Research Article

The Influence of the Agroecological Resources of Crimea on thePrimary and Secondary Metabolites of AligoteGrapes

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Abstract. This research focused on examining the interrelationships between the natural conditions for growing grapes, as well as the quantitative and qualitative characteristics of the harvest. These are important criteria for the scientifically grounded selection of a territory for planting a vineyard, selecting varieties and determining the use of the resulting products. The characteristics of six model vineyards of the Aligote cultivar, located in various natural zones and viticultural regions of the Crimea, were analyzed. The values of climatic indicators were calculated, including the growing degree days above 10°C ($\sum T^{\circ}C_{10}$), growing degree days above 20°C ($\sum T^{\circ}C_{20}$), Huglin index, Winkler index, average growing season temperature, average September temperature, ratio $\sum T^{\circ}C_{20}/\sum T^{\circ}C_{10}$,total precipitation during the year, total precipitation during the growing season, total precipitation in September, and Selyaninov hydrothermal coefficient. These were calculated usinggeoinformation and mathematical modeling for the locations of the analyzed vineyards. The content of the primary metabolites (total sugars, titrated acids and calculated indicators based on them) and secondary metabolites (phenolic components, oxidase activity) of grapes from the model vineyards were analyzed. The range of variation in the studied indicators within the analyzed territories was calculated, and the nature and magnitude of the relationships between the indicators were revealed. A cluster analysis of the analyzed vineyards was carried out and clusters were distinguished according to the degree of similarity in climatic parameters, as well as the content of the primary and secondary metabolites of the grapes.

Keywords: grapes, agroecological factors, primary and secondary grape metabolites, ampeloecological zoning, terroir

1. Introduction

The study of the impact of agroecological factors on the metabolism of grapes has a deep scientific and practical retrospective. The fundamental aspects of such studies are aimed at preserving and expanding the biological diversity of ampelosystems, identifying genetic specificity, adaptive plasticity of grape cultivars, etc. [1–4]. Revealing the relationship between the natural conditions of growing grape and the quantitative and qualitative characteristics of the harvest and wine production is necessary to achieve national economic goals: the scientific choice of the territory for planting a vineyard, the selection of cultivars and the determination of the direction of use of the resulting products (specialization of winemaking) [5]. Global climate change associated with an increase in the average ambient temperature, an increase in the difference between summer and winter temperatures, a destruction of the water balance, introduces significant adjustments to the metabolism of grapes, as a result of which the vegetative cycle of the plant is disrupted, the established agrobiological and technological characteristics of grapes change [6,7]. The above makes the study of agroecological resources as factors that form the primary and secondary metabolites of grapes and the object-oriented assessment of territories for its cultivation, especially relevant.

The problematic task of research in this direction is to determine the exact mesoclimatic characteristics of the analyzed grape growing areas, since they can differ significantly from the conditions at the nearest meteorological station, taken as the basis for obtaining climatic information. For this, various methods of data collection and processing are used, including remote sensing methods [8, 9]. A promising solution to this issue is geoinformation and mathematical modeling of the spatial variation of climatic indicators under the influence of orographic, hydrological and geographical parameters of the analyzed territories, which, however, is currently very limitedly used for zoning ampeloterritories [10–14].

The second important task is the selection of the most informative climatic indicators, the range of which is constantly expanding. So, in Russia, European countries,USA and Australiathe spatial and temporal variability of various climatic indices affecting grapes is studied with the aim of ampeloecological zoning of territories: Winkler's index, Huglin solar thermal index, average temperature during the growing season, growing degree days, biologically effective degree days, etc. [15–21].

Expansion of the taken into account quality characteristics of grapes and wine products is relevant in assessing the ampeloecological resources of geographic objects. The approach to the ampeloecological zoning of territories that has existed for decades on the basis of the fundamental possibility of growing grapes, the size of the yield and the basic indicators of its quality (the concentration of sugars and titratable acids) does not correspond to the modern achievements of world science and practice of winemaking. Numerous studies indicate that the quality of grapes and wine is due to a wide range of parameters, including the activity of native enzymes, the quantitative content and qualitative composition of phenolic, aroma-forming complexes, organic acids, etc., which

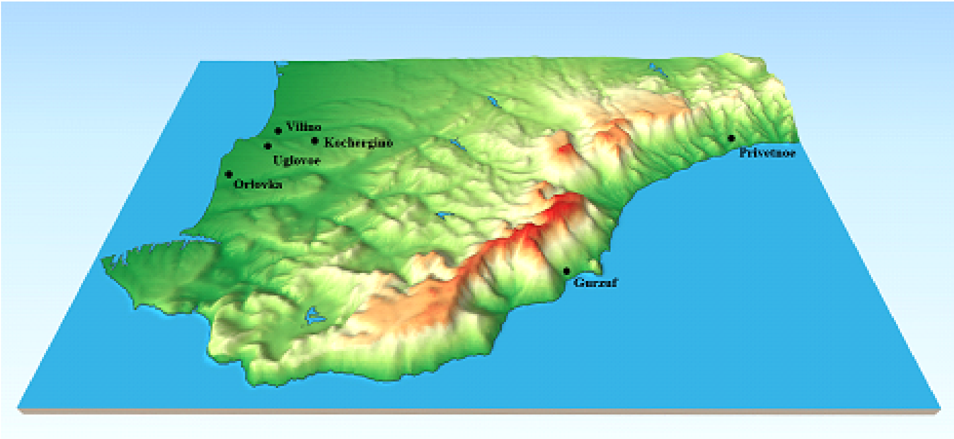

Figure 1: The location of the analyzed vineyards on the Crimea.

largely depend on both the natural conditions of plant growth and the grape cultivars [22].

Thus, a reliable study and zoning of the ampeloecological resources of territories is possible only with a systematic approach, including the identification and geoinformation modeling of multiparameter relationships of the spatial distribution of agroecological characteristics and metabolites of grapes (taking into account the variety specificity), the quality of the harvest and wine production. The first stage of these studies is the present work aimed at studying agroecological resources in the Aligote vineyards located on the Crimea, and their influence on the formation of the primary and secondary metabolites of grapes.

2. Materials and methods

2.1. Vineyards

The study of agroecological parameters was carried out in 6 industrial vineyards (Aligote cultivar) of the Crimea. Vineyards are located in geographical objects (Figure 1): Vilino village (hereinafter also used the digital designation of vineyards – 1), Kochergino village (2), Orlovka village (3), Uglovoe village (4) in the western foothill-coastal region; Gurzuf urban village (5) in the south coast region and Privetnoe village (6) in the mountain-valley coastal region of the South Coast zone [23]. Agricultural technology system of the vineyards is in accordance with the technological map adopted for each cultivar in the area.

2.2. Agroecological parameters of vineyards and methods for their determination

For each vineyard, the following agroecological parameters were determined: growing degree days above 10 °C ($\sum T°C_{10}$), growing degree days above 20 °C ($\sum T°C_{20}$), Huglin index, Winkler index, average growing season temperature, average September temperature, ratio $\sum T°C_{20}$ / $\sum T°C_{10}$, total precipitation during the year, total precipitation during the growing season, total precipitation in September, Selyaninov hydrothermal coefficient (HTC), which is the ratio of the total precipitation during the growing season period increased by 10 times togrowing degree days above 10 °C [20, 24–26].

To calculate agroecological indicators at the points of location of the analyzed vineyards, the geographical coordinates of the vineyards, morphometric features of the relief (absolute height above sea level, steepness and aspect of the slope, relative elevation over thalweg), soil cover characteristics, as well as the nearest stationary meteorological station were determined. The calculation of the value of each of the analyzed climatic factors at the location of the vineyards was carried out by the method of geoinformation modeling using long-term data from the network of stationary weather stations of the Crimea for 1985–2019, digital elevation models SRTM-3 and ASTER GDEM, the global climate model Worldclim ver. 2.0 and mathematical models developed by the authors describing the patterns of spatial variation of climatic indicators under the influence of orographic, hydrological and geographical parameters of the analyzed territory [27–30].

2.3. Grape samples and analysis methods

Aligote cultivar of 2013–2019 harvest were analysed. The sampling of grapes was carried out in the vineyards when they reached technical maturity during the industrial harvest. Samples were transported immediately under refrigeration (2–5 °C) to the laboratory for analysis.

To analyze grapes 500–600 g of the berries of each sample were crushed in a turbo blender (Moulinex-LM600E, France) during 2 min.

To determine the technological reserve of phenolic compounds (TRPh) the resulting pomace was heated and kept in the thermostat at 70 °C for 30 minutes with stirring. After pomace cooling, we separated the must and measured concentration of phenolic compounds with Folin-Ciocalteu reagent [31]. Technological reserve of phenolic compounds is that part of them that can transfer to the must during red winemaking. We calculated the degree of phenolic components'transition into must in the process of whole berry pressing (Ph_0 / TRPh) and 4-hour mash maceration fromtheir technological reserve (Ph_4 / TRPh).

The juice suspension was centrifuged at 5000 rpm for 15 min at room temperature to get a clarified juice to determine the content of total sugars in grapes, titrated acids, active acidity (pH). The juice was then filtered through 0.45 μm pore size membrane filters and incubated at 20 °C for analysis. Total sugars were determined using the aerometric method, titrated acids in terms of tartaric acid were determined by the titrimetric method [32]. Gluco-acidimetric index (GAI) and grape ripeness index (RI = Brix x pH^2) were calculated. The monophenolmonooxidase activity of wort (AMPhMO, item) was determined by the rate of oxidation of a pyrocatechol solution [33].

2.4. Statistical analysis of the data

The total number of grape samples was 32. All assays were performed in 2–3 replications. Experimental material was processed by variance (ANOVA), discriminative and cluster analysis methods (using Statistics 10 program). Normality of distribution was assessed by Kolmogorov-Smirnov test. Value comparison of quantitative attributes in independent subgroups was performed using either Student's t-test (for normally distributed attributes) or the Mann-Whitney U-test. Verification of statistical coefficients was performed for significance point of a <0.05. Information value of discriminant variables was assessed based on Wilks statistics.

3. Results and discussion

The values of the climatic indicators of the analyzed Aligote vineyards (for each and for all), obtained by nonlinear interpolation of long-term observations at the Crimean weather stations using the methods of geoinformation and mathematical modeling, are given in Table 1.The presented data demonstrate a moderate range of variation in the parameters of heat and moisture supply in vineyards. At the same time, the geographical location of vineyards is a significant factor in the dispersion of the studied climatic parameters. For most parameters, the level of significance of differences for vineyards is $\alpha<0.000001$, for HTC–$\alpha<0.0001$, for Huglin index and $\sum T^{\circ}C_{20}$ / $\sum T^{\circ}C_{10}$– $\alpha<0.05$. The amount of precipitation falling on the vineyards in September varied from 0.0 to 156.6 mm, regardless of the geographical location of the vineyards. The highest values (6–26% higher than the average values for all vineyards) of heat supply indicators were characteristic of the vineyards of Gurzuf urban village and Orlovka village. At the

TABLE 1: Values* of climatic parameters of Aligote vineyards located in different geographical objects.

Index	Natural zone / viticulture area / geographical location (vineyard number)						All vineyards
	Foothill zone				South coast zone		
	Western foothill-seaside area				South coast area	Mountain-valley seasidearea	
	Villino v. (1)	Kochergino v. (2)	Orlovka v. (3)	Uglovoe v. (4)	Gurzufurban v.(5)	Privetnoev. (6)	
Growing degree days $\sum T^{\circ}C_{10}$, °C	$\frac{3529 \pm 314}{2682 - 4114}$	$\frac{3438 \pm 314}{2590 - 4023}$	$\frac{3926 \pm 253}{3559 - 4430}$	$\frac{3447 \pm 314}{2600 - 4032}$	$\frac{4207 \pm 328}{3705 - 4861}$	$\frac{3760 \pm 496}{2809 - 4710}$	$\frac{3677 \pm 435}{2591 - 4861}$
Growing degree days $\sum T^{\circ}C_{20}$, °C	$\frac{1715 \pm 470}{647 - 2813}$	$\frac{1643 \pm 470}{539 - 2705}$	$\frac{2212 \pm 378}{1593 - 2797}$	$\frac{1671 \pm 470}{567 - 2733}$	$\frac{2408 \pm 456}{1546 - 3057}$	$\frac{1993 \pm 588}{988 - 3183}$	$\frac{1904 \pm 547}{539 - 3183}$
Huglin index	$\frac{2519 \pm 258}{1931 - 2967}$	$\frac{2487 \pm 258}{1899 - 2935}$	$\frac{2410 \pm 494}{268 - 2822}$	$\frac{2488 \pm 258}{1900 - 2936}$	$\frac{2715 \pm 189}{2341 - 2987}$	$\frac{2464 \pm 280}{1894 - 3021}$	$\frac{2508 \pm 305}{268 - 3021}$
Winkler index	$\frac{1585 \pm 202}{1093 - 2072}$	$\frac{1542 \pm 202}{1050 - 2029}$	$\frac{1799 \pm 144}{1551 - 2148}$	$\frac{1547 \pm 202}{1055 - 2034}$	$\frac{1998 \pm 189}{1622 - 2350}$	$\frac{1729 \pm 288}{1181 - 2346}$	$\frac{1677 \pm 260}{1050 - 2350}$
Average September temperature, °C	$\frac{16.6 \pm 2.0}{10.2 - 20.7}$	$\frac{16.0 \pm 2.0}{9.6 - 20.1}$	$\frac{19.6 \pm 1.2}{17.1 - 22.6}$	$\frac{16.2 \pm 2.0}{9.8 - 20.3}$	$\frac{18.9 \pm 2.1}{11.3 - 22.1}$	$\frac{17.9 - \pm 2.2}{10.7 - 22.4}$	$\frac{17.3 \pm 2.3}{9.6 - 22.6}$
Average growing season temperature, °C	$\frac{18.3 \pm 1.0}{16.4 - 20.4}$	$\frac{18.2 \pm 1.0}{16.3 - 20.3}$	$\frac{19.2 \pm 0.8}{17.9 - 20.5}$	$\frac{18.2 \pm 1.0}{16.3 - 20.3}$	$\frac{19.8 \pm 1.0}{17.8 - 21.3}$	$\frac{18.8 \pm 1.4}{16.3 - 21.7}$	$\frac{18.7 \pm 1.2}{16.3 - 21.7}$
$\sum T^{\circ}C_{20}/\sum T^{\circ}C_{10}$	$\frac{0.49 \pm 0.11}{0.19 - 0.75}$	$\frac{0.47 \pm 0.11}{0.17 - 0.74}$	$\frac{0.56 \pm 0.09}{0.40 - 0.71}$	$\frac{0.48 \pm 0.11}{0.17 - 0.74}$	$\frac{0.57 \pm 0.10}{0.36 - 0.77}$	$\frac{0.52 \pm 0.11}{0.33 - 0.77}$	$\frac{0.51 \pm 0.11}{0.17 - 0.77}$
HTC	$\frac{0.74 \pm 0.26}{0.39 - 1.49}$	$\frac{0.80 \pm 0.26}{0.45 - 1.6}$	$\frac{0.52 \pm 0.17}{0.22 - 0.92}$	$\frac{0.76 \pm 0.26}{0.41 - 1.51}$	$\frac{0.81 \pm 0.18}{0.48 - 1.28}$	$\frac{0.64 \pm 0.20}{0.35 - 1.15}$	$\frac{0.72 \pm 0.24}{0.22 - 1.55}$
Total precipitation during the year, мм	$\frac{464 \pm 101}{329 - 728}$	$\frac{496 \pm 108}{352 - 777}$	$\frac{396 \pm 85}{263 - 607}$	$\frac{475 \pm 103}{337 - 744}$	$\frac{655 \pm 139}{398 - 1033}$	$\frac{450 \pm 99}{278 - 643}$	$\frac{485 \pm 126}{263 - 1033}$
Total precipitation during the growing season, мм	$\frac{248 \pm 70}{142 - 469}$	$\frac{268 \pm 76}{154 - 508}$	$\frac{206 \pm 73}{79 - 386}$	$\frac{250 \pm 71}{144 - 475}$	$\frac{341 \pm 86}{181 - 515}$	$\frac{233 \pm 78}{128 - 420}$	$\frac{256 \pm 83}{79 - 515}$
Total precipitation in September, mm	$\frac{37.3 \pm 32.6}{0.0 - 144.4}$	$\frac{39.4 \pm 34.4}{0.0 - 152.3}$	$\frac{43.6 \pm 37.1}{1.1 - 142.1}$	$\frac{38.6 \pm 33.7}{0.0 - 149.2}$	$\frac{59.3 \pm 48.3}{0.5 - 156.6}$	$\frac{32.2 \pm 32.4}{0.0 - 129.8}$	$\frac{40.6 \pm 36.4}{0.0 - 156.6}$

* numerator – mean ± standard deviation (means±SD); denominator – range.

same time, the Gurzuf vineyard was distinguished by the highest moisture supply, the values of which were 13–35% higher than the average values for all vineyards. On the contrary, the Orlovka vineyard was characterized by the HTC value by 22% less than the average value of the parameter for all vineyards, and by the annual precipitation – by 18%.

The results of the hierarchical classification of long-term climatic data showed that vineyards of Kochergino, Uglovoe and Vilino are the closest in all climatic parameters –the standardized Euclidean distance (Ed) is 0.40–0.76 (Figure 2)–and belong to the same cluster (I). By heat supply, vineyards of Orlovka and Gurzuf form a separate cluster (II) – Ed between them is 2.95 and their distance from other vineyards is 4.22–5.51. In terms of moisture supply, a separate cluster (III) includes vineyards of Orlovka and Greetings (Ed = 1.11), distant from other vineyards at Ed = 2.95–4.27. In Figure 2A clearly shows the best result (α<0.00001) of discriminating the identified vineyard clusters in terms of heat supply, which was obtained with the aggregate consideration of the parameters: $\sum T^{\circ}C_{10}$, Huglin index and Winkler index. Increasing the values of these parameters in the diagrams in Figure 2 is indicated by arrows. As can be seen from the diagram of Privetnoye village occupies an intermediate position between the two clusters in terms of heat supply. The most significant parameters of moisture supply in discriminating vineyards were the HTC, the amount of annual precipitation and precipitation during the growing season. Their aggregate accounting discriminated

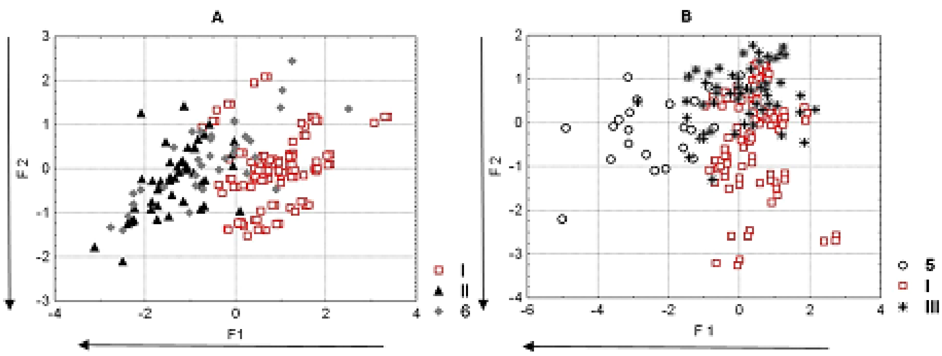

Figure 2: Diagram reflecting the differences in heat supply (A) and moisture supply (B) in vineyards: I – cluster: Vilino + Kochergino + Uglovoe; II – cluster: Orlovka + Gurzuf; III –cluster: Orlovka + Privetnoe; vineyards: 5 – Gurzuf, 6– Privetnoe.

against the identified clusters of vineyards at a significance level of $\alpha<0.00001$. The Gurzuf vineyard significantly exceeds the rest of the vineyards and is not included in any cluster. It should be noted the high (0.35–0.44) statistics of Wilks L. when discriminating vineyards by climatic parameters. This indicates that the analysis did not consider important factors, one of which is the year of observation (harvest).

The harvest year is a significant factor in the dispersion of all climatic parameters of vineyards at $\alpha<0.000001$. A consistent increase in the values of heat supply in vineyards over the years of observations was revealed, which is consistent with the trends in climate change according to geographically averaged data from all weather stations of the Crimea [34]. Compared to 1985–1994, in 2015–2019 the average values of $\sum T^{\circ}C_{10}$ increased ($\alpha<0.000001$) by 22%, $\sum T^{\circ}C_{20}$– by 80%, Huglin index–by 25%, Winkler index – by 36%, the average September temperature –by 26%, the average temperature during the growing season – by 14%. The ratio $\sum T^{\circ}C_{20}$ / $\sum T^{\circ}C_{10}$ for the same period increased by 1.5 times. At the same time, the relative increase in the amount of annual precipitation was 16%, the amount of precipitation during the growing season was 22%; the value of the HTC practically did not change, and the amount of precipitation in September decreased by 26%. The presented data clearly demonstrate the change in climatic parameters in the analyzed vineyards, which cannot but affect the plant metabolism.

Table 2 shows the values of some primary (total sugars, titrated acids, calculated indicators based on them) and secondary (phenolic components, oxidase activity) metabolites of Aligote grape of 2013–2019 harvest obtained from the investigated vineyards. Analysis of the data shows that the sugar content in berries varied in the range from 167 mg/dm^3 to 234 g/dm^3 and did not differ significantly depending on the geographical location of the vineyards. The latter is explained by the fact that the grape samples were taken during the industrial harvest. The exception was grapes from Gurzuf, in which the

Table 2: Values* of physicochemical and biochemical parameters of grapes of 2013–2019 harvest, obtained in different vineyards.

Index	Natural zone / viticulture area / geographical location (vineyard number)						All vineyards
	Foothill zone				South coast zone		
	Western foothill-seaside area				South coast area	Mountain-valley seasidearea	
	Villino v. (1)	Kochergino v. (2)	Orlovka v.(3)	Uglovoe v. (4)	Gurzufurban v.(5)	Privetnoev.(6)	
Total sugars , g/dm^3	208 ± 22 180 – 234	199 ± 18 180 – 220	183 ± 14 164 – 196	190 ± 16 167 – 218	228 ± 15 193 – 239	200 ± 6 196 – 204	197 ± 19 167 – 234
Titrated acids, g/dm^3	5.7 ± 0.9 4.7 – 6.8	7.6 ± 0.6 6.8 – 8.0	6.9 ± 1.6 5.8 – 9.3	6.7 ± 1.2 5.6 – 8.5	5.0 ± 0.8 4.3 – 6.0	7.5 ± 0.3 7.3 – 7.7	6.5 ± 1.3 4.7 – 9.3
Active acidity (pH)	3.22 ± 0.28 2.80 – 3.60	3.30 ± 0.13 3.10 – 3.49	3.24 ± 0.09 3.19 – 3.35	3.19 ± 0.12 3.03 – 3.34	3.40 ± 0.12 3.28 – 3.53	3.24 ± 0.15 3.13 – 3.34	3.23 ± 0.17 2.80 – 3.60
Gluco-acidimetric index (GAI)	3.7 ± 0.9 2.6 – 5.0	2.6 ± 0.5 1.8 – 3.0	2.8 ± 0.7 1.8 – 3.2	2.9 ± 0.5 2.2 – 3.6	4.6 ± 0.6 2.8 – 5.0	2.7 ± 0.2 2.5 – 2.8	3.1 ± 0.8 1.8 – 5.0
Grape ripeness index (RI)	220 ± 59 146 – 303	217 ± 34 185 – 264	192 ± 19 176 – 220	193 ± 19 167 – 217	264 ± 12 248 – 277	209 ± 13 200 – 217	206 ± 37 146 – 303
TRPh, mg/dm^3	695 ± 330 323 – 1127	1096 ± 146 855 – 1167	932 ± 48 891 – 999	953 ± 238 612 – 1272	620 ± 152 469 – 782	893 ± 156 772 – 1156	855 ± 253 323 – 1272
Ph_0/TRPh, %	72 ± 23 46 – 92	39 ± 13 22 – 51	32 ± 8 25 – 40	38 ± 7 29 – 45	64 ± 18 45 – 81	39 ± 17 21 – 64	44 ± 18 25 – 92
Ph_4/TRPh, %)	65 ± 16 55 – 83	27 ± 10 18 – 44	39 ± 5 36 – 45	37 ± 11 27 – 52	45 ± 12 35 – 61	41 ± 15 29 – 60	45 ± 18 27 – 84
A_{MPhMO}x10^2, item	12.1 ± 5.2 6.2 – 20.8	8.1 ± 0.8 7.4 – 10.3	10.4 ± 6.5 02 – 15.6	14.0 ± 11.1 4.6 – 34.5	15.3 ± 10.2 5.0 – 30.1	8.7 ± 0.9 7.5 – 9.7	12.1 ± 7.7 2.0 – 34.5
* numerator – mean ± standard deviation (means±SD); denominator – range.							

sugar content was on average 16% higher than the value of the indicator in berries obtained in other geographical areas. The concentration of titratable acids in grapes averaged 6.5 ± 1.3 g/dm^3. In the grapes obtained in Kochergino and Privetnoe, the value of the indicator exceeded the average by 17%, in the grapes from Gurzuf, on the contrary, the value was 23% less. Accordingly, the grapes from Gurzuf was characterized by the highest gluco-acidimetric index (GAI – 1.5 times higher than the average for vineyards), grape ripeness index (RI – 1.3 times) and pH (by 0.17 units). Differences of Gurzuf grapes in terms of the content of the main metabolites is consistent with the highest heat and moisture supply in the vineyard (see Table 1). It is known that the temperature factor affects the intensity of photosynthesis, the migration of nutrients in the plant: a temperature above 20 °C is most favorable for the growth of shoots, the accumulation of sugars and a decrease in the concentration of titratable acids during the ripening of grapes [35–37]. Cluster analysis confirmed the difference between the grapes from Gurzuf from the harvest from other vineyards in terms of the content of the main metabolites, GAI, RI and pH: Ed = 3.29–5.03. The similarity / difference of the analyzed indicators of the composition and properties of grapes from other geographic objects was characterized by Ed = 1.34–2.72 (Figure3A).

High moisture availability and low temperature in September prevent the accumulation of phenolic components in grapes [1; 37–39], which is reflected in the value of the technological stock of components in Aligote grapes form Gurzuf and Vilino,

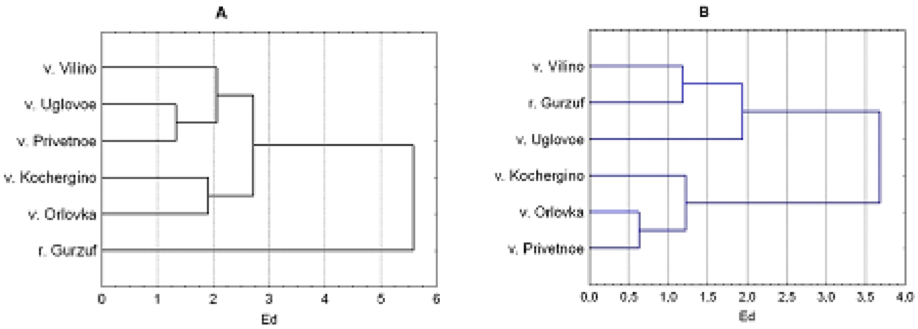

Figure 3: The result of vineyard clustering by a set of indicators of carbohydrate–acid (A), phenolic and oxidase (B) grape complexes.

which is on average 32% less than the values of the indicator for grapes obtained in other geographical objects. Grapes from Gurzuf and Vilino was characterized by a high degree of transfer of phenolic substances from the solid parts of the berry to the wort, both by pressing the berries and during 4 hours of infusion of the must (64–72% and 45–65% of the technological reserve of phenolic substances, respectively). During berries pressing, this is due to the permeability of the secondary cell walls of the skin and is interrelated with the accumulation of sugars [40]. With 4-hour infusion of the must, the formation of the phenolic complex of the wort is the result of two oppositely directed processes: the extraction of components and their oxidative transformation [41; 42]. The lowest oxidase activity of the must was observed for grapes from Kochergino and Privetnoe (30% lower than the average for all vineyards), the largest – grapes from Gurzuf (26% higher), which, as our earlier studies showed, is interconnected with the heat supply of vineyards [37]. According to the totality of indicators of phenolic and oxidase complexes, grapes from Vilino and Gurzuf form a cluster characterizing Ed = 1.19; the second cluster is made up of vineyards from Kochergino, Orlovka and Privetnoe (Ed = 0.63–1.23) (Figure 3B).

4. Conclusion

As a result of the research, several relationships have been revealed between the climatic parameters of vineyards and the content of primary and secondary metabolites in Aligote grapes. The scope was established in various natural zones and natural viticultural regions of the Crimea. The data obtained are the basis for the creation of multi-parameter geoinformation models of the spatial distribution of ampeloecological resources and a scientifically grounded methodology for the selection of object-oriented terroirs with exceptional agroecological potential, allowing to grow grapes to obtain wine products that are unique in their characteristics.

The work is aimed at development of winemaking with geographical status in the Russian Federation, enhancing the image and competitiveness of wines.

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6. Conflict of Interest

The authors declare no conflict of interest.

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