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EVALUATION OF QUALITY OF 'SULTANINE' AND 'CORINTH' RAISINS OBTAINED FROM GRAPES GROWN IN A COOL CLIMATE

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Abstract

Two Vitis vinifera grape varieties 'Sultanine' and 'Corinth' were used to obtain raisins. The vines are grown in a cool climate (Cluj Napoca - in NV of Romania, an area not included in a viticultural area). During 2020, the grapes were harvested at 195 g/l - 'Sultanine' and 234 g/l for 'Corinth'. The berries were dehydrated using a household Gorenje 240W drier, at 40°C, for 24 hours. The soluble dry matter content for raisin was higher for raisins of the 'Corinth' variety (61.11%) and for the 'Sultanine' (59.89%). Regarding the moisture of the finished product - raisins, a high content was determined for the variety 'Sultanine' - 19%, followed by the variety 'Corinth' - 15.61%. The rehydration power of raisins had values of over 80% for both types of raisins. For the amateur culture, these varieties can be recommended, given that, in recent years, due to climate change, there have been no temperatures in this area during the rest period that could cause frost over the winter. The warm autumn favoured reaching full maturity for these varieties, even in the conditions in Cluj. Raisins can be easily obtained in the household, by using household dryers..

Key words*: 'Corinth', dried berries, dried grapes, grape, raisin, 'Sultanine', quality.*

INTRODUCTION

Drying fruit is an ancient practice for the preservation of food that is still in use nowadays (Coimbra et al., 2011). Raisins are obtained by drying different cultivars/varieties of *Vitis vinifera* L. The 'Thompson Seedless' variety 'Sultana') covers approximately 95% of the market. Raisins have been included in the human diet since ancient times, for their energetic value but also for the presence of specific nutritional compounds (Restani et al., 2016). From the nutritional point of view, raisins are often considered negatively due to their high sugar content; as a consequence, their inclusion in the diet of children, obese and diabetic subjects is debated (Wang et al., 2016). The main raisin producers are Turkey, USA, China, and Iran, contributing to approximately 73% of the global raisin production for 2018/19 (USDA, 2019). The process of raisin production from grapes includes three main steps, pre-treatment, drying, and post-drying. The pre-treatment step is optional but is usually employed to remove the waxy layer formed on the skin of the grape during the ripening stage, providing a barrier to permeability and water diffusion (Pangavhane and Sawhney, 2002; Carranza-Concha et al., 2012; Wang et al., 2012).

Grapes can be dried in the sun, in an oven, or in a food dehydrator by using the right combination of warm temperatures, low humidity, and air current (Lokhande et al., 2016). Mechanical or conventional drying was developed to coincide with the commercialization of raisins and the need to meet the consumer's demands. Grapes are placed in dehydration tunnels for at least 24 h, using air circulation at a controlled temperature (Benlloch-Tinoco et al., 2015).

It is known that raisin is grown in a warm climate, to obtain the best quality production (Uysal and Karabat, 2017). Each year, the weather can be different and consequently has a big impact on the harvest outcome, hence creating great, good, and poor grapes. The 'micro-climates' within a larger climate type can

often occur. Cool climate regions definitely get just as hot as warm climates in vegetation season, but the temperatures drop off so quickly towards harvest and that makes it difficult for grapes to ripen (Tarko et al., 2014).

Our work aimed to characterize the quality of raisins obtained from 'Sultanine' and 'Corinth' grape varieties grown in a cool climate. In this study, we investigated the grape quality before drying, such as sugar content and total acidity. The dehydration was made using a household drier. The quality of the raisin was tested such as moisture content, total soluble mater, level of tartaric and ascorbic acid, pH, and rehydration capacity.

MATERIALS AND METHODS

Grapes were harvested during the 2020 season, at commercial harvest, in Cluj-Napoca (46°46′0″N, 23°35′0″E) located in the center part of Transilvania (northwest of Romania). Cluj Napoca is not included in a viticultural area, but the climatic condition of the 2020 year, favored the ripening of grapes. Three kilograms of grapes from both varieties were collected. One kilogram was used for mechanical analysis and two kilograms were used for raisin. For the mechanical analysis, the components of the grapes are determined gravimetrically and numerically: the number of berries, skin, seeds, and pulp. Based on those data, some uvological indices were calculated, as follows:

Grape structure index = berries weight/rachis weight

Berry index = number of berries on 100 g of grapes

Berry composition index = pulp weight/(skin weight + seeds weight)

Also, the 100 berries' weight was calculated, following the formula:

100 berries weight (g) = (total weight of berries/number of weighed berries) x 100

After weighing the samples, the content of sugar and total acidity level was determined. The samples were analyzed in the Laboratory of Oenology of USAMV Cluj-Napoca, for each sample, three repeats were used. The determination of sugar in must samples was performed using the hand refractometer Zi du Bompas F-49120 (Alla France) with an accuracy of 0.02, according to Bora et al., 2014. To determine the total acidity of the must samples, titration was used in the presence of phenolphthalein. The principle of the method consists in determining the must acids with an alkaline solution of sodium hydroxide (NaOH), based on the constant that a milliliter of NaOH 0.1N can neutralize 0.0049 g sulfuric acid. The total acidity is expressed in g/L H_2SO_4, according to Bora et al., 2014.

The other two kilograms of each variety were used to obtain raisins. After washing the grape samples and draining the rest of the water, the bunches sat on the grills of the Gorenje FDK24DW, 240W, 35-70° electric dryer. The grapes were dried at 40°C for 24 hours. After dehydration, the raisins were stored at 4°C until analysis.

Determining the degree of moisture content of dehydrated products was made according to the formula (AOAC 20 013, 1997):

Moisture content (%) = ([initial weight - final weight]/initial weight)

Establishing the rehydration capacity of dehydrated products as determined by the method proposed by Rozsa, 2020, 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 %

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, 2020).


a)

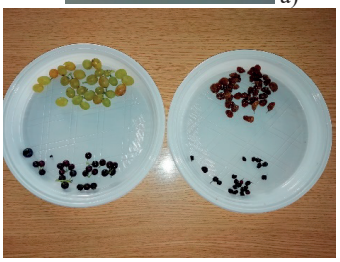
b)

Figure 1. a) The drying of the grapes to obtain raisin; b) left - the fresh berries before drying and right - the raisins

The soluble solids of the liquid phase of the samples (◦Brix) at 20°C were made using the refractometer Atago NAR-3T, Tokyo, Japan. Total acidity of the raisin was measured by titration with NaOH (0.1 N) and expressed in mg of the main acid (tartaric acid, TA) and ascorbic acid (AA) was determined by titration according to AOAC 985.33 (1997) and Carranza-Concha et al., 2012. The pH was measured with the InoLab PH 720 WTW pH-meter, with an accuracy of 0.001.

Statistical analyses were performed using the statistical software package SPSS (version 18.0; SPSS Inc., Chicago, IL, USA). The data were expressed as the mean of three replications for each sample analyzed. To determine the significant differences among values, an analysis of variance (ANOVA) was performed. The significance of difference was defined at 5%, 1%, and 0,01%.

RESULTS AND DISCUSSIONS

The resistance of grapes to external mechanical influences, to pressing, crushing, to the detachment of the pedicel, which largely determines the resistance to transport or storage, are the mechanical properties of grapes. Determining the mechanical properties of grapes is especially important for table and raisin grape varieties that are transported over long distances or kept fresh for a long time (OIV, 2016). The mechanical properties of grapes show high variability between different varieties.

The mechanical properties are dependent on the degree of ripeness of the grapes, on their position on the vine, on the position of the berries on the grapes, and, of course, on their sanitary condition. The size of the berry also plays an important role in determining the resistance to crushing or detachment of the pedicel. The mechanical composition of the grapes varies depending on the variety, the limits of variation, in this case, being large and characteristic of the specific characteristics of the varieties and their direction of use.

Table 1. Mechanical analysis per 1 kg of grapes

Vitis vinifera L. grape variety	No. of berries	% degraded berries	Pulp (g)	Skin + Seeds (g)	Rachis (g)
'Corinth'	931	36.29	641	272	86
'Sultanine'	417	10.63	769	166	65

In the studied varieties, the number of berries in a kg of grapes varied from 931 berries to the 'Corinth' variety, to 417 to the 'Sultanine' variety (Table 1). The health of the grapes particularly influences the data obtained from the mechanical analysis; therefore, it is necessary that in the study varieties for the knowledge of their qualitative potential. Under the conditions of 2020, during the vegetation period, large amounts of precipitation were registered, which led to the deterioration of the berries, differently, depending on the variety. In the 'Corinth' variety, the damaged grains were over 36%, while in the 'Sultanine', almost 11% of the berries in the bunches were damaged or attacked by *Botritys*.

Table 2. Uvological indexes

Vitis vinifera L. grape variety	Grape structure index	Berry index	Berry composition index
'Corinth'	10.67	101.97	2.35
'Sultanine'	14.38	44.59	4.63

The relationships between these uvological components are expressed by 3 indices. The structure index of the 'Sultanine' variety is 14.38, this being the higher of the two studied varieties. The 'Corinth' grape variety had the lowest value of the structure index, of 10.67, this is because, in this variety, the amount of rachis is higher.

The berry index, on the other hand, shows the lowest values for table varieties and the highest, sometimes exceeding 100, for wine varieties with very small berries. Regarding the berry index, from the data in Table 2, it is noticed that the 'Corinth' variety has the highest value of this index (101.97) which shows, among the analyzed varieties, for this variety, the berries are the smallest. Instead, the 'Sultanine' variety has the largest berries, with a berry index value of 44.59.

The composition index of the berry has high values, 10-15, for the varieties with large grain, in which the pulp massively dominates the skin, such as 'Afuz Ali', 'Muscat of Hamburg' or 'Cardinal'. Regarding the composition index of the berries, the varieties that have a thinner skin ('Sultanine') have a value of this index of 4.63. In contrast, for the varieties with thicker skin ('Corinth'), the values of this index were 2.35 (Table 2).

Regarding grape quality (Table 3) under the conditions of 2020, the best accumulation of sugar in the berries was in the Corinth variety, with 243 g/l. Instead, the lowest amount of sugar was in the 'Sultanine' variety, with 195 g/l, although, the Cluj area is not a viticultural area. The highest value of the mass parameter of 100 berries was determined for the 'Sultanine' variety, with 224 g. In exchange, the 'Corinth' variety had the highest value of the mass of 100 berries, with only 98 g.

Table 3. Evolution of Milk Production (kg/year)

Vitis vinifera L. grape variety	Grape weight (g)	100 berries weight (g)	Sugar content (g/l)	Total acidity level (g/l H_2SO_4)
'Sultanine'	434***	224***	195°	3.67°
'Corinth'	66°°°	98°°°	234*	4.43*
Mean	250	161	219	4.05
DL 5% =	12.90	3.79	12.25	0.32
DL 1% =	29.94	8.80	28.42	0.98
DL 0.1% =	94.88	27.87	90.00	2.23

In general, fresh fruit consists of water and dry matter. If the water is removed from the fruit, the dry matter remains. The remaining part is generally called total dry matter. This is because dry matter consists of two different elements.

Part of the total dry matter is composed of water-insoluble matter. These water-insoluble substances are called water-insoluble dry matter. Part of the total dry matter is composed of water-soluble substances (Rosza, 2019). In general, drying treatments caused a decrease in sugar content. After drying, the raisin content of the total dry matter was 59.89% Brix for 'Sultanine' and 61.11% Brix for 'Corinth'. Our results are lower than the values obtained by Işçi and Altındisli, 2015 for 'Sultanine' raisin, with 68.89-78.67% total soluble solids content in different drying methods.

It is known that tartaric acid is the most abundant organic acid in grape varieties (Chayjan et al., 2011). The summary of pH and tartaric acid results of the raisin sample is presented in Table 4. In the raisin samples, pH values ranged from 3.92 for 'Sultanine' to 3.31 for 'Corinth'. On the other hand, tartaric acid values ranged from 509.11 mg/100 g for 'Sultanine' to 422 mg/100 g. Ascorbic acid is the most potent enhancer of nonheme iron absorption. The enhancing effect occurs largely because of its ability to reduce ferric to ferrous iron. In the raisin samples, ascorbic acid values ranged from 9.82 mg/ 100 g for 'Sultanine' to 7.79 mg/100 g.

Both acids are affected by the drying treatments, causing losses in almost every case. This is because the skin of the grapes could change much in the drying process and could not protect the acid from the effects of oxygen. On the other hand, it is well known that ascorbic acid is seriously affected by high temperatures (Vikram et al., 2005).

For fruit, the value of 25% was maintained for a long time as the upper limit of the final humidity; today this limit has been reduced for many fruit species, depending on their chemical composition and, in particular, their sugar content (Rosza, 2019). Due to the considerable high sugar and moisture content, seedless grapes are very susceptible to microbial spoilage during storage (Carranza-Concha et al., 2012).

If the raisin after being dried and washed has more than 18% of moisture, it will be contaminated with molds, and if the moisture content is less than 11%, it will have an undesirable flavor and have a hard mouthfeel (Kowalska et al., 2017). The most appropriate

moisture content for raisins should be between 14 to 16% (Bakhshipour et al., 2012). The moisture level of a raisin in our experiment was 19.41% for 'Sultanine' and 15.61% for 'Corinth'. Other authors obtain a moisture level between 9.70-16.27% for 'Sultanine' raisins, depending on the drying method.

An important indicator of the quality of dried material is its rehydration capability (Figiel, 2007). Rehydration is a very important quality property for dried products. It is a complex process intended to restore the properties of the fresh product by contacting dried products with a liquid (Winiczenko et al., 2018). The methods of removing water from food result in a variety of changes in the tissue which impairs the possibility of regaining volume, mass, and water content.

The best rehydration power was determined for raisins obtained from the 'Sultanine' variety - 88.55%. The value for this parameter obtained for raisins obtained from the Corinth variety was 80.70%. For the dried fruit rehydration, the drying method was the most important factor in the ability to absorb water.

The key to the quality of raisins is the drying process and their water content. If the raisins are too dry their nutritional value and flavor are diminished, while if they are too wet, they degrade very quickly and will not survive storage or transportation.

Table 4. Raisin quality

Vitis vinifera L. grape variety	SDM Brix %	Moisture %	Tartaric acid (mg/ 100 g)	Ascorbic acid (mg/ 100 g)	pH
'Sultanine'	59.89^{o}	19.41**	509.11**	9.82*	3.92*
'Corinth'	61.11*	15.61^{oo}	422.90^{oo}	7.79^{o}	3.31^{o}
Mean	60.50	17.20	466.00	8.80	3.61
DL 5% =	0.58	0.76	8.08	0.53	0.20
DL 1% =	1.35	1.76	18.66	1.23	0.46
DL 0.1 % =	4.29	5.61	59.39	3.91	1.45

SDM - soluble dry matter

The low water content ensures a better microbiological behavior and prevents unwanted chemical reactions (oxidation, discoloration, non-enzymatic browning, etc.) during the storage of dry products. However, enzymatic phenomena are not inhibited by this reduction in water content.

CONCLUSIONS

The research carried out on the two grape varieties for raisins 'Sultanine' and 'Corinth', aimed to better understand their behavior in the pedoclimatic conditions in Cluj-Napoca, the suitability of their cultivation in this area, and obtaining new information about their production and quality. Sugar content at harvest for both varieties was good, with 195 g/l sugar for Sultanine and 234 g/l sugar for Corinth.

Following dehydration, the soluble dry matter content was higher for raisins of the 'Corinth' variety, with values of 61.11%, followed by the 'Sultanine' variety, with a content of 59.89% soluble substance. Regarding the moisture of the finished product - raisins, a high content was determined for the variety 'Sultanine' - 19%, followed by the variety 'Corinth' - 15.61%. The rehydration power of raisins had values of over 80% for both types of raisins. For the amateur culture, in the Cluj area, these varieties can be recommended, given that, in recent years, due to climate change, there have been no temperatures in this area during the rest period that could cause frost over the winter. Also, the long autumns favored reaching full maturity for these varieties, even in the conditions in Cluj. Raisins can be very easily obtained in the household, by using household dryers.

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