RESEARCH ARTICLE

Ampelographic Characterization and some Quality Indicating Parameters of Several Indigenous Albanian Grapevine Varieties

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Abstract

As a Mediterranean country, Albanian soils and climate conditions are ideal in developing viticulture. In addition to importance of maintenance, study, collection and conservation of indigenous grapevine species is performed a three-year study with some of the most important grapevine cultivars at ATTC Vlore collection, located in south of Albania. The ex situ collection is composed of 75 native cultivars and 68 foreign varieties. Ampelographic study of Vitis vinifera L is performed focusing on 51 characters, following list of descriptors for sixteen of grapevine Albanian cultivars (‘Kotek e bardhë’, ‘Sinanbel’, ‘Rrushvere’, ‘Tip merlot’, ‘Dimërakës’, ‘Tip korith’, ‘Rrush me supe’, ‘Debinë e zezë’, ‘Muskatroze’, ‘Rrushkishe’, ‘Çaushiverdhë’, ‘Roze’, ‘Rrushkungulli’, ‘Volluna’, ‘Vallaribardhë’, ‘Karkanjoz’). Referred morphological characters included: young leaves and shoot, mature leaves, matured berry, woody shoot, grape bunch, flower, must parameters and parameters that indicate wine quality during ripening process. Results pointed out these cultivars have significant differences, referred to descriptors analysed. Hierarchical cluster analysis showed the cultivars grouped in three main clusters, based on berry traits. As well, related to berry weight, cultivars ‘Rrushkungulli’ and ‘Rrushkishe’ recorded the highest values, meanwhile ‘Rrushvere’ and ‘Debinë e zezë’, the lowest. Sugar content of ‘Rrushvere’ turned out to be the highest and the lowest was recorded from cultivars ‘Roze’ and ‘Muskatroze’. ‘Çaushiverdhë’ and ‘Volluna’ recorded the lowest total acidity level, highest pH and the highest TSS:TA ratio, while ‘Roze’ and ‘Sinanbel’ recorded the highest total acidity level, lowest pH and lowest TSS:TA ratio.

Keywords: ampelographic characterization; Albanian indigenous cultivars; ripening process.

1. Introduction

Grapevine, Vitis Vinifera L is one of the oldest and most important agricultural crops. Domesticated more than 6000 years ago and grown between 32-50°N and 28-42°S, where Albania is located within these limits in Northern Hemisphere. The crop needs long, warm, dry summer and cool winter [11; 25]. It has been cultivated widely for a long period of time and its domestication has led to many biotypes and cultivars [25], resulting in a great genetic variability and rootstocks are used widely in vineyards because of avoiding biotic and abiotic stresses [1; 28; 31]. Grapes can tolerate and adapted widely with the kind of soils but drainage process is very important [6; 28]. Albania ensures ideal climate conditions for grapevine growing, considered a rich country in plant genetic resources and origin for some cultivated species and varieties [15]. There are dozens of cultivars well adapted to local climate conditions, cultivated across the country, well known for their high quality and yield, competing introduced cultivars [5; 7; 13; 27; 29]. Some of them are more frequent in terms of distribution and more appreciated for their superior qualities, estimated as genetic resources and use in breeding program. ‘Sheshi Zi’ and ‘Sheshibardhë’, autochthonous varieties, constitute about 60% of plantings, because they are well adapted, flexible to all types of cultivation and relatively more resistant to fungies. Grapevine cultivars with inferior qualities are gradually disappearing and the others with high quality traits are increased owing to their high
economic values [5;7; 31]. Because of genetic erosion and pathogens, some native varieties with superior qualities have been disappeared, during years. Certain native varieties are identified with different names in different areas of cultivation. ‘Kallmet’ cultivar is also known with synonyms ‘Gjashore’, ‘Skadarka’, ‘Zadrimore’, ‘Tocainero di scutari’, ‘Branicevka’. ‘Pulëz’ cultivar is known as ‘Verdhëza’, ‘Landar’. ‘Seriñëizi’ is known with synonym as ‘Lavardar’, meanwhile ‘Sinanbel’ is known as ‘Kryqëz’[13; 27]. The preservation of genetic resources is essential, in order to protect varieties in danger of extinction. About 174 varieties and grape accessions are identified and registered in EURISCO (European Search Catalogue for Plant Genetic Resources) by Institution of Gene Bank in Albania [15]. Identification of local varieties is essential in preserving germplasm and is carried out through characterization, based on measurement of characters or features that are part of genetic inheritance and expressed in all environmental conditions. Difficulties encountered in grapevine characterization are due to high number of varieties, presence of synonyms or presentation with the same name of accessions with variability amongst them and high level of polymorphism in these species. This identification becomes complex because of adaptability of plants, being capable to alter, depending on environment, soil and agro-technical conditions. This ampelographic characterization, carried out under the same environmental and soil condition and in the same parcel, highlighted differences between these cultivars.

Tendency of consumer requirements during the last years is focused towards products with high quality [16; 20]. From the other side, the globalization, has highlighted local products and their survival and importance. Meanwhile, in Albania, the crop of table grapes is prevailed by high yield indigenous varieties, there are a high number of varieties with strong potential in wine-making, being competitive with foreign well-known wine varieties. Grape quality is related with several parameters such as; sugar content, acidity, colour, texture and flavor [17; 19; 28; 33]. Sugar content varies based on climate condition. Major acids in grapes are tartaric acid, malic acid and citric acid, while tartaric acid and malic acid constitute 90% of total acidity where the strongest acid, tartaric acid is dissolved to $\text{H}^+$ ions and anions tartarate ($\text{C}_4\text{H}_4\text{O}_4^-$) but in wine exist forms of nonionizing of tartaric acid [12;24]. Some principal features of grape berry juice are that make perfect medium for wine, inhibit microbial activity. pH of wine is one of the most important parameters of grapes quality and is an indicator of amount strength of acids and indicate effects of minerals and the materials presented in wine. pH has impact on fruit flavor, acidity, is responsible for pigmentation of grapes and is critical factor in fermentation, in wine quality and colour stability [10; 12; 17]. Actually, some native varieties are in danger of extinction and is crucial to study, evaluate and preserve grapevine resources. This work aims to characterize indigenous varieties, in order to contribute in preserving and assessment of national genetic resources, based on measurements of characters or features that are part of genetic inheritance and are expressed in all climate conditions, referred to international descriptors [4; 5]. As ampelography is a scientific method for characterization of grapevine, based on description of morphological, phenological traits, it’s important to carry out genetic characterization, as a task in the future in order to improve grape breeding [3].The germplasm resources in collection of ATTC Vlore, are crucial to preserve as autochthonous grapevine varieties.

2. Material and Methods

The study was carried out during 2017-2019 on sixteen grapevine varieties that are part of ATTC Vlore Collection, in south of Albania (Figure 1). The ex situ collection is composed of 75 native (not known their origin areas) and 68 introduced cultivars, recorded as part of grapevine resources. The training system is a horizontal bilateral cordon; the planting distance is 2.5 x1.25 m and used rootstock is SO4.

Figure 1. Geographic location of grapevine collection at ATTC Vlore, Shamogjin, Vlorë.
2.1. Ampelographic characterization

Ampelographic analysis was performed according to International Organization of Vine and Wine [22] descriptors focusing on 51 characters, including; twelve characters of young shoot and leaf, observed during flowering on 10 plants; twelve mature leaf characters, measured on 10 leaves/plants between berry set and veraison; three woody shoot characters (cross section, structure of surface and main colour), observed after leaves fall until early winter; three flower characters (flower type, insertion of 1st inflorescence and number of inflorescences per shoot) evaluated on 10 shoots; five bunch characters measured on 10 shoot at maturity; nine berry characters (size, weight, shape, colour of skin, uniformity of size, pulp mellowness, bloom, particular flavor, presence of seeds) measured on 100 berries taken randomly from the middle part of bunches; grape maturity period; time of bud burst; time of full bloom; time of beginning of berry ripening (veraison); three productivity characters (sugar content of the must, total acidity and pH), measured during harvest. Total soluble solids (°Brix) was measured using a calibrated refractometer, titratable acidity based on 0.1N NaOH titration, referred to A.O.A.C official method (AOAC, 2000)[2] and pH was measured with pH meter Lab 845, SI Analytics, calibrated with pH 4 and 7 buffers.

2.2. Statistical analysis

Analysis were performed for each variety and data are reported as means of four replicates. ANOVA and comparison between means are made with Tukey Kramer test, using JMP Statistic 15 software and SPSS Statistic 20 software was used for hierarchical cluster analysis. Cluster analysis (Figure 2) was performed for all cultivars (‘Kotek e bardhë’, ‘Sinanbel’, ‘Rrushvere’, ‘Tip merlot’, ‘Dimërakës’, ‘Tip korig’, ‘Rrush me supe’, ‘Debinë e zezë’, ‘Muskatroze’, ‘Rrushkishe’, ‘Çashiverdhë’, ‘Roze’, ‘Rrushungulli’, ‘Voltuna’, ‘Vallaribardhë’, ‘Karkanjoz’) for all morphological characters, using Ward method, as the most appropriate with our data [32].

Three-year study period was considered sufficient to reach the adequate conclusions for all the traits we have analysed in these cultivars.

3. Results and Discussion

Results, referred to survey and statistical analysis for 51 characters, showed that; varieties of grapevine collection at ATTC Vlore have significant differences in inherit traits and obviously can be considered as different cultivars. The qualities of varieties are influenced by genetic factors but also cultural and environmental management [9; 23; 28]. Taking into consideration the fact of planting in the same plantation, with the same soil and climate conditions, they have displayed their distinctive ampelographic characteristics.

Based on assessment between ‘Kotek e bardhë’ and ‘Sinanbel’ (Figure 2), are the first grouped varieties that limits cluster number in 14 (with an agglomeration coefficient 7.5, data not shown) despite similarities, they differ from colour of the upper side of blade, area of anthocyanin coloration of main veins on upper side of blade, bunch dimension related characters, time of bud burst and quality of berry, which are enough to consider differences amongst them.

Cultivars such as ‘Rrushkishe’ and ‘Roze’ (Figure 2) despite other differences, have distinct characters in sexual organs (OIV 151) [22] expressed in ‘Roze’ (with an agglomeration coefficient 22) with reflexed stamens and fully developed gynoecium, meanwhile in cultivar ‘Rrushkishe’, stamens and gynoecium are fully developed.

Analysed cultivars, are valuable if are cultivated in their adapted areas or near these areas when possess good qualities in terms of outputs of local products. This one, stand for trend of consumer requirements and a better opportunity in order to be competitive in conditions of global market, where crop of known varieties have difficulties to put up with highly developed agriculture.

A comparison of duration period of bud burst until full ripening of berries, showed that cultivars like; ‘Çashiverdhë’, ‘Debinë e zezë’, ‘Rrush me supe’, ‘Rrushvere’ and ‘Tip merlot’, recorded below average values for this indicator and are suitable for cultivation in areas above sea level, meanwhile ‘Sinanbel’, ‘Muskatroze’ and ‘Tip korig’ aren’t suitable in these areas. Under changes of climate conditions, the first group of varieties are not recommended to plant in warm coastal areas because their maturity period fit with a period with high
temperatures causing damages in flavor and level of polyphenols, reducing wine quality [20; 23]. Comparing period of buds burst in all sixteen cultivars, ‘Roze’, ‘Tip merlot’ and ‘Çaushiverdhë’, are earlier with an average difference 4-7 days. In areas in danger of frost returning, it’s suggested replacement with other cultivars in order to avoid damages of shoots.

Flower characters (OIV 151-155) [22] are crucial to make comparative analysis between varieties and have practical impact in cultivation technology. Varieties such as ‘Çaushiverdhë’, ‘Roze’, ‘Rrush me supe’, ‘Dimërakes’, have flowers with reflexed stamens and fully developed gynoecium, causing their bunch to manifest millerandage at high levels, especially if the flowering phase is associated with rainfall. May this occurrence have caused lack of these cultivars in wide cultivation. In case they are needed for planting of vineyards, should also be consider the presence of other cultivars with healthy flowers, in order to realize pollination and provide stable crop.

Hierarchical cluster (Figure 2), for linkage distance 10, shows that cultivars are grouped in three main clusters. The varieties grouped, are similar mainly based on berry qualities.

![Dendrogram using Ward Linkage](image)

**Figure 2.** Dendrogram of cluster analysis is performed using Ward’s method for sixteen varieties.

Parameters indicating the quality of berry must, pointed out these varieties have significant differences based on traits of berries measured with a significance p<0.001. Related to weight of berry (Table 1), ‘Rrushkungulli’ recorded the highest value, 4.27 g followed by ‘Rrushkishe’ 3.54 g and the lowest values were recorded from ‘Rrushvere’ and ‘Debinë e zezë’, respectively 1.90 g and 1.97 g of berry. Half of them have the capacity to produce high quality wines, competitive with well-known foreign wine varieties. ‘Rrush me supe’, ‘Tip merlot’, ‘Rrushvere’, ‘Debinë e zezë’ and ‘Roze’ are suitable in red wine-making while reach sugar level 20-25% and level of acidity from 0.35-0.69 g/ml. As described by Matthews and Nuzzo (2007) [21] wine derived from small berries have higher concentration of anthocyanins compared with wines made from large berries. Cultivars such ‘Tip Merlot’, ‘Rrushvere’, ‘Rrush me supe’, reach high sugar content, having a great impact on amount of alcohol presented in wine.

Sugar content is an indicator to assess ripeness in grape [17].‘Kotek e bardhë’, ‘Çaushiverdhë’ and ‘Volluna’, have an early ripening period compared with other varities of warm coast region, reach high sugar content and can be adapted in high altitudes [27; 28; 31].Cultivars corresponding ‘Rrushkungulli’, ‘Rrushkishe’, ‘Dimërakes’, ‘Karkanjoz’, ‘Muskatrozë’, ‘Vallaribardhë’, ‘Tip Korith’, based on bunch characters, berry size and firmer pulp, can be used as dual-use crops (for wine and table) [11; 22], creating diversity in market, next to foreign cultivars.
Table 1. Values of mean, standard error and groups for main parameters of fruit quality such as berry mass, sugar content, total acidity, in all varieties analysed.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Berry mass (g)</th>
<th>Sugar content %</th>
<th>Titratable acidity (g/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Çauuśiverdhë</td>
<td>2.61±0.30 (bcd)</td>
<td>21.13±0.46 (abcd)</td>
<td>0.30±0.01 (b)</td>
</tr>
<tr>
<td>Debinë e zezë</td>
<td>1.97±0.08 (e)</td>
<td>18.95±0.74 (bcd)</td>
<td>0.63±0.05 (a)</td>
</tr>
<tr>
<td>Dimërakës</td>
<td>3.25±0.4 (abcd)</td>
<td>21±0.45(abcd)</td>
<td>0.627±0.04 (a)</td>
</tr>
<tr>
<td>Karkanjoz</td>
<td>2.71±0.26 (bcd)</td>
<td>21±0.11(abcd)</td>
<td>0.633±0.005 (ab)</td>
</tr>
<tr>
<td>Kotek e bardhë</td>
<td>2.37±0.11(bcd)</td>
<td>19.2±0.97(bcd)</td>
<td>0.51±0.04 (ab)</td>
</tr>
<tr>
<td>Muskatrozë</td>
<td>2.72±0.05(bcd)</td>
<td>17.7±0.66(d)</td>
<td>0.49±0.061 (ab)</td>
</tr>
<tr>
<td>Roze</td>
<td>2.15±0.12 (cde)</td>
<td>17.6±0.76(d)</td>
<td>0.69±0.06 (a)</td>
</tr>
<tr>
<td>Rrushkishe</td>
<td>3.54±0.33 (ab)</td>
<td>19.55±1.10 (abcd)</td>
<td>0.472±0.07 (ab)</td>
</tr>
<tr>
<td>Rrushkungulli</td>
<td>4.27±0.26(a)</td>
<td>18.97±0.34 (bcd)</td>
<td>0.477±0.02 (ab)</td>
</tr>
<tr>
<td>Rrush me supe</td>
<td>2.67±0.22(bcd)</td>
<td>22.46±0.17 (abc)</td>
<td>0.53±0.01 (ab)</td>
</tr>
<tr>
<td>Rrushverë</td>
<td>1.90±0.18 (e)</td>
<td>23.75±1.03 (a)</td>
<td>0.55±0.01 (ab)</td>
</tr>
<tr>
<td>Sinanbel</td>
<td>2.45±0.19(bcd)</td>
<td>18±0.88 (cd)</td>
<td>0.66±0.11(a)</td>
</tr>
<tr>
<td>Tip korith</td>
<td>2.70±0.23(bcd)</td>
<td>20±1.65 (abcd)</td>
<td>0.62±0.1 (a)</td>
</tr>
<tr>
<td>Tip merloti</td>
<td>2.10±0.16 (de)</td>
<td>22.95±0.63 (ab)</td>
<td>0.49±0.05 (ab)</td>
</tr>
<tr>
<td>Vallaribardhë</td>
<td>3.32±0.37 (abc)</td>
<td>20.85±0.53(abcd)</td>
<td>0.41±0.03 (ab)</td>
</tr>
<tr>
<td>Volluna</td>
<td>2.45±0.20 (bcd)</td>
<td>21.32±1.0 (abcd)</td>
<td>0.32±0.04 (b)</td>
</tr>
</tbody>
</table>

Total soluble solids is influenced by genetic and environmental factors. Temperature, irrigation, climate changes have their influence on sugar content [17]. ("Brix") content (Table 1) showed that ‘Rrushverë’ recorded the highest value of 23.75 %, and the lowest was recorded from cultivars ‘Roze’ 17.6 % and ‘MuskatRoze’ 17.7 %. ‘Volluna’, ‘Kotek e bardhë’ and ‘Tip korith’ had high level of sugar content increased during process of fruit ripening, recorded up to 5 % meanwhile ‘Rrush me supe’, ‘Çauuśiverdhë’, ‘Karkanjoz’, ‘Tip merlot’ recorded the lowest levels of variation in values measured.

Total acidity level (Table 1) turned out that ‘Roze’ and ‘Sinanbel’ has a high level of total acidity, 0.69 and 0.66 compared to other cultivars and also has the lowest pH and the lowest TSS: TA ratio meanwhile ‘Çauuśiverdhë’ and ‘Volluna’ has the lowest level of total acidity, respectively 0.30 and 0.32 and the highest pH and highest TSS:TA ratio. During ripening period, ‘Sinanbel’ showed high level of variation in total acidity measured, from 0.90 to 0.37 and ‘Tip korith’ from 0.90 to 0.45 at the end of ripening while ‘Roze’ recorded values from 0.82 to 0.56, meanwhile ‘Karkanjoz’, ‘Debinë e zezë’, were recorded, respectively 0.71-0.52 for ‘Karkanjoz’, 0.68 to 0.47 for ‘Debinë e zezë’. At the same time, other cultivars showed average or low levels of variation during this process.

It’s found good relationship between Brix/Acidity ratio and consumer acceptability for Crimson Seedless table grapes. After Jayasena and Cameroon [16] it’s suggested that low acid varieties, should be harvested based on Brix scale and high acid varieties should be harvested based on acid values and medium acid varieties, should be harvested based on acid measured values and Brix scale. Furthermore TSS; TA ratio is a good indicator about grape ripeness and commercial maturation of grape[26; 33].

Massive accumulation of glucose and fructose in vacuoles of mesocarp cells, occur after veraison [17]. Hellman et al [14], Keller [18] reported that the sugar content of berry, amino acids and phenolic compounds, increases rapidly, acidity decreases and pH increases as grape ripen (Figure 3a). This tendency was observed during maturity of berries for sugar content, titratable acidity and pH and it was found in almost of varieties we have analysed. During ripening process, berry start to accumulate phenolic compound and after full maturity, berry size reaches a maximum and accumulation of sugars slows.

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The chart shows decreasing level of total acidity and increasing level of sugar content, until stability is reached. The chart represents pH mean values and standard deviation for all cultivars pH values are typical indicators in wine analysis. In all cultivars analysed, pH measurement showed increasing values during ripening time, also increasing level of pH change based on cultivars. That means ‘Rrushvere’, ‘Roze’, ‘Karkanjoz’, resulted to have the lowest increasing pH level during ripening period, similar to 3.36 to 3.54 for ‘Rrushvere’, 3.32 to 3.55 for ‘Karkanjoz’ and 3.17 to 3.47 for ‘Roze’. Cultivars such as ‘Sinanbel’, ‘Debinë e zezë’, ‘Vallaribardhë’, ‘Tip korith’ recorded highest level of pH variation measured, occurred during ripening period of grape berries.pH values of must shouldn’t exceed 3.60 value (above this level may appear stability problems), in order to obtain a wine with good qualities [10; 18], pH affect directly grape juice and wine quality and it turned out that ‘Roze’, ‘Rrushvere’, ‘Karkanjoz’, ‘Debinë e zezë’, ‘Rrush me supe’, ‘Dimërakes’, ‘Muskatroze’, have good wine- making qualities (Figure 3b). Parameters that indicate the quality of fruit and the must, have an important impact in wine production.

4. Conclusions

Several native grapevine varieties resulted to have good qualities and can be considered as table grapes and appropriate in wine making. Some of them corresponding to ‘Çaushiverdhë’, ‘Debinë e zezë’, ‘Rrush me supe’, ‘Rrushvere’ and ‘Tip merlot’, are suitable for cultivation in areas above sea level. For the varieties such as ‘Çaushiverdhë’, ‘Dimërakes’, ‘Roze’ and ‘Rrush me supe’, where the presence of reflexed stamens encourage millerandage, is essential planting with other cultivars that enable pollination. Cultivars such as; ‘Dimërakës’, ‘Vallaribardhë’, ‘Rrushkishe’, ‘Rush kungulli’, ‘Tip korithi’ and ‘Çaushiverdhë’, based on characters of berry, can be considered appropriate as table grapes, while ‘Roze’, ‘Rrushvere’, ‘Karkanjoz’, ‘Rrush me supe’, ‘Muskatroze’, for their must quality can be considered as varieties with good quality in wine making. This study provide important information but is essential to expand it further, involving genetic characterization.

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