $P_{0.99}$.

The hybrid combinations between Grand noir and the seedless cultivars from Group II form Group IV. The percentage values in F_1 progeny are within the range 77.5%/22.5% - 87.0%/13.0% at a ratio varying from 3.5:1 to 6.7:1. The total values of these indices are 80.9%/19.1% - at 4.2:1 and homogeneity with $P_{0.97}$. The theoretical ratio 4:1 with $P_{0.43}$ and P_{100} has been confirmed in all crosses. The consolidated results from Group III and IV reveal that the percentage values are 82.5%/17.5% - 4.7:1 with reliability at $P_{0.26}$ of the theoretical ratio 4:1.

The collected experimental data makes it possible to carry out a comparative analysis of the percentage ratios of phenotypic decomposition of the colour of berry juice in the seedlings from F_1 progeny, comparing the researched hybrid combinations by determining the certainty of differences in the alternative variation. The difference between the total values of indices in the crosses from Group I and II is 5.8% at $t_{exp.}=1.29 – P_{0.400}>P_{0.050}$, for the crosses from Groups III and IV the difference is 3.4% at $t_{exp.}=0.80 – P_{0.500}>P_{0.050}$, for the consolidated groups I+II and III+IV – 2.8% at $t_{exp.}=0.90 – P_{0.500}$,

Table 1
Inheritance of the colour of berry juice in F_1 progeny of crosses between seeded and seedless vine cultivars

Hybrid combinations	Decomposition							Theoretical ratio			
	Total number	Number		%		Ratio		3:1		4:1	
		W	R	W	R	W	R	χ^2	P	χ^2	P
GROUP I *Seeded cultivar with black berry skin and red berry juice x Seedless cultivar with black berry skin and white juice*											
Alicante Bouschet x Beauty seedless	52	45	7	86.5	13.5	6.4	1	3.70	0.09	1.39	0.24
Alicante Bouschet x Kondarev 10	46	33	13	71.7	28.3	2.5	1	0.26	0.70	1.96	0.21
Alicante Bouschet x Roussalka 3	25	21	4	84.0	16.0	5.3	1	1.08	0.32	0.25	0.64
Alicante Bouschet x Korintsko black	27	25	2	92.6	7.4	12.5	1	4.50	0.04	2.67	0.18
Total	150	124	26	82.7	17.3	4.8	1	4.70	0.03	0.67	0.44
Homogeneity df=3								4.84	0.20	5.30	0.17
GROUP II *Seeded cultivar with black berry skin and red berry juice x Seedless cultivar with white berry skin and white juice*											
Alicante Bouschet x Roussalka 1	53	42	11	79.2	20.8	3.8	1	0.51	0.48	0.02	0.90
Alicante Bouschet x Kondarev 6	38	28	10	73.7	26.3	2.8	1	0.04	0.75	0.94	0.27
Alicante Bouschet x Roussalka	40	28	12	70.0	30.0	2.3	1	0.53	0.47	2.50	0.13
Alicante Bouschet x Nedelchev VI-4	29	25	4	86.2	13.8	6.3	1	1.94	0.18	0.69	0.43
Total	160	123	37	76.9	23.1	3.3	1	0.30	0.61	0.97	0.35
Homogeneity df = 3								2.72	0.45	3.18	0.99
Total Groups I + II	310	247	63	79.7	20.3	3.9	1	3.62	0.05	0.02	0.90
GROUP III *Seeded cultivar with black berry skin and red berry juice x Seedless cultivar with black berry skin and white juice*											
Grand noir x Beauty seedless	38	32	6	84.2	15.8	5.3	1	1.42	0.20	0.42	0.73
Grand noir x Kondarev 10	44	37	7	84.1	15.9	5.3	1	1.94	0.19	0.46	0.75
Grand noir x Roussalka 3	43	36	7	83.7	16.3	5.1	1	1.74	0.20	0.37	0.56
Grand noir x Korintsko black	28	24	4	85.7	14.3	6.0	1	1.71	0.20	0.57	0.72
Total	153	129	24	84.3	15.7	5.4	1	7.08	0.00	1.78	0.21
Homogeneity df = 3								0.03	0.99	0.04	0.99
GROUP IV *Seeded cultivar with black berry skin and red berry juice x Seedless cultivar with white berry skin and white juice*											
Grand noir x Roussalka 1	54	43	11	79.6	20.4	3.9	1	0.62	0.55	0.0	100
Grand noir x Kondarev 6	36	30	6	83.3	16.7	5.0	1	1.33	0.25	0.25	0.65
Grand noir x Roussalka	49	38	11	77.5	22.5	3.5	1	0.17	0.70	0.18	0.88
Grand noir x Nedelchev VI-4	23	20	3	87.0	13.0	6.7	1	1.75	0.20	0.70	0.43
Total	162	131	31	80.9	19.1	4.2	1	2.97	0.10	0.08	0.94
Homogeneity df = 3								0.79	0.85	0.20	0.97
Total Groups III + IV	315	260	55	82.5	17.5	4.7	1	9.55	0.00	1.27	0.26
GROUP V *Seeded cultivar with black berry skin and white berry juice x Seeded cultivar with black berry skin and red juice*											
Mavrud x Alicante Bouschet	35	25	10	71.4	28.6	2.5	1	0.24	0.67	1.61	0.22
Mavrud x Grand noir	41	33	8	80.5	19.5	4.1	1	0.66	0.44	0.0	100
Evmolpiya x Alicante Bouschet	57	46	11	80.7	19.3	4.2	1	0.99	0.30	0.0	100
Evmolpiya x Grand noir	28	22	6	78.6	21.4	3.7	1	0.19	0.60	0.04	100
Total	161	126	35	78.3	21.7	3.6	1	0.91	0.37	0.30	0.61
Homogeneity df = 3								1.77	0.75	0.05	100
Total Seeded x Seedless	625	507	118	81.1	18.9	4.3	1	12.5	0.05	0.49	0.50
Homogeneity df = 15								11.39	0.73	12.61	0.62
Total Groups I + II + III + IV + V	786	633	153	80.5	19.5	4.1	1	12.84	0.01	0.14	0.72
Homogeneity df = 19								13.2	0.76	14.8	0.74

LEGEND: W - seedlings with white berry juice; R - seedlings with red berry juice.

and for groups I-IV and V – 2.8% at $t_{exp.}$=0.78 – $P_{0.500}$>$P_{0.05}$. This means that the seedlings with red colour of berry juice in the hybrid combinations between Alicante Bouschet and the seedless cultivars are 20.3%, and in the hybrid combinations with Grand noir – 17.5%. The differences between the crosses seeded x seedless and seeded x seeded cultivars are 18.9% and 21.7% respectively.

Group V encompasses the crosses between the seeded cultivars: Mavrud x Alicante Bouschet, Mavrud x Grand noir and Evmolpiya x Alicante Bouschet, Evmolpiya x Grand noir. Their percentage values are 71.4%/28.6% - 80.7%/19.3% with ratios 2.5:1 – 4.2:1, and totally – 78.3%/21.7% with reliability $P_{0.61}$ at a theoretical ratio 4:1.

In all hybrid combinations, the white colour (W) of berry juice in seedlings dominates over the red colour (R). The average percentage ratio W/R is 4.1:1 with variation from 2,3:1 to 6,7:1, with the exception of the cross Alicante Bouschet x Korintsko black. The zero hypothesis at the assumed theoretical ratios has high reliability in four crosses at 3:1 – from $P_{0.45}$ to $P_{0.75}$, and in sixteen crosses – at 4:1 – from $P_{0.18}$ to P_{100}. The obtained ratios between seedlings with white and red berry juice differ in the separate crosses, which characterizes the genotypic heterogeneity of parent cultivars. The genotypic heterogeneity is best presented by means of the analysis of the certainty of differences in the alternative variation of the trait colour of berry juice in the hybrid combinations be-

Table 2
Inheritance of the colour of berry skin and juice and seedlessness in F_1 progeny of crosses between seeded and seedless vine cultivars

Hybrid combinations	Total number	Number of plants				%				K	
		Seeded		Seedless		Seeded		Seedless		Seeded	Seedless
		W	R	W	R	W	R	W	R	W/R	W/R
GROUP I *Seeded cultivar with black berry skin and red berry juice x Seedless cultivar with black berry skin and white juice*											
Alicante Bouschet x Beauty seedless	52	45	3	-	4	86.5	5.8	-	7.7	14.9	-
Alicante Bouschet x Kondarev 10	46	33	12	-	1	71.1	26.1	-	2.2	2.7	-
Alicante Bouschet x Roussalka 3	25	21	1	-	3	84.0	4.0	-	12.0	21.0	-
Alicante Bouschet x Korintsko black	27	25	2	-	-	92.6	7.4	-	-	12.5	-
Total	150	124	18	-	8	82.7	12.0	-	5.3	6.9	-
GROUP II *Seeded cultivar with black berry skin and red berry juice x Seedless cultivar with black berry skin and white juice*											
Grand noir x Beauty seedless	38	32	3	-	3	84.2	7.9	-	7.9	10.6	-
Grand noir x Kondarev 10	44	37	6	-	1	84.1	13.6	-	2.3	6.2	-
Grand noir x Roussalka 3	43	36	5	-	2	83.7	11.6	-	7.7	7.2	-
Grand noir x Korintsko black	28	24	4	-	-	85.7	14.3	-	-	6.0	-
Total	153	129	18	-	6	84.3	11.8	-	3.9	7.1	-
Total Groups I + II	303	253	36	-	14	83.5	11.9	-	4.6	7.0	-
GROUP III *Seeded cultivar with black berry skin and red berry juice x Seedless cultivar with white berry skin and white juice*											
Alicante Bouschet x Roussalka 1	53	40	6	2	5	75.5	11.3	3.8	9.4	6.7	0.4
Alicante Bouschet x Kondarev 6	38	27	9	1	1	71.1	23.7	2.6	2.6	3.0	1.0
Alicante Bouschet x Roussalka	40	24	10	4	2	60.3	25.0	10.0	5.0	2.4	2.0
Alicante Bouschet x Nedelchev VI-4	29	24	3	1	1	82.8	10.4	3.4	3.4	8.0	1.0
Total	160	115	28	8	9	71.9	17.5	5.0	5.6	4.1	0.9
GROUP IV *Seeded cultivar with black berry skin and red berry juice x Seedless cultivar with white berry skin and white juice*											
Grand noir x Roussalka 1	54	41	8	2	3	75.9	14.8	3.7	5.6	5.1	0.7
Grand noir x Kondarev 6	36	28	4	2	2	77.8	11.1	5.6	5.6	7.0	1.0
Grand noir x Roussalka	49	35	9	3	2	71.4	18.4	6.3	4.0	3.9	1.5
Grand noir x Nedelchev VI-4	23	19	2	1	1	82.6	8.8	4.3	4.3	9.4	1.0
Total	162	123	23	8	8	75.9	14.3	4.9	4.9	5.3	1.0
Total Groups III + IV	322	238	51	16	17	73.9	15.8	5.0	5.3	4.7	0.9
Total Groups I + II + III + IV	625	491	87	16	31	78.6	13.9	2.6	5.0	5.7	0.5

LEGEND: W - seedlings with white berry juice; R - seedlings with red berry juice; K - coefficient W/R

tween each of the cultivars crossed with Alicante Bouschet and Grand noir. In the studied eight alternative hybrid combinations the differences between the arithmetical means are within the range 0,8%-9,6% with varying reliability of the zero hypothesis from $P_{0,100}$ to $P_{0,500}$ at a borderline level of the differences $P_{0,050}$. In comparison with the ratio between seedlings with white and red berry juice (W/R), the parallel crosses of the seedless cultivars with Alicante Bouschet and Grand noir are characterized by relatively small differences – in Beauty seedless – 6.4 and 5.3, in Roussalka 3 – 5.3 and 5.1, Nedelchev VI-4 – 6.3 and 6.7, Roussalka 1 – 3.8 and 3.9, Roussalka – 2.3 and 3.5, Evmolpiya – 4.2 and 3.7; larger differences are observed in Kondarev 10 – 2.5 and 5.3, Kondarev 6 – 2.8 and 5, Mavrud – 2.5 and 4,1; and the biggest difference is reported in Korintsko black – 12.5 and 6.0 in which heterogeneity is the highest. The small and unproven differences between the percentage ratios of the traits means that genotypic similarity exists between the seedless and seeded cultivars (analyzers), which determines this inheritance.

In order to determine the influence of the trait colour of berry skin on the inheritance of the colour of berry juice, the alternative crosses of Alicante Bouschet and Grand noir with the seedless cultivars with black berry skin from Groups I and III, and with white berry skin – Groups II and IV, have been analyzed. The difference between Group I – cultivars with black berry skin, and Group II – with white berry skin, crossed with Alicante Bouschet having black skin, is 5.8% at $t_{exp.}>P_{0.400}$, and between Group III – cultivars with black berry skin and Group IV – with white berry skin, crossed with Grand noir, the difference is 3.4% at $t_{exp.}>P_{0.500}$, which means that the zero hypothesis has been confirmed since $t_{exp.}>P_{0.05}$. The difference between the total values of Groups I + II and III + IV, which is 5.0% at $t_{exp.}>P_{0.500}$, is also unreliable. Data indicates that even though by a small and unproven difference, seedlings with black skin slightly exceed in number the ones with red colour of berry juice, which is also confirmed by the percentage ratio of the trait in the consolidated groups.

The results related to the decomposition of the studied trait in the separate hybrid combinations according to its percentage ratio in the seeded and seedless seedlings, have been presented by dividing the crosses into four groups (Table 2). Groups I and II include the crosses of Alicante Bouschet and Grand noir with Beauty seedless, Kondarev 10, Roussalka 3 and Korintsko black, and Groups III and IV – the crosses with Roussalka 1, Kondarev 6, Roussalka and Nedelchev VI-4. In the first group of crosses the percentage ratio between seedlings with white and red berry juice from the seeded plants is 71.1%/26.1% - 92.6%/7.4%, and from the seedless ones – from 2.2% to 12.0% of seedlings have red colour only. In the consolidated data, the ratio is 82.7%/12.0% - 5.3%. The results from Group II are analogous – this ratio is from 83.7%/11.6% to 85.7%/14.3% for the seeded plants, and from 2.3% to 7.9% - only with red colour for the seedless. In the total results, the percentage ratios for the seeded seedlings are 84.3%/11.8% and for the seedless – 3.9% are with red colour. The total ratios for the crosses from Groups I and II respectively are 83.5%/11.9% for the seeded, and 4.6% for the seedless plants with red colour.

In Group III the percentage ratios for the seeded seedlings range from 60.3%/25.0% to 82.8%/10.4%, for the seedless ones – from 2.6%/2.6% to 10.0%/5.0%, and in total – 71.9%/17.5% for the seeded and 5.0%/5.6% for the seedless plants. In Group IV this ratio is from 71.4%/18.4% to 82.6%/8.8% for the seeded seedlings, and from 3.7%/5.6% to 6.3%/4.0% for the seedless. The total results for the seeded plants are 75.9%/14.3%, and for the seedless – 4.9%/4.9%. The total ratio for the combined groups III + IV is 73.9%/15.8% for the seeded plants, and 5.0%/5.3% – for the seedless. The consolidated data from all groups – I + II + III + IV is 78.6%/13.9% for the seeded plants and 2.6%/5.0% - for the seedless.

The phenotypic decomposition of this trait in F_1 progeny of the investigated hybrid combinations shows that genetic processes do not take place synchronously in the seeded and seedless plants. In the crosses from Groups I and II in which the seedless cultivars with black berry skin participate, only the red colour of berry juice is manifested in all seedless seedlings, whereas in Groups III and IV where the seedless parent cultivars have white colour of the skin, both colours have been observed in the berry juice of seedlings. Data shows that in Group III the coefficient K is within the range from 2.4 to 8.0 for the seeded plants, from 0.4 to 2.0 – for the seedless, and totally – 4.1/0.9. In Group IV its values are from 5.1 to 9.4 for the seeded plants, from 0.7 to 1.5 for the seedless, and in total – 5.3/1.0. Totally for groups I + II + III + IV this coefficient is 5.7 for the seeded and 0.5 for the seedless plants.

Due to the comparatively limited number of the experimental plants used in this research, only a few assumptions can be made about the inheritance of the colour of berry juice in the seeded and seedless seedlings from F_1 progeny. A genetically determined interrelation exists between the colours of berry skin and berry juice. In the hybrid combinations from Groups I and II where both parent cultivars are with red colour of berry skin but with a different colour of berry juice, only the red colour of berry juice is manifested in the seedless seedlings. In the crosses form Groups III and IV parent cultivars have different colours of berries and juice, and in the seedless seedlings, both colours are manifested in berry juice. The analysis shows that the inheritance of this trait does not correspond to the monohybrid dominant and incompletely dominant decomposition in all possible theoretical homozygotic and heterozygotic combinations. There

is also no correspondence with the hypothesis about the complementary action of the genes which determine the development of a new trait, in contrast to what is established for the inheritance of the colour of berry skin in vine. Seeded and seedless seedlings with red colour of berry juice have been obtained in all hybrid combinations, with the exception of the crosses with the cultivar Korintsko black, which shows that the manifestation of this trait in F_1 progeny depends on the type of parthenocarpy of the seedless cultivars. The quantity of the seedless plants having red berry juice is small and varies from 2.2% to 12.0%, and their number is relatively larger in the hybrid combinations Alicante Bouschet x Beauty seedless – 7.7%, Grand noir x Roussalka 3 – 7.7%, Grand noir x Beauty seedless – 7.9%, Alicante Bouschet x Roussalka 1 – 9.4%, Alicante Bouschet x Roussalka 3 – 12.0%, followed by Alicante Bouschet x Roussalka – 5.0%, Grand noir x Roussalka 1 – 5.6% and Grand noir x Kondarev 6 – 5.6%.

Conclusions

The inheritance of the white and red colour of berry juice in F_1 progeny of hybrid combinations between seeded and seedless vine cultivars is in a ratio from 2.3:1 to 6.0:1. The white colour of the juice is a dominant trait in all hybrid combinations in spite of the very slightly manifested heterogeneity of parent cultivars. The theoretical ratios between seedlings with white and red berry juice – 4:1 and 3:1 – are characterized by high reliability of the zero hypothesis in the majority of the studied crosses. The homozygotic dominance of the tinctorial cultivars Alicante Bouschet and Grand noir in relation to the colour of berry skin has been confirmed.

The manifestation of the trait colour of berry juice is specific in each of the hybrid combinations. When parent cultivars with red berry skin are crossed, the seeded seedlings have white and red colour of berry juice, while the seedless plants are with red colour only. If the parthenocarpic parents have white berry skin, the seedless seedlings are with white and with red colour of berry juice. The ratios between the two colours differ significantly in the seeded and seedless plants. The phenotypic expression of this trait in F_1 progeny depends on the type of parthenocarpy of the seedless cultivars.

In the course of this investigation, seedless plants with red berry juice have been developed for the first time, which provide rich and diverse initial source for further breeding research and selection of elite vine forms and cultivars. Their grapes will be suitable for direct consumption, as well as for the production of raisins, juice and wine, which will possess superior nutritional and medicinal qualities. The obtained experimental data provides valuable information, which can be used for extensive scientific researches aimed at determining the genetic character of this trait.

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