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BIOCHEMICAL FEATURES OF WINE MATERIALS FROM WHITE HIGHLY ADAPTIVE VARIETIES OF GRAPES

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Abstract

The European varieties of grapes being the main source of raw material for our wine-making have a number of qualitative merits in the ready wines, but they also have the demerits in productivity and resistance under our climatic conditions of cultivation. For laying new plantings of white grape varieties the old assortment is used, which in the extreme winters of 2005-2006 was heavily damaged. The purpose of our research is to study the physical, chemical and biochemical composition of wine materials and wines from perspective varieties of grapes. Their characteristic on the main estimated indicators will allow the creation of a whole series of new qualitative wines. The results of the long-term study of new highly-adaptive grape varieties are presented in this article. The research was carried out at the Anapa's Experimental Zonal Station of Wine growing and Winemaking for the period from 2001 to 2013, the research allowed to reveal a number of perspective white technical varieties which were resistant to adverse ecological factors of the environment and capable to give high-quality wines. On the basis of organoleptic properties the wine materials from the following varieties were recognized as the best samples: Varvarovskiy, Zolotaya Osen, Bokator (7,85 points); AZOS Riesling (7,83 points); Arabushlo (7,8 points) and Aligote's control (7,78 points). Referring to the physical and chemical indicators, all studied wine materials corresponded to the requirements of GOST. As far as the total accumulation of biologically active agents was concerned, the wine material from cv Mtsvane Kakhetinskiy (47,6 mg/dm^3) was selected. Based on the results of the long-term research carried out by us the conclusion is that the selected varieties of grapes should be allowed for use in the industrial application and also for wide use in the breeding work as donors of frost resistance, drought resistance and wine quality that will expand the borders of steady grapes production in the region.

Key words: grapes, cultivar, resistance, biological potential, biochemical composition, organoleptic analysis, quality of wines.

INTRODUCTION

Many years of experience show that the quality of matured wines depends directly on the quality of raw materials – grapes, while the quality of grapes is most influenced by the characteristics of grape varieties [1].

At present the wine making and grape growing industry in our country is at the stage of restoration. However, almost all new vineyards have recently been planted with red wine grape varieties from France, as usual [2].

As a result, now we are facing overproduction of red wines. In this connection we are making timid attempts to reduce these imbalances in production of red and white wines increasing the production of white ones. Establishing new vineyards of white grapes for wine making we have to use old assortment which was severely damaged during the extreme years 2005-2006 [3].

European varieties that have represented the bulk of raw materials for the national wine making industry until recently have a number of advantages in terms of quality of matured wines, but they also have certain weaknesses in terms of productivity and resistance to our conditions of viticulture [4].

A study of physiochemical and biochemical composition of wines and juice concentrates from promising grape varieties, their characteristics in terms of basic ratings: flavor, bioenergetics and sanitary, shall contribute to the establishing of an entirely new series of high quality wines.

Therefore, studies of adaptability and quality potential of new introduced and indigenous white wine grape varieties are of vital importance. We have been carrying out our studies on the basis of the Anapa ampelographic collection since 2001, and we have revealed a number of white wine grape varieties that showed their high resistance to abiotic site factors during the extreme winter conditions in 2005-2006 and then in 2012-2013 [5].

The studies and analysis of productivity and quality of wines in a certain number of years have shown some advantages of these new varieties in terms of quality parameters and commercial criteria, therefore we can recommend them for variety changing.

Research objective is to study wines and juice concentrates from new promising wine grape varieties, both introduced and bred at the GNU Anapa ZOSViV (the State Scientific Institution *Anapa Zone Viticulture and Winemaking Experimental Station*); to identify associations between the characteristics of grape varieties and quality parameters, biological values and enotherapeutic properties, as well as safety profile of wines, which shall offer the possibility to predict the operation modes and performance parameters for the production of high quality grape wines with the given characteristics, on the basis of the comprehensive physiochemical testing of wines and juice concentrates from the grapes grown in the Anapa district.

Subject of research is wines and juice concentrates from promising white wine grape varieties growing in the Anapa ampelographic collection field.

Methods of research. Agro-biological, commercial and technological record keeping and monitoring have been performed using traditional methods recognized in viticulture. Wines and juice concentrates have been produced using the microvinification method in the processing facility of the GNU Anapa ZOSViV. Mass concentrations of basic components of wines and juice concentrates have been calculated in accordance with the requirements of valid GOST and GOST R and also using the methods developed at the Scientific Center of Viniculture of SKZNIISiV of Rosselkhozakademia (the Russian Academy of Agricultural Science) [6].

Organoleptic properties of young wines and juice concentrates have been assessed by the panel of wine tasters of the GNU Anapa ZOSViV.

RESULTS AND DISCUSSION

Long-term observations of the development of a great number of grape varieties growing in one field are especially valuable. Weather conditions in 2001–2013 varied significantly in terms of temperature and moisture regimes, which gave us the opportunity to identify biological peculiarities of grape varieties adaptability to existing abiotic conditions and their potential capabilities.

For our purposes we divide the years of research into two periods: the 1st period – the study of the grape varieties in 2001-2005, and the 2nd period – the study of the grape varieties in 2006-2013.

Both periods had good and bad years for the development of vines.

On the whole, the period of 2001-2005 can be characterized as good for grapes growing. In the result of the research conducted in the years 2001-2005 we identified quite a great number of promising white wine grape varieties.

Stress weather conditions in winter 2005-2006 gave us more reliable data about the frost resistance and productivity potential of the varieties under study, so we identified those with good resistance to frosts, with medium resistance, with low resistance and very low (no) resistance, and the list of promising grape varieties shortened much.

We identified a group of wine grape varieties with high yield and quality of grapes manifested for a number of years. These grape varieties showed good resistance to frosts in 2005-2006 and high yield in 2006-2013, thus becoming promising ones [7].

Phenological observations of 2006-2013 resulted in the conclusion that these grape varieties had very early and early ripening, thus being even more valuable.

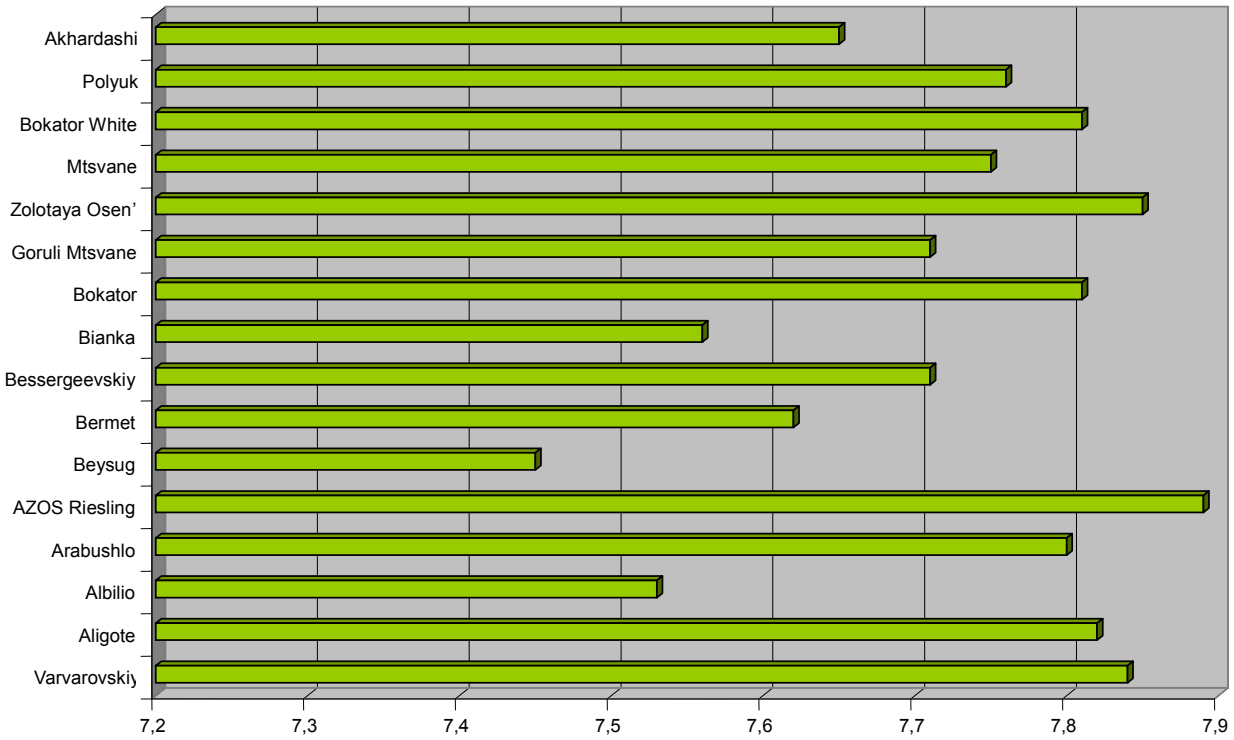
Weather conditions in 2001-2013 varied significantly in terms of temperature and moisture regimes, which gave us the opportunity to identify biological peculiarities of grape varieties adaptability to existing abiotic conditions, and assess organoleptic, physiochemical and biochemical properties of wines and juice concentrates from them and their potential capabilities for high quality wine making.

One of the most important characteristics of wines is their organoleptic ratings. Organoleptic ratings of young wines and juice concentrates (8-point rating scale) from grapes with high adaptability potential helped us in identifying grape varieties capable of producing high quality wines.

The highest flavor ratings were registered for experimental wines and juice concentrates from the grape varieties of AZOS Riesling, Varvarovskiy, Zolotaya Osen' and Bokator White – 7.81-7.89 points, and the control sample of Aligote (7.78 points) (Pic. 1).

They had golden straw color, dried fruit and floral aroma, and clean, harmonious, pleasant flavor. A little lower were ratings of the samples of Arabushlo (7.8 points), Kakheti Mtsvane (7.75 points), Goruli Mtsvane and Bessergenevskiy (7.71 points). All the rest samples got the ratings lower than 7.6 points due to low acidity, high alcohol, and out-of-balance flavor.

All wines and juice concentrates produced by the microvinification method in the processing facility of the Anapa ZOSViV got their comprehensive technochemical characteristics, which provides us the opportunity to give well-reasoned grounds of organoleptic and enotherapeutic properties and vitamin-nutritional value of these wines and form the database of biochemical composition of wines from new and promising grape varieties. All wines and juice concentrates under study were in compliance with the requirements of GOST in terms of their physiochemical properties (Table 1).



Pic. 1. *Flavor ratings of white table grape juice concentrates from promising grape varieties, score points (2001–2013)*

Table 1. Physiochemical properties of wines and juice concentrates (2001-2013)

Name of wines and juice concentrates	Ethanol, %	Titratable acidity, g/dm^3	Volatile acidity, g/dm^3	SO_2, mg/dm^3	Residual sugar	Extract	pH
Varvarovskiy	12.7	6.2	0.5	19.8	1.2	18.7	3.2
Aligote	11.4	5.4	0.4	17.5	1.3	19.4	3.4
Albilio	12.1	5.8	0.5	27.4	0.6	19.9	3.5
Arabushlo	13.9	4.9	0.7	24.1	0.9	19.7	3.8
Akhardashi	12.5	5.7	0.5	19.0	0.8	22.2	3.8
Beysug	11.2	4.9	0.5	12.6	1.1	20.6	3.8
Bermet	12.2	4.6	0.7	19.2	1.3	18.1	3.9
Bessergenevskiy	11.4	5.7	0.6	13.1	1.1	18.2	3.3
Bianka	14.2	5.8	0.5	35.3	3.1	19.5	3.6
Bokator	12.7	5.7	0.3	43.0	2.5	19.9	3.5
Goruli Mtsvane	12.1	5.8	0.7	39.7	1.7	18.8	3.4
Zolotaya Osen'	11.0	5.9	0.8	23.0	2.6	20.3	3.4
Mtsvane	11.9	6.1	0.5	35.1	1.1	18.3	3.4
Bokator White	12.0	5.7	0.7	19.6	2.0	21.1	3.3
Polyuks	10.9	5.8	0.6	21.5	1.4	19.6	3.3
AZOS Riesling	11.6	6.5	0.4	24.2	0.9	19.5	3.2

It is known that dry white wines and juice concentrates are resistant to clouding only if their pH is less than 3.4. With such values the colloidal system is more resistant to sedimentation. Wines and juice concentrates from the grape varieties of Aligote (control sample), Bessergenevskiy, Bokator, Varvarovskiy, Zolotaya Osen', Pleven Muscat, Kakheti Mtsvane, Goruli Mtsvane, Polyuks, and AZOS Riesling had their pH within 3.2-3.4. Very high values of pH were registered for the samples made from the grape varieties of Bermet (3.9), Arabushlo (3.8), Akhardashi and Beysug (3.8).

All wines and juice concentrates under study had quite high alcohol – from 10.9 (Polyuks) to 14.2 (Bianka). Such alcohol content values resulted in microbiologically stable high alcohol table wines of high quality.

Volatile acidity of all samples from wines and juice concentrates was within 0.3-0.9 g/dm^3 and exceeded no limits established by GOST (1.5-2.0 g/dm^3).

We identified 6 organic acids in the experimental wines and juice concentrates.

Maximum content of tartaric acid was registered in wines made from the grape varieties of Varvarovskiy – 4.8, AZOS Riesling – 4.2, and the control sample of Aligote – 4.5 g/dm^3; however, it had no adverse effect on their flavor or organoleptic ratings. Wine and juice concentrates from the grape variety of Beysug had the minimum value of 1.7 g/dm^3, resulting in the out-of-balance flavor of this sample. All the rest wines and juice concentrates had the tartaric acid content varying within 1.9-3.4 g/dm^3 (Table 2).

Succinic acid found in wines as a fermentation byproduct was registered in all wines and juice concentrates under study – from 0.4 (Akhardashi) to 1.7 g/dm^3 (Varvarovskiy).

Acetic acid is a major volatile acid present in concentrations of 0.1-1.0 g/dm^3. In this case its small concentration has good effect on wines' flavor ratings.

Total content of organic acids in white table wines and juice concentrates was the greatest in the control sample of wine and juice concentrates of Aligote (9.2 g/dm$^{3)}$, and the experimental sample from the grape variety of Varvarovskiy (8.9 g/dm^3) (Pic. 2).

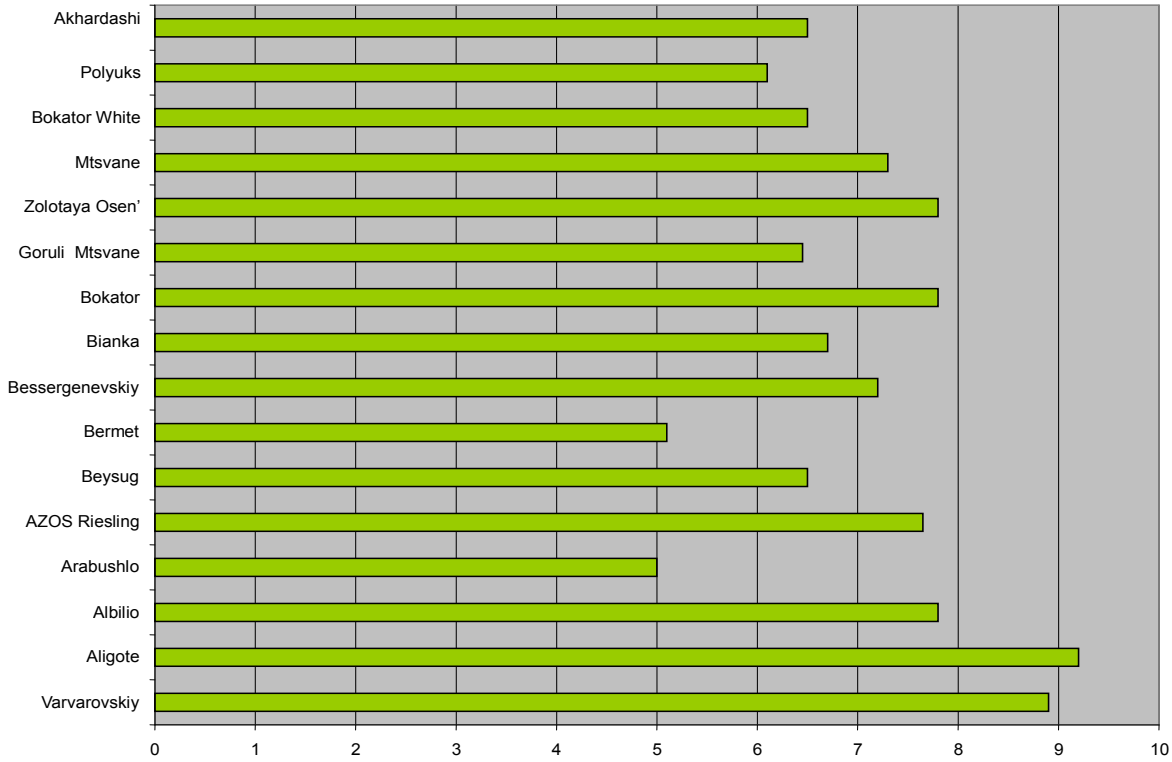
Along with the wines and juice concentrates from the grape varieties of Mtsvane, Zolotaya Osen', Bokator White and Bessergenevskiy (total organic acids 7.3; 7.8; 7.8; 7.2, correspondingly), these wine samples got the highest organoleptic ratings.

Nitrogen compounds and, first of all, amino acids are very important as substances that have significant impact on the main organoleptic properties of wines (aroma, flavor, color).

Wine amino acid composition is made up by must amino acids and amino acids produced by yeast cells as their byproduct and in the result of autolysis during fermentation and especially after its completion.

Table 2. Mass concentration of organic acids in white table wines and juice concentrates, g/dm^3 (average for 2001-2013)

Name of wines and juice concentrates	Tartaric acid	Malic acid	Succinic acid	Citric acid	Acetic acid	Lactic acid
Varvarovskiy	4.8	1.1	1.7	0	0.2	1.1
Aligote	4.5	0.4	1.0	0.3	0.1	2.9
Albilio	3.1	0	1.1	0.1	0.4	3.1
Arabushlo	1.9	0	0.8	0	0.2	2.1
Akhardashi	2.9	0.1	0.4	0.2	0.5	2.4
Beysug	1.7	0	0.8	0.1	0.1	3.8
Bermet	2.5	0	0.5	0.1	0.2	1.8
Bessergenevskiy	3.4	0.3	1.2	0.1	0.1	2.1
Bianka	2.8	2.3	0.6	0.1	0.2	0.7
Bokator	3.2	2.1	1.2	0.2	0.2	0.9
Goruli Mtsvane	3.0	0.15	0.7	0.2	0.5	1.9
Zolotaya Osen'	3.3	0.3	1.3	0.2	0.2	2.5
Mtsvane	3.7	0.6	0.7	0.2	0.4	1.7
Bokator White	2.7	0.2	0.7	0.1	0.3	2.5
Polyuks	2.6	0.4	0.8	0.1	0.1	2.1
AZOS Riesling	4.2	0.2	1.1	0.2	0.25	1.7



Pic. 2. *Total content of organic acids in white table wines and juice concentrates, g/dm³ (average for 2001-2013)*

Total amino acids in grape juice is within 250-2500 mg/dm³, which makes 20% of their total concentration in a cluster; other amino acids are concentrated in the peduncle (up to 30%), seeds – (30%), and skin (20%). When grapes start ripening they accumulate arginine, glutamine, aspartic acid, and serine, which make 80% of all amino acids.

Further along the ripening process grapes accumulate valine, histidine, threonine and other aliphatic amino acids, and at the final stage – proline, phenylalanine, tyrosine and tryptophan.

Quality and quantity of amino acids vary greatly in different grape varieties and depend on soil characteristics and climate conditions, fertilizers and cultural practices used, while in must they also depend on grapes processing techniques and the time of contact with solid parts of the grape cluster and oxygen [8].

Wine amino acids are made up by must amino acids and amino acids produced by yeasts during fermentation and autolysis. The results of our research show that total amino acids in wine are less than in must, which can be explained by the fact that yeasts take up amino acids during fermentation, so, in wine amino acids content is lower. Basic amino acids in wine are proline, arginine, threonine, and methionine (they make 76-94% of total amino acids in wine). Amino acids are active in oxidative deamination and further decarboxylation resulting in the formation of aldehydes giving off-character tones to natural wines.

We identified 14 basic amino acids in wines and juice concentrates. The content of proline, arginine, threonine, methionine, and serine greatly exceeded the content of other amino acids. During the years of research we identified the following regularity: the content of serine, methionine, threonine and tryptophan in wines from the promising white wine grape varieties greatly exceeded their content in wine from the traditional variety of Aligote.

It is known that sulfur-containing amino acids threonine and serine give sulfide tones to wines. Our data show that wine from the grape variety of Anapskiy Early has a greater tendency for sulfide tones than the control samples from Aligote, as its content of the above mentioned amino acids exceeds such content in the control samples.

Vitamin content of wines and juice concentrates under study is made up by ascorbic acid, chlorogenic acid, nicotinic acid, orotic acid, caffeic acid, gallic acid, protocatechuic acid, and resveratrol.

Resveratrol helps grapes to resist the environment. It also prevents cardiovascular, cancerous and other human diseases.

Our white wines and juice concentrates showed that the resveratrol content in wine and juice concentrates from the grape variety of Zolotaya Osen' is 1.4 mg/dm^3, while the control sample of Aligote has it at the level of 1.0 mg/dm^3. High resveratrol contents were also registered for wines and juice concentrates from the grape varieties of Akhardashi and Kakheti Mtsvane (1.2 mg/dm^3). Other white wines and juice concentrates had resveratrol contents within the range of 0.3 (Goruli Mtsvane) to 1.1 mg/dm^3 (Arabushlo).

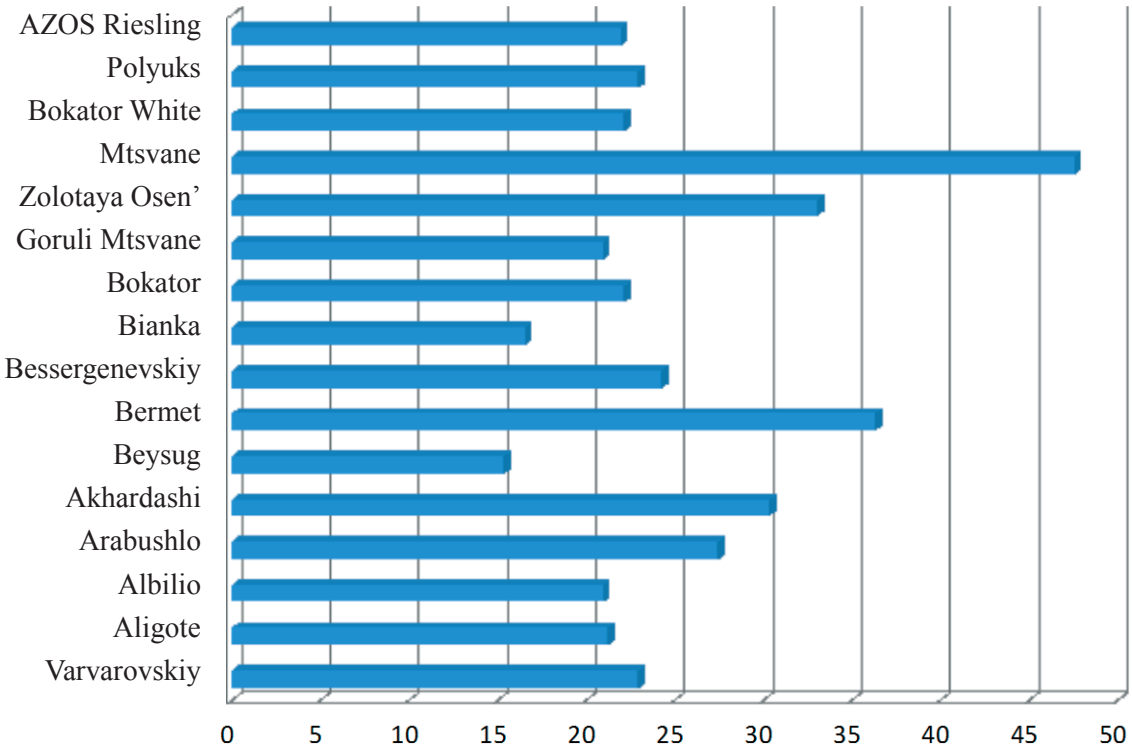
Maximum ascorbic acid content in wines and juice concentrates was registered for the samples from the grape variety of Anapskiy Early – 6.8 mg/dm^3, which is almost 4.5 times higher than in the control sample of wine and juice concentrates from the grape variety of Aligote and 5-10 times higher than in the samples from the grape varieties of Pleven Muscat, Kakheti Mtsvane and Goruli Mtsvane. Almost all experimental wines and juice concentrates had ascorbic acid contents higher (1.7-6.4 mg/dm^3) than in the control sample (1.5 mg/dm^3), except for Goruli Mtsvane (0.7 mg/dm^3), Pleven Muscat (1.1 mg/dm^3), Zotkina Memory (1.2 mg/dm^3), and Kakheti Mtsvane (1.3 mg/dm^3).

Total micronutrient content was the highest in wine and juice concentrates from the grape variety of Kakheti Mtsvane – 47.6 mg/dm^3, due to high contents of nicotinic, orotic and gallic acids. (Pic. 3).

Aromatic substances in grapes are various and numerous, and they are responsible for organoleptic properties of the products. At present we know about more than 350 aromatic compounds. They are alcohols, volatile acids, aldehydes, terpenes, and ethereal substances [9]. Aldehydes are characterized with low flavor threshold and almost no off-flavors. They are intermediates in the formation of superior alcohols, and any conditions good for their formation contribute to the formation of aldehydes as well.

Experimental wines and juice concentrates had 1.3-5.5 times lower acetaldehyde levels as compared to the control sample (Aligote), except for the samples from Bianka and Bokator.

Furfural, a component of the bouquet substances, was identified in many wines and juice concentrates at the levels of 0.1 (the control sample of Aligote) to 8.2 (Pleven Muscat).



Pic. 3. *Total content of micronutrients in white table wines and juice concentrates, g/dm^3 (average for 2001-2013)*

In terms of total volatile compounds in table wines and juice concentrates the top positions were given to the varieties of Albilio and Goruli Mtsvane (54.2 and 62.1 mg/dm^3 correspondingly), the basic component being acetoin – in wines and juice concentrates from the grape varieties of Albilio and Goruli Mtsvane its content amounted to 43.0 and 46.9 mg/dm^3 correspondingly.

Low contents of ethyl acetate balance the aroma of high quality wines; however, the aroma has its value due to the presence of other ethers.

White wines and juice concentrates under study showed the highest contents of ethyl acetate in wines and juice concentrates from Arabushlo (83.4 mg/dm^3), Bianka (82.5 mg/dm^3), Bermet (76.9 mg/dm^3), and Beysug (69.8 mg/dm^3), which is 2-3 times higher than in the control sample of wine and juice concentrates from the grape variety of Aligote (30.7 mg/dm^3).

The second highest in content ether was methyl acetate. Its highest contents were registered in wines and juice concentrates from Bermet (38.4 mg/dm^3) and Bianka (25.0 mg/dm^3). Red wines and juice concentrates had this ether in much lower concentrations amounting to 0.9-2.7 mg/dm^3 in variants of the experiment.

Other ethers found in the experimental wines and juice concentrates were ethyl formate, ethyl valerate, methyl caprylate, etc. Their contents varied within 0.1-2.4 mg/dm^3.

Total ethers in white wine grape varieties were the highest in wines and juice concentrates from Bermet (120.0 mg/dm^3), Bianka (112.4 mg/dm^3), Arabushlo (105.7 mg/dm^3), which is more than 3 times higher than in the control sample of wine and juice concentrates from Aligote (32.1 mg/dm^3).

As methyl alcohol is an extremely toxic substance, its high content in wine is undesirable. Its concentration in wines and juice concentrates under study was low. Its maximum content (39.7 mg/dm^3) was identified in the samples of Albilio, and 35.6 mg/dm^3 in wine from the grape variety of Bianka. Other white wines and juice concentrates had it below 31.9 mg/dm^3.

Fusel oils are byproducts of alcoholic fermentation of carbohydrates. The most important of fusel oils is isoamyl. Its maximum concentration in wines and juice concentrates was identified for the grape varieties of Beysug (221.7 mg/dm^3), Kakheti Mtsvane (203.9 mg/dm^3), and Goruli Mtsvane (173.2 mg/dm^3).

Aliphatic acids also play an important role in the formation of wine odor and flavor. We identified 5 volatile acids in wines and juice concentrates under study. Their concentration was low and varied within 1.4-10.6 mg/dm^3. We identified the odor-active aldehyde of decanal in all wines and juice concentrates under study, its concentration being from 2.8 (Kakheti Mtsvane) to 25.7 mg/dm^3 (Beliy Winniy (White Wine)).

Total aromatic compounds in the studied samples were the highest in wines and juice concentrates from the grape variety of Albilio (514.7 mg/dm^3), which is almost 2 times higher than in the control sample of Aligote with the minimum concentration of aromatics (264.8 mg/dm^3).

CONCLUSIONS

The results of the long-term integrated research in wines and juice concentrates from various grape varieties bred by the Anapa ZOSViV and from the Anapa ampelographic collection have shown the following:

1. 5 years of study in organoleptic properties show that the best samples are wines and juice concentrates from the white wine grape varieties of Varvarovskiy, Zolotaya Osen', Bokator (7.85 points), AZOS Riesling (7.83 points), Arabushlo (7.8 points), and the control sample of Aligote (7.78 points).

2. In terms of physiochemical properties identified all experimental wines and juice concentrates meet the requirements of GOST.

3. White wines and juice concentrates from the grape varieties of Albilio and Beysug have the highest concentrations of aromatic compounds, but they got lower flavor ratings, which resulted from higher contents of fusel oils and methanol.

4. We determined that high concentrations of organic acids in wines and juice concentrates from the grape varieties of Aligote, Zolotaya Osen', and Bokator had no adverse effect on their organoleptic properties or flavor ratings.

5. Total micronutrient content was the highest in wine and juice concentrates from the grape variety of Kakheti Mtsvane – 47.6 mg/dm^3, due to high contents of nicotinic, orotic and gallic acids.

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