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# COMPARATIVE TECHNOLOGICAL CHARACTERISTIC OF THE ALIGOTE 61-6 AND ALIGOTE N 10 CLONES, CULTIVATED IN THE SOIL AND CLIMATIC CONDITIONS OF THE REGION OF PLEVEN

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In the period 2011–2013 a technological characteristic of the Ukrainian clone Aligote 61-6 was made at the Institute of Viticulture and Enology – Pleven. The Bulgarian candidate-clone Aligote N 10 was used for control. During the grapes ripening, the dynamics of sugar accumulation was monitored. Upon technological maturity the indicators of the yields were accounted and mechanical analysis was performed. The chemical composition of the must, the obtained wines and their organoleptic qualities were analyzed. In its mechanical composition, Aligote 61-6 was typically wine one and it did not differ significantly in the texture and structure of the cluster and berry from the control. The theoretical yield of both clones was high. They exhibited good sugar accumulation and similar acid content. Grapes from the control had better technological indicators for obtaining wines of optimal chemical composition and quality. In the 2011 and 2013 vintages, the control wines exceeded those of the Ukrainian clone in terms of sugar-free extract content. The experimental wines Aligote N 10 had higher titratable acidity compared to the Ukrainian clone. The difference in the phenolic substances ratio and the colour intensity in the samples from both clones were insignificant. The control wines were superior in their organoleptic qualities to those of the Ukrainian clone.

**Keywords:** Aligote, grapes, wine, chemical composition, organoleptic characteristics

In the study of the grapevine species and varieties, it had been important to apply objective and accurate methods of ampelographic characterization. Its aim was to clarify their origin and distribution, to show their basic botanical features, their agrobiological specifics and their economic and technological qualities (Roychev, 2012).

Much of the widespread industrial vine varieties had been characterized by considerable interspecific diversity. That was due to mutational variability and the occurrence of morphological and physiological changes transmitted to the offspring and sometimes impairing the economic qualities of the varieties and their economic efficiency (Katerov et al., 1990). Worldwide, the clone selection has been the most common method for extending the structure of vineyards of varieties within *Vitis vinifera*. It aims to improve the individual agro-biological, technological and economic characteristics of a variety. As a result, diversification of the vine collection is achieved, based on the selection of clones with high levels of realization of the potential economic productivity and quality indicators of grapes and wine (Petrov et al., 2009; Meneghetti et al., 2010).

Aligote is an old French variety, originating from the Burgundy region, but common in other European wine-growing countries. In Bulgaria it has been grown mainly in the northeastern part of the country, on an area of about 263 ha, representing 1.28% of the white wine varieties and 0.472% of all vineyards. Aligote is a medium ripening wine variety. The grapes mature in the first half to mid-September. The vines are distinguished for medium growth, high fertility and yields. It is grown on stem training with mixed pruning. The variety is not resistant to diseases and pests, it is resistant to low winter temperatures but not to drought. The most suitable for its cultivation are carbonate black earth and gray-brown forest soils. In France, through clonal selection, 8 clones of Aligote variety were created, out of which 263, 264 and 651 were of medium yield, and 402, 591, 920, 935 and 936 of high yield (Roychev, 2012).

By its mechanical composition, Aligote cluster is typically a wine variety with a high theoretical yield of the must. It shows its valuable technological qualities in the moderately cool regions of northeastern Bulgaria, where the grapes have optimal sugar accumulation of 18–21% and titratable acids 7 $g.l^{-1}$. In warmer regions, with a higher temperature sum, the variety demonstrates rapid sugar accumulation (up to 22–24%) and reduced titratable acidity (5–5.8 $g.l^{-1}$). Quality white dry wines and sparkling wines are produced by Aligote (Radulov, Babrikov and Georgiev, 1992; Roychev, 2012).

The factors determining the wine features are of a complex nature. The biochemical indicators of the grapes and must related to the variety, the applied agricultural and technical practices, the conditions in the process of vinification, etc. are of importance. The influence of terroir – the mineral composition of the soil and the climatic conditions (sunshine, temperature, precipitation) in the cultivation area – is also of significance. In Romania, Aligote is one of the most common wine varieties. Bora et al. (2016) studied Aligote wines composition, 2015 vintage, and found

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a low ratio of malic acid, mineral components (potassium, calcium, iron) and high glycerol content. Aroma is one of the most important indicators of wine features. Vararu et al. (2015) identified 38 components of the aromatic profile of Romanian Aligote wines. Of the analyzed terpenes, norisoprenoids, aldehydes, ketones, higher alcohols, benzene derivatives, fatty acids and esters, the highest amounts found were of 3-methyl-1-butanol, decanoic acid, ethyl octanoate and ethyl decanoate.

The objective of this study was to make a technological characteristic of Aligote clone 61-6 and Aligote clone N 10, grown under the soil and climatic conditions of the town of Pleven (central northern Bulgaria).

## Material and method

The technological characteristics study of Aligote 61-6 and Aligote N 10 clones was carried out at the Institute of Viticulture and Enology (IVE) – Pleven during the period 2011–2013, and it comprised three consecutive vintages. Aligote 61-6 was a Ukrainian clone (Fig. 2) while Aligote N 10 was a Bulgarian candidate-clone (Fig. 1) used for control.

The studied clones were grown at the Experimental Base of IVE at Ombrella training and planting distance of 3.00/1.30 m. The applied growing practice to the vines was mixed pruning and equal loading – 32 winter eyes per vine (6 spurs of 2 eyes and 2 fruit canes of 10 eyes). During the grapes ripening, the dynamics of sugar accumulation was monitored by a refractometer to determine the grapes' technological maturity. Upon reaching the technological maturity, the productivity indicators were accounted, and a mechanical and chemical analysis of the grapes was performed (Katerov et al., 1990).

The grapes were processed in the Experimental Winery of IVE according to the classical technology for dry white wine making under the conditions of micro-vinification (Yankov, 1992) – crushing, destemming, pressing, sulphuring (50 mg.l$^{-1}$ $SO_2$), must clarification, adding pure culture dry wine yeast *Saccharomyces cerevisiae Vitilevure* B + C (20 g.hl$^{-1}$), fermentation temperature 20 °C, racking, further sulphuring, storage.

The grape must chemical composition was determined according to the following methods (Ivanov et al., 1979): sugars, g.l$^{-1}$ – areometer of Dujardin; glucose, g.l$^{-1}$ – iodometric method; fructose, g.l$^{-1}$ – calculation method; titratable acids (TA), g.l$^{-1}$ – titration with NaOH; tartaric and malic acid, g.l$^{-1}$ – method of Pochinok; pH – pH-meter; glucoacidometric index (GAI) – calculation method as the ratio of sugars (%) and TA (g.l$^{-1}$).

The main indicators of wines chemical composition were analyzed by conventional methods in the wine-making practice (Ivanov et al., 1979; Chobanova, 2007): sugars, g.l$^{-1}$ – Schoorl's method; alcohol, vol. % – distillation method, Gibertini apparatus with densitometry of the distillate density; total extract (TE), g.l$^{-1}$ – Gibertini apparatus with densitometry, density of alcohol-free sample; sugar-free extract (SFE), g.l$^{-1}$ – calculation method (the difference between TE and sugars); titratable acids (TA), g.l$^{-1}$ – titration with NaOH; volatile acids (VA), g.l$^{-1}$ – distillation method with titration with NaOH; tartaric and malic acid, g.l$^{-1}$ – method of Pochinok; total phenolic compounds (TPC), g.l$^{-1}$ – method of Singleton et Rossi; colour intensity, [abs. units] – method of Glories, by measuring the absorption at $\lambda$ 420 nm; pH – pH-meter. The value of each analyzed indicator of the composition of the experimental wines was average of the measurement of two parallel samples. If a significant difference was found in the values, a third sample was measured and the two closest values were taken into account.

The organoleptic features of the experimental samples were determined according to 100-score scale for the indicators: colour, aroma, taste and general impression (Tsvetanov, 2001) by a nine-member tasting committee. The tasting score of the experimental wines was average value of the committee members' estimates, eliminating the highest and the lowest ones.

**Figure 1** Aligote clone N 10

**Figure 2** Aligote clone 61-6

## Results and discussion

At technological maturity of the studied clones, the productivity indicators were accounted, and a mechanical analysis of the grapes was performed (Table 1).

The mechanical analysis showed that Aligote 61-6 was typically a wine clone and there was no significant difference in the texture and structure of the cluster and the berry from the control (Aligote N 10). On the average for the period of the study the weight per cluster of Aligote 61-6 was 201.3 g and that of Aligote N 10 was 221.5 g. Aligote 61-6 cluster had a higher rachis content – 3.89% and fewer berries – 96.11%, compared to the control – 3.40% rachis and 96.60% berries. The average mass per 100 berries from the Ukrainian clone was insignificantly higher (202.67 g) than the control (193.33 g), which also determined the difference in their berry structure. Aligote 61-6 berry had less skins (10.03%) and seeds (3.85%) and higher mesocarp content – 86.12%. As for Aligote N 10 its berry had more skins (10.66%) and seeds (4.05%) and less mesocarp – 85.29%. The theoretical yield of the Ukrainian clone was 82.77% and of the control – 82.39%. The insignificantly higher theoretical yield of Aligote 61-6 was the result of the higher rate of mesocarp in the berry.

During the grape ripening of the studied clones, the intensity of sugar accumulation was investigated (Fig. 3 a, b, c).

In 2011, the reporting of the sugar accumulation dynamics in both clones started on 30/08/, as the grapes from Aligote N 10 having 15.9% sugars and from Aligote 61-6 – 16.0%. In the following two measurements, it was found that in both clones the accumulation of sugars proceeded at the same rate: from 30/08/ to 06/09/ – by 1.2% each and from 06/09/ to 13/09/ – by 1.4% each. During the period from 13/09/ to 20/09/ the intensity of sugar accumulation decreased by 1.0% for Aligote N 10 and 1.2% for Aligote 61-6, due to the decrease in temperatures and the rainfall (Fig. 3a). The grape must analysis revealed that on 20/09/ the sugar content of Aligote N 10 was 19.5% and the titratable acids were 6.30 g.l$^{-1}$. In Aligote 61-6, the sugars were 19.8% and the titratable acidity lower – 5.93 g.l$^{-1}$.

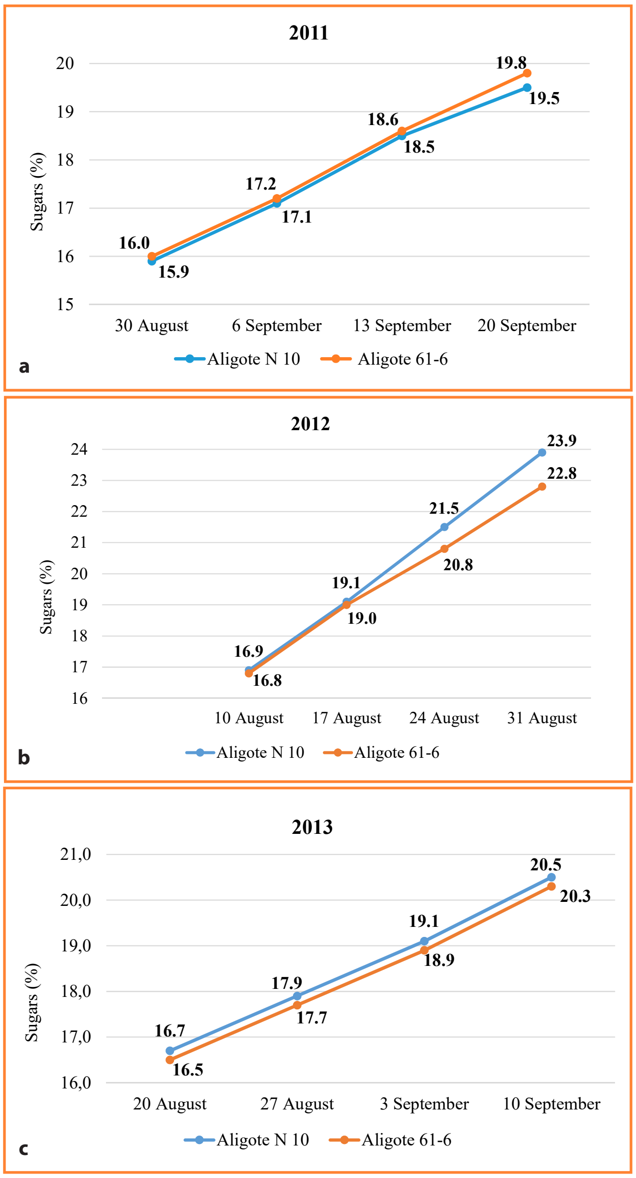


**Figure 3** Changes in sugars during the grapes ripening period of the studied Aligote clones

**Table 1** Mechanical analysis of grapes from the studied Aligote clones for the period 2011–2013

| Vintage | Average mass of a cluster (g) | Cluster texture | | Average mass per 100 berries (g) | Berry structure | | | Theoretical yield (%) |
|---|---|---|---|---|---|---|---|---|
| | | rachis (%) | berry (%) | | skins (%) | seeds (%) | mesocarp (%) | |
| **Aligote N 10** | | | | | | | | |
| **2011** | 237.0 | 2.99 | 97.01 | 190.00 | 9.58 | 3.79 | 86.63 | 84.04 |
| **2012** | 202.0 | 2.97 | 97.03 | 220.00 | 11.36 | 4.04 | 84.60 | 82.09 |
| **2013** | 225.5 | 4.24 | 95.76 | 190.00 | 11.05 | 4.31 | 84.64 | 81.05 |
| **Average** | 221.5 | 3.40 | 96.60 | 193.33 | 10.66 | 4.05 | 85.29 | 82.39 |
| **Aligote 61-6** | | | | | | | | |
| **2011** | 218.5 | 3.62 | 96.38 | 193.30 | 9,31 | 3.52 | 87.17 | 84.01 |
| **2012** | 198.0 | 3.53 | 96.47 | 225.00 | 10,12 | 4.02 | 85.86 | 82.83 |
| **2013** | 187.5 | 4.53 | 95.47 | 190.00 | 10,67 | 4.00 | 85.33 | 81.46 |
| **Average** | 201.3 | 3.89 | 96.11 | 202.67 | 10,03 | 3.85 | 86.12 | 82.77 |

Due to the hot and dry months of July and August 2012, the grapes ripening began considerably earlier than in the preceding year. On 10/08/ the sugar content of Aligote N 10 grapes was 16.9% and that of Aligote 61-6 – 16.8%. That year, the sugar accumulation in the grapes of clone N 10 occurred more intensively: from 10/08/ to 17/08/ by 2.2%, from 17/08/ to 24/09/ and from 24/08/ to 31/08/ by 2.4%. In the grapes of clone 61-6 the sugar accumulation was from 10/08/ to 17/08/ by 2.2%, from 17/08/ to 24/09/ by 1.8%, and from 24/08/ to 31/08/ by 2.0% (Fig. 3b). The grape must analysis showed that the clones had high sugar ratio – 23.9% (Aligote N 10) and 22.8% (Aligote 61-6) and lower titratable acids – 5.33 $g.l^{-1}$ and 5.85 $g.l^{-1}$, respectively.

In 2013, the first evaluation was made on 20/08/, where it was found that in the grapes from Aligote N 10 the sugars were 16.7% and in Aligote 61-6 – 16.5%. In the following measurements, no difference in the sugar accumulation intensity was found between both clones. During the periods from 20/08/ to 27/08/ and from 27/08/ to 03/09/ the amount of sugars increased by 1.2% and from 03/09/ to 10/09/ by 1.4% (Fig. 3c). In analyzing the must on 10/09/ the sugar ratio in the grapes was good – 20.5% (Aligote N 10) and 20.3% (Aligote 61-6).

The grapes from both studied Aligote clones were harvested upon reaching technological maturity. The data on the must composition are presented in Table 2. During the study period, both clones showed good sugar accumulation. The average rates were 213.00 $g.l^{-1}$ (Aligote N 10) and 209.67 $g.l^{-1}$ (Aligote 61-6) respectively, as in 2011 and 2013 vintages of both clones had similar sugar content and, in the harvest 2012, the control exceeded significantly the Ukrainian clone 61-6. Of the monosaccharides identified in grape must, fructose was predominant in both clones – 77.58 $g.l^{-1}$ glucose and 125.42 $g.l^{-1}$ fructose (average) for N 10 and 84.58 $g.l^{-1}$ glucose and 125.09 $g.l^{-1}$ fructose (average) for 61-6. An exception was observed only in the must of Aligote N 10, vintage 2011, where their rates were almost equal.

The clones had the specific titratable acidity for Aligote variety. For the studied period, similar acid content was analyzed in the musts of both clones – the average of 5.78 $g.l^{-1}$ (N 10) and 5.93 $g.l^{-1}$ (61-6), as in the 2012 and 2013 vintages of the Ukrainian clone contained more acids compared to the control. The tartaric and malic acids were prevailing from the organic acids in the wine. When analyzing their amount in the samples, no unidirectionality was found in the results. In 2011, the malic acid in Aligote N 10 must predominated, while the tartaric acid was prevailing in 61-6 must. In 2012 vintage, the malic acid predominated in both clones and the tartaric acid in the 2013 harvest. GAI had a higher average rate in the control grapes (average 3.73) than in 61-6 grapes (average 3.54). That indicated that the must from Aligote N 10 had better technological indicators for the production of wines with optimal chemical composition and quality. In both studied clones, the 2012 grapes had a higher content of sugars, GAI rates and lower titratable acidity due to the more favourable weather conditions during the period of grapes ripening phase.

The chemical composition of the experimental wines obtained from the studied clones of Aligote variety is presented in Table 3 (a, b).

The alcohol content in the wines from both clones was on the average 12.87 vol. % (N 10) and 12.67 vol. % (61-6). In the control, the rates were within the range from 12.25 to 13.70 vol. % and in the Ukrainian clone from 12.02 to 13.67 vol. %. The alcohol in the samples corresponded to the sugars in the grapes per vintages and respectively, the highest rates were found in the wines from the 2012 harvest. The alcoholic fermentation in all the test samples occurred normally without deviation and with complete degradation of the fermentable sugars. That was confirmed by the residual sugars in the obtained wines – on the average 1.62 $g.l^{-1}$ (Aligote N 10) and 1.61 $g.l^{-1}$ (Aligote 61-6).

The sugar-free extract ratio was an important indicator of wine composition. Its rates were within the typical range for Aligote variety. In the samples of N 10 the quantity of SFE was in the narrow range from 17.04 to 17.66 $g.l^{-1}$, while in the samples of 61-6 the difference between the individual vintages was greater – from 16.16 to 17.82 $g.l^{-1}$. In the 2011 and 2013 harvests, the control wines exceeded those of the Ukrainian clone. In 2012, just the opposite was observed (Table 3a).

The experimental samples had normal titratable and volatile acidity (Table 3b). During the study period, Aligote N 10 wines contained more titratable acids (the average of 6.05 $g.l^{-1}$) compared to those from the Ukrainian clone

**Table 2** Chemical composition of grape must from the studied Aligote clones, for the period 2011–2013

| Vintage | Date of harvest | Sugars ($g.l^{-1}$) | Glucose ($g.l^{-1}$) | Fructose ($g.l^{-1}$) | Titratable acidity ($g.l^{-1}$) | Tartaric acid ($g.l^{-1}$) | Malic acid ($g.l^{-1}$) | GAI | pH |
|---|---|---|---|---|---|---|---|---|---|
| **Aligote N 10** | | | | | | | | | |
| **2011** | 20/09/ | 195.00 | 100.10 | 94.90 | 6.30 | 3.37 | 5.29 | 3.10 | 3.29 |
| **2012** | 31/08/ | 239.00 | 80.10 | 158.90 | 5.33 | 1.12 | 4.23 | 4.48 | 3.27 |
| **2013** | 10/09/ | 205.00 | 52.53 | 122.47 | 5.70 | 5.62 | 3.22 | 3.60 | 3.24 |
| **Average** | | 213.00 | 77.58 | 125.42 | 5.78 | 3.37 | 4.25 | 3.73 | 3.27 |
| **Aligote 61-6** | | | | | | | | | |
| **2011** | 20/09/ | 198.00 | 88.40 | 109.60 | 5.93 | 5.10 | 4.22 | 3.34 | 3.25 |
| **2012** | 31/08/ | 228.00 | 80.10 | 147.90 | 5.85 | 3.97 | 5.59 | 3.90 | 3.26 |
| **2013** | 10/09/ | 203.00 | 85.23 | 117.77 | 6.00 | 5.70 | 2.98 | 3.38 | 3.24 |
| **Average** | | 209.67 | 84.58 | 125.09 | 5.93 | 4.92 | 4.26 | 3.54 | 3.25 |

**Table 3a** Chemical composition of wines from the studied Aligote clones, in the period 2011–2013

| Vintage | Alcohol (vol. %) | Sugars (g.l$^{-1}$) | Total extract (g.l$^{-1}$) | SFE (g.l$^{-1}$) | TPC (g.l$^{-1}$) | Colour intensity (I) [abs. units] |
|---|---|---|---|---|---|---|
| **Aligote N 10** | | | | | | |
| **2011** | 12.25 | 1.14 | 18.80 | 17.66 | 0.51 | 0.004 |
| **2012** | 13.70 | 2.46 | 19.50 | 17.04 | 0.75 | 0.004 |
| **2013** | 12.65 | 1.27 | 18.60 | 17.33 | 0.57 | 0.101 |
| **Average** | 12.87 | 1.62 | 18.97 | 17.34 | 0.61 | 0.036 |
| **Aligote 61-6** | | | | | | |
| **2011** | 12.02 | 1.04 | 17.20 | 16.16 | 0.50 | 0.006 |
| **2012** | 13.67 | 2.18 | 20.00 | 17.82 | 0.70 | 0.008 |
| **2013** | 12.33 | 1.61 | 18.70 | 17.09 | 0.33 | 0.090 |
| **Average** | 12.67 | 1.61 | 18.63 | 17.02 | 0.51 | 0.035 |

**Table 3b** Chemical composition of wines from the studied Aligote clones, in the period 2011–2013

| Vintage | Titratable acidity (g.l$^{-1}$) | Tartaric acid (g.l$^{-1}$) | Malic acid (g.l$^{-1}$) | Volatile acidity (g.l$^{-1}$) | pH |
|---|---|---|---|---|---|
| **Aligote N 10** | | | | | |
| **2011** | 6.00 | 1.84 | 3.02 | 0.42 | 3.12 |
| **2012** | 5.45 | 1.52 | 4.86 | 0.66 | 3.23 |
| **2013** | 6.70 | 2.25 | 3.62 | 0.54 | 3.10 |
| **Average** | 6.05 | 1.87 | 3.83 | 0.54 | 3.15 |
| **Aligote 61-6** | | | | | |
| **2011** | 5.75 | 2.21 | 2.98 | 0.54 | 3.05 |
| **2012** | 5.38 | 1.84 | 3.25 | 0.66 | 3.18 |
| **2013** | 6.00 | 2.70 | 2.91 | 0.60 | 3.06 |
| **Average** | 5.71 | 2.25 | 3.05 | 0.60 | 3.10 |

(the average of 5.71 g.l$^{-1}$). The lowest titratable acidity had the samples from both clones – 2012 vintage. From the organic acids analyzed in all experimental wines there was found a predominance of malic acid over tartaric acid.

The phenolic substances ratio and the colour intensity in the experimental samples were also in the range characteristic of white wines, with minor differences between the wines of the studied clone and the control. The TPC ratio was on the average 0.61 g.l$^{-1}$ (N 10) and 0.51 g.l$^{-1}$ (61-6), with higher rates reported for 2012 vintage for both clones (Table 3a).

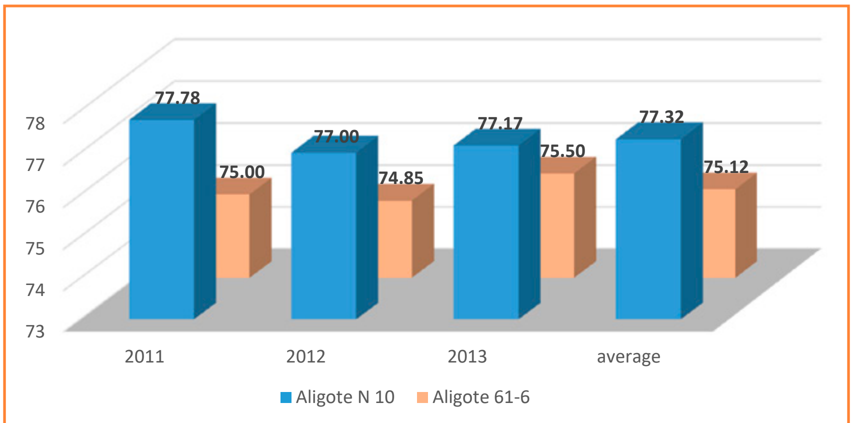


**Figure 4** Tasting score of wines from the studied Aligote clones, in the period 2011–2013

The results of the chemical and organoleptic analysis did not show a direct correlation between the content of the studied indicators and the tasting score of the samples (Table 3 (a, b), Fig. 4).

From Aligote N 10 wines, the best organoleptic qualities had the sample of 2011 vintage (77.78 points), where the lowest alcohol and TPC and the highest SFE rates were analyzed. From Aligote 61-6 wines, the best characteristics had the sample from the 2013 vintage (75.50 points), where the lowest TPC rates and the highest titratable acidity were found. During the study period, the control samples surpassed those of the Ukrainian clone in their organoleptic properties (Fig. 4, Fig. 5). The average tasting score of N 10 wines was 77.32 points, and of 61-6 wines it was 75.12 points (Fig. 4).

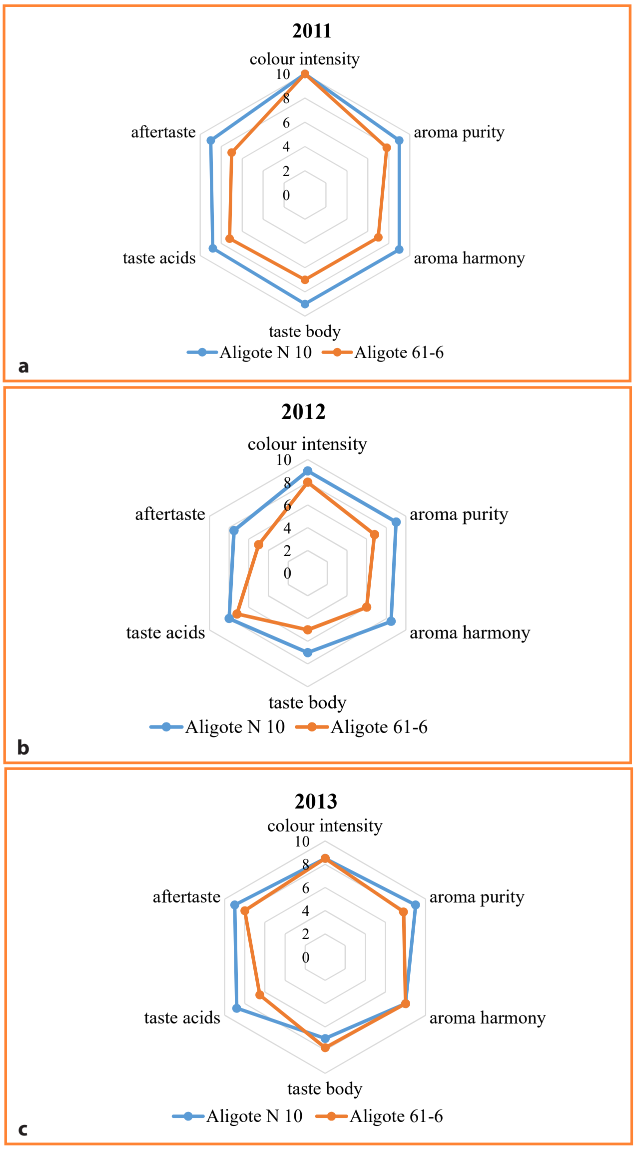


**Figure 5** Organoleptic profile of wines from the studied Aligote clones, in the period 2011–2013

That indicated that the control samples had better tasting characteristics in terms of aromatic and taste indicators, harmony and balance (Fig. 5).

## Conclusion

On the basis of the obtained results from the comparative technological study, the following could be summarised:

- In its mechanical composition, Aligote 61-6 was typically wine one and it did not differ significantly in the texture and structure of the cluster and berry from the control. Its cluster had a higher rate of rachis (3.89%) and less berries (96.11%) compared to Aligote N 10. Aligote 61-6 berry has less skins (10.03%) and seeds (3.85%) and higher rate of mesocarp – 86.12%. The theoretical yield of both clones was high – 82.77%(Aligote 61-6) and 82.39%(Aligote N 10).
- Both clones showed good sugar accumulation with average rate of 213.00 $g.l^{-1}$ (Aligote N 10) and 209.67 $g.l^{-1}$ (Aligote 61-6) respectively, and similar acid content – the average of 5.78 $g.l^{-1}$ (N 10) and 5.93 $g.l^{-1}$ (61-6).
- In 2011 and 2013 vintages, the control wines were superior to those of the Ukrainian clone in terms of sugar-free extract ratio.
- The experimental Aligote N 10 wines had a higher titratable acidity (the average of 6.05 $g.l^{-1}$) compared to the Ukrainian clone (the average of 5.71 $g.l^{-1}$). The samples from the 2012 vintage had the lowest titratable acids. A predominance of malic acid over tartaric acid was observed.
- The difference in the phenolic substance ratio and colour intensity in the experimental samples of the studied clone and the control were insignificant. Higher TPC rates were reported in 2012 vintage wines for both clones.
- No direct correlation was found between the content of the tested chemical indicators and the tasting score. The wines from the control surpassed in organoleptic qualities those from the Ukrainian clone.

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