Scientific Papers. Series B, Horticulture. Vol. LXVIII, No. 1, 2024
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

STUDY ON THE QUALITATIVE PROFILE OF SOME SEEDLESS VINE VARIETIES IN A TEMPERATE CLIMATE

Marinela STROE, Georgeta Mihaela BUCUR, Laura BRAUMAN

University of Agronomic Sciences and Veterinary Medicine of Bucharest,
59 Marasti Blvd, District 1, Bucharest, Romania

Corresponding author email: marinelastroe@yahoo.com

Abstract

In grapevine varieties - the lack of seeds seen from the perspective of two phenomena parthenocarpy and stenospermocarpy - has a major impact on the consumer, representing an important added economic value, currently being one of the most appreciated features of table grape varieties. In the present work, four varieties of grapes intended for fresh consumption but also for raisins were studied - 'Sultanina' (Thompson seedlles), 'Sublima', 'Supernova' and 'Călina'. The obtained results showed that the productive and qualitative performances obtained, expressed by the values of the productive indices and the organoleptic qualities (brix, glucose, fructose, acidity, gluco-acidometric index), both in the fresh product and in the raisins, correspond to the quality standards. The surprising fact is that these varieties ensure a double use - firstly as table grapes for fresh consumption and secondarily as raw material for obtaining raisins (artificial dehydration at a temperature of 50^{0}C).

Key words*: grape, raisins, temperature, varieties, yield.*

INTRODUCTION

Grapes (*Vitis vinifera*) are one of the most famous fruits in the world (Khiari et al., 2019; Olmo-Cunillera et al., 2019; Keqin Chen et al., 2022). In grapevine varieties - the lack of seeds seen from the perspective of two phenomena parthenocarpy and stenospermocarpy - has a major impact on the consumer, representing an important added nutraceutical and economic value, being one of the most appreciated features of table grape varieties along with the other qualities, like: table grapes are delicacy fruits, they are the requested and consumed fruit-food, due to the rich and varied chemical composition necessary for the health and vitality of the human body. Their consumption, both fresh, but also as a raw material in the confectionery industry, has always been an important economic pole. Regular and correct consumption in the fresh state has also proven its therapeutic action, given by the concentration of phenolic compounds (over 500 compounds) accumulated in the skin, pulp and seeds of a series of microelements that favor metabolism, the presence of resveratrol - a powerful antioxidant, a real inhibitor of cancer cell growth (Cichi et al., 2023; Stroe and Catuneanu, 2022; Mahanna et al., 2019; Tahereh et al., 2020; Benbouguerra et al., 2021), and last but not least, the presence of substances that favor the weight loss process, however they also contain glucose (Haitao et al., 2021). The high content of raisins in sugars, fiber, vitamins, minerals and antioxidants against the background of a low to moderate glycemic index helps to maintain the best oral pH and oral health. Therefore, raisins are usually consumed as healthy snacks or food additives (Khiari et al., 2019). Three-four decades ago, only varieties intended for obtaining raisins were cultivated - raisins are produced by partially dehydrating berries grape - but nowadays, in the world, the cultivation of these varieties has come to be practiced in over 30 countries, although for a long time their cultivation it could not exceed the limits of the warm climate (Mediterranean climate), where drying was done right under the open sky. In this context, obtaining seedless varieties has become a main objective in the breeding programs of countries with a wine-growing tradition, along with the increase in consumer demands and demands for seedless fruits and vegetables. It's weel known that in the raisin industry the varieties belonging to the 'Corinth' and 'Sultanine' sortogroups are the most used, but due to the fact that through their culture in more northern areas (they are of southern origin) they

have a weak differentiation of the fruit buds, found in a small percentage of fertility buds, it was necessary to create and cultivate new varieties, varieties adaptable to less favorable climatic conditions (temperate climate). In this context, producers and researchers focus more on the quality of the product - described by the specific and also measurable carpometric indicators: berry size, shape, compactness of the grapes, color of the berries, consistency, taste and aroma of the pulp, thickness of skins, thickness of the skin layer, color uniformity at full maturity, ripening period or any other qualitative attribute specific to the fruit. Therefore, the assortment of new varieties introduced into the culture took on a new allure, that of ensuring a double use - first of all as table grapes for fresh consumption and secondarily as raw material for obtaining raisins. Against this background, the consumer market both globally and nationally has grown significantly from year to year (FAO, 2020), drawing attention to the need to ensure competitive products in terms of sensory and visual characteristics. In our country, table grapes currently have a share of only 6.9% of Romania's wine production (O.I.V., 2022), and on a global level, table grapes represent 31.5 million tons - 44.5% of the total wine production and dried grapes is 5.7 million tons - 8.0%. In other words, in Romania, the production of table grapes is almost stagnant in the last 10 years and at a quarter of the maximums recorded in the last 30 years.Based on these principles, the present study was approached starting from two considerations: to evaluate the quantitative and qualitative performances of the varieties in an area different from the one of origin and to appreciate their profile in terms of the possibility of obtaining raisins following the kinetics of individual ripening of the berries at the time of harvesting (quantitative evaluation of the fresh mass and sugar accumulation), related in the second plan to the dehydration capacity.

MATERIALS AND METHODS

Plant Material and Growth Condition

The research was carried out in the 2022-2023 seasons and for this were taken into study, 4 varieties of grapes intended for fresh consumption but also for raisins: ‘Sultanina’ (Thompson seeds), ‘Sublima’, ‘Supernova’ and ‘Călina’. The first three varieties are some of the most cultivated in the world, but also in our country ‘Sultanina’ (Thompson seedlles) and a local variety Calina.The varieties are located in the experimental field of the ampelography collection from University of Agronomic Sciences and Veterinary Medicine of Bucharest, with the code “ROM 06” in www.vivc.de (N Lat.: 44°47'07"; E Long.: 26°07'28"; alt. 87 m). The experimental field planted in 2018 at a distance by 2.2 m (inter-row) and 1.2 m (intra-row), with a density of 3787 plant ha-1. The type of pruning applied is double Guyot on the stem 1.0 m, and the crop load distributed on the plant was 30 buds/vine. The variety ‘Călina’ was grafted on Teleki 4 SO4-4 Blaj (*Vitis berlandieri* × *Vitis riparia*) rootstock; The variety ‘Sublima’ and ‘Supernova’ were grafted on SO4-5 and variety ‘Sultanina’ was grafted on SO4-102. During the vegetation period, a whole set of green works and operations specific to the apyrene varieties was applied - the shoots were manually directed vertically whenever necessary and in the last days of July a slight shortening of the shoots was carried out, leaving a canpy eight of approximately 1.8 m. The vine was managed with irrigation in the critical phenophases (intense berrie growth) and a standard disease control program to control downy mildew, powdery mildew and gray rot (*Botrytis*), as well as applying a 23.05.2023 one treatment to stimulate the flower set process and balanced nutrition, thus increasing plants resistance to stress conditions as well as "hidden" deficiencies of other micronutrients. (quite difficult in seedless varieties).

Short presentation of variety ‘Călina’

The variety studied was the Călina variety - It is the first apiren variety obtained in our country and immediately introduced into culture. a new apirin variety obtained in Romania in 1985 in the Research and Development Station for Viticulture and Oenology Dragasani-Valcea by Mircea Mărculescu in the cross section of the two varieties ‘Braghina’ and ‘Sultanina’. The main direction of production is for fresh consumption, but also for the production of raisins. In terms of the appearance, it resembles the ‘Sultanina’ a variety.

https://www.vivc.de/index.php?r=passport%2Fview&id=1996

Short presentation of 'Sublima'

It is a variety native to Argentina, created by Angel A. Gargiulo at the National Institute of Agricultural Technology Rama Caida in Argentina. The parents of this variety are 'Carina' and Gargiulo 88435 ('Almeria' x 'Cardinal'). The main direction of production is for fresh consumption and production of raisins. https://www.vivc.de/index.php?r=passport%2Fview&id=17812

Short presentation of 'Supernova'

It was obtained by M.S. Zhuravel, G.M. Borzikova and I.P. Gavrilov at the Horticultural Research Institute of Uzbekistan. The parents are 'Cardinal' and 'Kişmiş Rozovyi'. The variety has a medium-large, ovoid, pink berrie. The flesh is crunchy and it is used in the country of origin both as a table variety and as a variety for raisins (https://www.vivc.de/index.php?r=passport%2Fview&id=15517)

Short presentation of 'Sultanina' (Thompson seedles)

It is a variety of Asian origin, the exact region of origin not being known. It is assumed that it originates from Iran or Turkey and is part of Proles orientalis - subproles antasiatica. The grapes of this variety are used especially for raisins and for consumption in the state fresh, juice (https://www.vivc.de/index.php?r=passport%2Fview&id=12051)

Climate Data

For this study, there were used weather data recorded at Bucharest-Baneasa meteorological station for the experimental period (2022-2023), a series of climatic data were studied (Table 1), and monthly average temperatures were used to evaluate a set of bioclimatic indices commonly used in viticulture: Huglin index (HI), Winkler index (WI) and cool night index (CNI).

Sampling and Chemical Analysis

In order to assess the descriptive parameters of the quality, determinations of biochemical parameters of the grapes was made, as follows: For the determination of fruit firmness, the electronic penetrometer TR was used, with a piston of 3 mm diameter, the results being expressed in N/cm^2. The contents of total soluble solids, glucose and fructose were determined from 4 grape berries for each sample: with refractive device Kruss DR301-95 (% Brix) for total soluble solids (TSS) (Mureşan, 2014; Oltenacu, 2015; Saei, 2011; Tolić, 2015; Yoon, 2005), with refractive device Milwaukee MA873 (%) for glucose and with refractive device Milwaukee MA872 (%) for fructose (Enciu (Bunicelu) et al., 2021). The total titratable acidity (TA) was determined by titration with 0.1N NaOH to pH 8.1, and the results were expressed in g tartaric acid/100 g. Titratable acidity calculation was done using the formula: Titratable acidity (%) = (V x N x C x 100)/m, where: V = volume of NaOH consumed; N = NaOH normality; C = tartaric acid equivalent; m = sample mass; C has values: 0.0075 to express acidity in tartaric acid (grapes, shoots, bananas). The maturity index, known also like acidometric equilibrium index, was calculated using the formula: TSS/TA. Dehydration and drying of berrie was carried out with the Excalibur 4948CDB dehydrator, 600W used for drying vegetables, fruits, greens, medicinal plants, aromatic plants, vegetable chips and vegetable leaves.

Table 1. The main climatic parameters and bioclimatic indices during the experimentation period

Climatic parameters and bioclimatic indices	Average	Years		Average
	1981-2010	2022	2023	2022-2023
Average annual temperature, ºC	11.55	12.99	14.61	13.80
Average temperature in the growing season (IV-X), ºC	18.07	18.95	21.01	19.98
Average temperature in summer (VI-VIII), ºC	22.50	24.07	27.22	25.64
Average annual minimum temperature, ºC	5.03	5.9	7.1	6.5
Average annual maximum temperature, ºC	17.05	19.8	21.2	20.50
Average maximum temperature in the warmest month, ºC	29.87	32.94	33.9	33.42
Average maximum temperature in summer (VI-VIII), ºC	29.01	32.03	32.86	32.44
Annual total precipitation, mm	608	383.6	435.1	410.35
Total precipitation in the growing season (IV-X), mm	428	281	216.5	298.75
Total precipitation in summer (VI-VIII), mm	198	90.4	93.7	92.05
Huglin index (HI)	2346	3549.6	4054.4	3802
Winkler index (WI)	1726	1898.18	2356.14	2127.16
Cool night index (CNI)	10.45	10.43	14.1	12.26

For this, 2500 g of berrie from the entire harvest obtained from the 9 vines/variety, for each individual sample, were randomly detached from the pedicel. Regarding the determinations made to establish the degree of dehydration was made according to the formula (AOAC 20 013, 1997), and the time was 24 h. In this regard, Moisture content (%) = [(initial weight - final weight)/initial weight]. Establishing the rehydration capacity of dehydrated products as determined by the method proposed by Rozsa, 2019, and using the following formulas. The rehydration ratio Rr represents the ratio between the mass of the rehydrated sample (R) and the mass of the dehydrated sample (D), is calculated according to the relation: RR = the mass of the rehydrated sample/the mass of the dehydrated sample. The water content of the rehydrated sample is as follows: WC = {R-[D-(DxU)]/R} x 100 in which: WC = amount of water of the rehydrated sample, in %; R = mass of the rehydrated sample, in g; D = mass of the dehydrated sample taken as analysis, in g; U = the amount of water contained in one gram of product dehydrated in g. The rehydration capacity represents the percentage of water in the rehydrated material and is calculated according to the relation: Rc = R/[D-U/100-W) in which: Rc = rehydration capacity, in %; W = water content of the fresh product, in %. 400 ml of water were used for rehydration for 100 g raisins. Products that absorb more than 80% of the water lost during dehydration in the rehydration process are considered to be of very good quality, and when the water absorbed is below 50%, the products are considered to be of poor quality (Rozsa, 2019; Călugăr A. et al., 2022). All determinations were performed in triplicate. Statistical analyses were performed using Excel, including: average, standard deviation.

RESULTS AND DISCUSSIONS

Climatic conditions

The analysis of the climatic elements (Table 1) of the 2023 wine year shows high thermal resources, against the background of much too low water resources, at least during the vegetation period (IV-X), with very fluctuating values compared to the 2022 wine year, but also to the average of the last decade (1981-2020) taken into account, as a starting point in assessing the impact of climate change on livelihoods. Practically, since then, the trial of varieties less adapted to the temperate climate has become a source of study and the diversity of vine varieties is an important resource for adapting to climate change (Destrac-Irvine et al., 2020; Antolin et al., 2021). As for the synthetic indicators - Huglin index (HI), Winkler index (WI), Cool night index (CNI), their values were very high, but the largest amplitude was for (HI), which passes from IH4 – warm temperate climate in the arm climate of the type warm IH5 - (IS1, IH5, IF2) (Savu and Stroe, 2005; Savu and Stroe, 2007). For the indicator (CNI), the recorded values are also very high - indicating a climate with cold nights of the IF+1 type (Savu and Stroe, 2007), with the limits between 12^0C and 14^0C at least for the year 2023 and the average of the last 2 years, indicating a possible decrease during the night of some fractions of the quality compounds. Practically the temperatures recorded during the night and the differences from day to night in the last month of the ripening of the grapes leaving their mark, as follows: the TSS, TA values listed in Table 3, are located at the lower limit of its potential according to the data in the genetic passport of the varieties.The evaluation of the quantitative and qualitative performances for the four experimental variants cultivated in/an area different from the one of origin, highlights a behavior that suggests a rather low degree of adaptation, as follows: at the time of harvesting, (4^{th} September 2023), the 'Supernova' variety obtains the highest number of grapes per vine, reflected in a high production per vine and per hectare, respectively 4.73 kg/vine and 17916.66 kg/ha, practically recalling the productivity of the parents - the 'Cardinal' and **'**Kişmiş Rozovyi' varieties. Equally, the native variety 'Călina' excels under the conditions of the 2022-2023 wine year with an equally high production, 16,931 kg/ha, being within the productive limits of the variety in the area where it was obtained (Dragăsani, an area with vocation and for apyrene varieties). The 'Sultanina' variety achieves the lowest production, but considering that the specialized literature shows (Stroe, 2012) that this variety has a low production in Romania, the harvest of the wine year in the experimental field reflects

an exceptional amount - 1.53 kg/vine and 5,814.39 kg/ha. Regarding the qualitative panel of the harvest presented in Tables 3, 4, a somewhat expected evolution can be observed under the quantity/ quality ratio, highlighted by the accumulation limits of TSS (%) and TA (mg/100 g fw), as follows: the 'Sultanina' variety, which had the lowest harvest, has the highest value of 22.35% (equivalent to 214.7 g/L), which, associated with the acidity, demonstrates a perfect organoleptic balance, illustrated by the gluco-acidometric index value.

On the same note, the 'Călina' variety is presented, very productive, but not without balance.

The 'Sublima' and 'Supernova' varieties with 19.76% - 189.6 g/L and 21.17% - 205.5 g/L, against the background of a slightly lower acidity, maintain their quality profile for a more fresh consumption compared to production of raisins. Firmness and pH did not show significant differences between the varieties, the values being very close.

Table 2. Grapes quantitative and qualitative parameters (2022-2023)

Varieties	No. of grapes/vine	Average weight of a grape (g)	Weight of 100 berries (g)	Y/v[1] (kg/vine)	Y/ha (kg)
Calina	23	201.4	148.66	4.47	16.931
Sultanina	10	161.0	130.88	1.53	5814.39
Sublima	10	226.11	246.00	2.20	8344.69
Supernova	31	151.00	202.66	4.73	17916.66

[1]Y/v = Yield/vine (kg)

Table 3. Variation of: TSS (%), glucose (%), fructose (%), TA during the 2022-2023

Samples	TSS[2](%)		Glucose (%)		Fructose (%)		TA[3](mg/100 g fw)	
	Average	Std. dev.	Average	Std. dev.	Average	Std. dev.	Average	Std. dev.
Calina	22.08	±2.39	22.95	±2.37	23.04	±2.33	2.38	±0.16
Sultanina	22.35	±1.10	24.06	±0.99	24.15	±0.89	3.14	±0.22
Sublima	19.76	±2.32	20.58	±2.62	20.73	±2.73	1.86	±0.14
Supernova	21.17	±2.20	21.77	±2.11	22.31	±2.10	1.97	±0.15

[2]TSS% = total soluble solids (Brix); [3]TA% Titrable acidity

Table 4. Variation of: Gluco-acidometric index, ph and fermity during the 2022-2023

Samples	Gluco-acidometric index		pH		Fermity (N/cm²)	
	Average	Std. dev.	Average	Std. dev.	Average	Std. dev.
Calina	9.28	±1.40	3.66	±0.08	0.19	±0.08
Sultanina	7.12	±0.49	3.49	±0.08	0.22	±0.16
Sublima	10.36	±1.60	3.5	±0.05	0.18	±0.08
Supernova	10.72	±1.51	3.41	±0.08	0.20	±0.14

Tabel 5. Variation of degree of dehydration and rehydration capacity for varieties seedlles analyzed (2022-2023)

Formulas	Parameters	Varieties			
		Călina	**Sultanina**	**Sublima**	**Supernova**
Moisture content (%) = [(initial weight - final weight)/initial weight]	initial weight (g)	2500	2500	2500	2500
	dehydrated weight (g)	732.95	924.87	946.37	946.89
RR = the mass of the rehydrated sample/the mass of the dehydrated sample	water content of the rehydrated sample (g)	1767.05	1575.13	1553.63	1553.11
	water content of the rehydrated sample (%)	70.68	63.01	62.15	62.12
WC = {R-[D-(DxU)]/R} x 100	weight mass fresh for 100 g raisins:	341.09	270.31	264.17	264.02
Rc = R/(D-U/100-W)					
	weight 100 raisins (g)	43.01	48.42	93.23	76.79

Figure 1. Dehydration of berries grapes in Excalibur 4948CDB dehydrator (50^0C)

Following the dehydration process carried out with the Excalibur 4948CDB dehydrator, 600W (Figure 1) and using 2500 g of berries from the entire harvest obtained for each individual sample, then listed in Table 5, it shows that the 'Călina' and 'Sultanina' varieties have the highest dehydration capacity, seen from the perspective of quantity total water lost and a weight mass fresh for 100 g raisins - 341.09 g, respectively 270.31 g. This fact underlines the profile of the two varieties, namely, that of being intended mainly for obtaining raisins and then fulfill the advantage as a table variety. The 'Sublima' and 'Supernova' varieties, as a result of the obtained data, lose an amount close to the 'Sultanina' variety after dehydration, but the amount of weight mass fresh for 100 g raisins is lower.

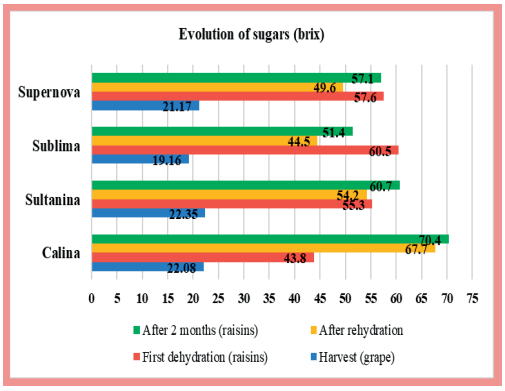

Figure 2. Qualitative limits after rehydration

The results obtained by rehydration (Figure 2). after one month in 400 ml of water show that the trend is opposite to that of dehydration. The varieties 'Călina' and 'Sublima' assimilate the largest amount of water (Figure 3).

Figure 3. Qualitative raisins for the experimental variants

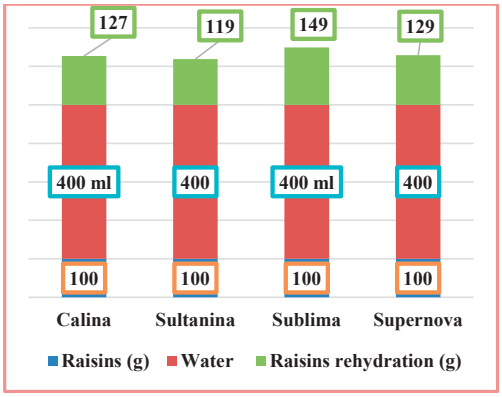

Figure 4. The evolution of sugars in the 4 experimental variants

Regarding the evolution of sugars in the four experimental variants, it can be observed that (Figure 4), the varieties 'Călina' and 'Sultanina' keep their high values, even two months after obtaining the raisins. This fact highlights once more, that the native variety 'Călina' has the profile of a fiery variety for raisins first and then as a table grape. For the 'Sublima' variety, the data recorded during this study demonstrate that it is a variety for fresh consumption, quite productive, and on a secondary level it can be used in obtaining raisins or industrialization. The 'Supernova' variety surprises in the climatic conditions of Romania, both in terms of

productive growth and in terms of quality, having a well-defined mixed profile.

CONCLUSIONS

The behavior of the four varieties in an area quite favorable for grapevine cultivation (N Lat.: 44°47'07"; E Long.: 26°07'28"; alt. 87 m), reported to the objectives of the study - cultivating them in somewhat cooler areas, once unsuitable for the cultivation of fire varieties, permissive as a solution to climate changes - demonstrates their good adaptability. The 'Supernova' variety surprises in the climatic conditions of Romania, both from a productive and from a qualitative point of view, having a well-defined mixed profile, based on the results obtained.

Following the study, a mixed profile of these varieties can be noted - fresh consumption of the four, less the 'Călina'variety, but also the obtaining of raisins, perhaps for this second quality, at the beginning, only at the artisanal farm level (guest house). Raisins, in this case, can be obtained very easily at home, by using the dryers used in this study.

Although, in the years in which the varieties were obtained, climate change was modestly anticipated and the possibility that they could be cultivated in/an area less friendly for obtaining raisins, the results obtained demonstrate this advantage of them.

ACKNOWLEDGEMENTS

This research work was carried out with the support and was financed from Project ADER 6.1.7/18.07.2023, partnership No. 7, University of Agronomic Sciences and Veterinary Medicine of Bucharest.

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