Features of physicochemical and organoleptic characteristics of wine from Krasnostop Zolotovskyy grapevine variety

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Abstract. The aim of the work was a detailed study of physicochemical and organoleptic components of the wine from native Don grapevine variety Krasnostop Zolotovskyy, in comparison with the classic variety Cabernet Sauvignon. The work was carried out in 2000–2019 at the Don ampelographic collection (Novocherkassk, Russia). Samples of wine materials were prepared in micro-winemaking conditions according to the classical technology of making for red dry table wines. The article analyzes data on the amount of: sugars, volatile and titratable acids, total dry extract, phenolic substances, anthocyanins, sulfur dioxide and others. The content of organic acids – tartaric, malic, succinic, citric and others – was determined in wine materials. Wine tasting assessments and sugar content in berry juice for 20 years are given. The results of long-term studies of the agrobiological features of the Krasnostop Zolotovskyy grapevine variety allow us to draw conclusions about its high adaptability over 20 years of research. The wine made from the Krasnostop Zolotovskyy variety surpasses in many respects the wine from the widely known and widespread variety Cabernet Sauvignon. The wine is rich in biochemical components with dietary and medicinal properties and can compete with wines that have become famous in the world market.

1 Introduction

Intensive technologies for grapevines growing require the use of varieties that are maximally adapted to the climatic conditions of the growing zone, capable of ensuring high reliability and productivity of plantations. The region's suitability for the cultivation of certain specific varieties is mainly determined by the climate, which is the most important component of the terroir that controls the production and quality of grapes. Nevertheless, the soil, variety and applied agronomic technologies are also significant factors in the reaction of the vine [1-7]. Recently, scientists from many countries have paid great attention to the adaptation of vine to various natural climatic environmental changes [8–11].

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In many countries, grapes are the main agriculture crop. A large proportion (75%) of the harvest is used for making wines. Numerous studies of scientists from many countries show that grapes and products of its processing are valuable food. The grapevine varieties used for making wine and juices are distinguished by a high content of phenolic substances, which have a beneficial effect on the human body, since they contain biologically active components, having anti-inflammatory properties and protect against cardiovascular diseases. Antioxidants reduce the risk of chronic disease and cancer. Vitamins and organic substances found in small quantities in wine have nutritional and medicinal value [12-16].

Wastes generated during the processing of grapes, such as skins and seeds with antioxidant activity, can be used as food additives and in the pharmaceutical industry [17, 18].

The consumption of wine in small quantities is beneficial for the human body due to its nutritional, medicinal, bactericidal and other properties [19, 20].

The wines that have received recognition in the global alcoholic beverages market are made from a very limited number of classic European varieties. Cabernet Sauvignon is among the most famous grape varieties, from the harvest of which high quality wines are produced. Grape varieties with a wide growing area have a high biopotential and are of greatest interest of grape growers.

According to sources, Krasnostop Zolotovskiy has been known in the Don region since the beginning of the 19th century. In the State Register of Breeding Achievements, it has been approved for use since 1959. This is one of the best Don wine varieties. High-quality dry table and original dessert wines are prepared from this variety, and this variety can also be used (in a blend with other aboriginal Don varieties) to make sparkling wines such as Tsimlyanskoye.

The aim of the research is to study in detail the physicochemical and organoleptic components of wine from the indigenous Don variety Krasnostop Zolotovskiy in comparison with the classic variety Cabernet Sauvignon grown in the Rostov region.

2 Materials and methods

The autochthonous Don variety grapevine Krasnostop Zolotovskiy was studied as an object of research, and the Cabernet Sauvignon variety was taken as control.

The research work was carried out in 2000–2019 at the ampelographic collection of ARRIV&W (Novocherkassk, Russia). Grafted varieties, stock Berlandieri x Riparia Kober 5BB. The bushes are planted every 1.5 m, the row spacing is 3 m. The vineyards are not irrigated, covering. The plants are shaped like a multi-sleeve fan.

Groundwater does not contribute to the development of the grape plant, since it is not accessible for roots, their occurrence was noted at a depth of 15-20 meters. The cultivation of vineyards is carried out according to the generally accepted technology for the northern zone of industrial viticulture of the Russian Federation.

The Rostov region has the most severe climatic conditions of all the viticulture regions of the North Caucasus. The winter period is characterized by unstable weather. Sharp fluctuations in air temperature are often observed. Severe frosts are replaced by thaws. Grapevine bushes have to be covered for the winter, protecting them from destructive low temperatures. The average annual freezing of the soil was observed at a depth of 39 cm. The probability of late spring and early autumn frosts is high.

Precipitation is low (200-500 mm per year), and in summer there is very high insolation and evaporation, resulting in insufficient moisture.

The growing season is favorable for the temperature regime in almost the entire region.

A long period with temperatures above +10°C contributes to a good growth and development of vine bushes, maturation of shoots and sugar accumulation in a berry juice.

The cultivation of grapes in this area is favored by prolonged sunlight in early autumn – during the ripening period of grapes, which provides a high quality harvest.

The soils are ordinary calcareous chernozem, medium thick, slightly humus, heavy loamy on loess-like loams. They have a high content of assimilable forms of phosphorus, average mobile potassium, enriched with calcium carbonates. The humus horizon (A–B) reaches a thickness of 90 sm. The soil contains 3.5–4% humus.

For the study of grapevine varieties, the methods generally accepted in the viticulture of the Russian Federation were used (Lazarevsky M.A., Prostoserdiv N.N., Amirdzhanov A.G., Suleimanov D.S., Dospekhov B.A.). The sugar content of berry juice was determined according to Russian Standard 27198–87, titratable acidity – Russian Standard 32114–2013.

Samples of wine materials were prepared in the laboratory of wine-making technology (in micro-wine-making conditions) according to the classical technology for the preparation of red table dry wines in accordance with the regulatory documentation (Collection of technological instructions, rules and regulatory materials for the wine industry / edited by G.G. Valuiko) and Russian Standard 32030–2013.

Physicochemical analyzes of wort, wine materials and wines were determined according to Russian Standard:

- mass concentration of nitrogenous substances (total nitrogen – by the Kjeldahl method, amine nitrogen – by formol titration);
- mass concentration of phenolic substances, anthocyanins, monomeric compounds – (photocolorimetric method using the Folin-Chocalteu reagent);
- the content of glycerin (method International organization of grapes and wine).

The wine materials were evaluated by the institute's tasting committee, approved by the order of the director.

3 Results and Discussion

Analysis of the data in Table 1 shows that the studied grape varieties differ slightly in terms of the main agrobiological indicators. Both varieties have strong performance in terms of the percentage of blossoming buds, the fruitfulness of the shoots, the rate of fruiting.

High percentage of blossoming buds and the fruitfulness of shoots ensure stable grape yields in the northern zone of industrial viticulture.

In terms of the duration of the production period, Krasnostop Zolotovskiy variety belongs to the medium ripening period, and Cabernet Sauvignon to the medium-late ripening period. In our growing conditions, varieties of medium ripening are of special interest, because varieties of late maturity do not always achieve the technological maturity of berries and the accumulation of extractive substances.

The Krasnostop Zolotovskiy variety slightly surpasses the Cabernet Sauvignon variety in terms of the average bunch weight.

The yield directly depends on the average mass of a bunch, the fruiting coefficient, the bush load with shoots and applied agricultural technology. With the same load of fruit-bearing shoots (28 per bush), the yield was about 3 kg per bush in both varieties. As a result, the estimated yield was 6.8 t/ha (Krasnostop Zolotovskiy) and 6.6 t/ha (Cabernet Sauvignon).

The vine is very responsive to changes in climatic conditions. The final production of viticulture is greatly influenced by the variety and the place of growth.

The basis for the production of high-quality table wines is conditioned raw materials.

During the period of technological maturity, the accumulation of sugars, acids, aromatic and tannins occurs in grapes.

Table 1. Agrobiological indicators of studied grape varieties (average for 2000-2019).

Indicators	Krasnostop Zolotovskiy	Cabernet Sauvignon
Bud break date	April 29	April 29
Blossoming buds, %	66.0	69.6
Fruiting coefficient	0.9	1.1
Average bunch weight, g	121	96
Fruit-bearing shoots, %	63.2	72.9
Shoot yield, g	109	106
Estimated yield, t/ha	6.8	6.6
Harvest date	September 13	September 24
Sugar content of berry juice, g/100 cm ³	24.1	20.9
Titrateable acidity, g/dm ³	8.4	8.9
The number of days from the bud break to full ripeness	137	148

The content of sugars in a berry juice met the requirements of Russian Standard for raw materials.

Krasnostop Zolotovskiy has an earlier ripening period and a higher sugar content and good titrateable acidity of a berry juice.

The criteria for quality assessing of red grapes are the glucoacidometric indicator (GAI) and the indicator of technical maturity (ITM). Based on many years of experience, average conditions have been established for using the crop in a certain direction. The grapes used for the production of red table wines should have a ITM value of 155–270, and a GAI value of 2.5–3.9. Physicochemical indicators of wort and wine materials are presented in tables 2 and 3.

Table 2. Physicochemical parameters of wort made of studied varieties.

Variety	GAI	ITM	pH	Mass concentration, mg/dm ³	
				total nitrogen	amine nitrogen
Krasnostop Zolotovskiy	3.76	249.8	3.22	621.8	309.6
Cabernet Sauvignon	2.93	225.5	3.18	567.3	321.8

In the analyzed samples, the values of the indicator of active acidity index pH from 3.18 (Cabernet Sauvignon) to 3.22 (Krasnostop Zolotovskiy) were recorded.

The presence of nitrogen in grape berries and products of its processing has a positive effect on taste, dietary and nutritional qualities. The content of nitrogenous substances in red wines is higher than in white ones. In addition, the amount of nitrogen depends on the type of wine and the technology of its preparation.

The nitrogenous compounds of the wort make it possible to foresee the possibilities of yeast and its nutrition. With a lack of nitrogen in the fermenting wort, yeast multiplies poorly and does not give the desired alcohol yield.

The volume fraction of ethyl alcohol in the studied varieties was within acceptable limits of at least 10% and no more than 15% (Table 3).

The content of titrateable acids in wines ensured the microbiological stability of the samples. Volatile acidity characterizes the health of wine materials. The mass concentration of volatile acids did not exceed the standards allowed by Russian Standard (no more than 1.1 g/dm³).

Table 3. Physicochemical indicators of wine materials made of studied varieties.

Wine material from the variety	Volume fraction of ethyl alcohol, %	Mass concentration, g/dm ³				Phenolic substance d, mg/dm ³	Anthocyanins, mg/dm ³	Total sulfur dioxide, mg/dm ³
		titratable acids	volatile acids	sugars	total dry extract			
Krasnostop Zolotovskiy	13.8	5.8	0.54	1.7	25.8	2634	284	78.9
Cabernet Sauvignon	12.8	6.7	0.64	1.2	23.8	2354	254	88.4

The amount of total dry extract is an important indicator of a wine quality. The mass concentration of total dry extract in the studied samples was 25.8 g/dm³ for the Krasnostop Zolotovskiy variety and 23.8 g/dm³ for the control variety Cabernet Sauvignon. The content of total sulfur dioxide was within the normal range (no more than 200 mg/dm³).

A special feature of red wines is the high content of phenolic and coloring substances. Phenolic compounds play an important role in characterizing the ripeness of grapes. They contribute to the formation of taste, aroma and color of wines.

In the wine material from the Krasnostop Zolotovskiy variety, the amount of phenolic substances was at the level of 2634 mg/dm³.

Anthocyanins are responsible for the color intensity of red wines, their accumulation in grapes is not the same and directly depends on the varietal characteristics of a grapevine and growing conditions. The content of anthocyanins in the wine material of the Krasnostop Zolotovskiy variety was higher than that of the Cabernet Sauvignon variety, which affected the organoleptic evaluation of the wine. The wine had a dark ruby color.

Organic acids determine the acidity of wines, which forms the taste. The increased content of acids (especially malic) causes an unpleasant sharpness in the taste (the so-called green acidity), and vice versa, if the acidity is low, the wine turns out flat.

The main ones in the chemical composition of grapes and wine are tartaric, malic, succinic, citric, oxalic, glycolic, lactic and pyruvic acids.

Tartaric acid is the most important that influences the taste of the wine. In the studied samples, it was determined at the level of 2500–2800 mg/dm³ (Table 4).

Table 4. Content of organic acids in studied wine materials.

Variety	Organic acid content, mg/dm ³					
	Wine acid	Malic acid	Succinic acid	Lemon acid	Acetic acid	Lactic acid
Cabernet Sauvignon	2500	12	830	300	640	1900
Krasnostop Zolotovskiy	2800	0	700	0	540	1400

A low concentration of malic acid and an accumulation of lactic acid were also noted. It is associated with the process of biological acid reduction. In all tested wines, the accumulation of succinic acid occurred, which is typical during the verification process, its amount was 700–830 mg/dm³.

During the passage of malolactic fermentation, the concentration of malic acid decreased with the formation of lactic acid. Healthy red wines have lactic acid from 1 to 5 g/dm³.

The citric acid content in studied samples was within acceptable limits (no more than 1 g/dm³), which indicates the quality of the wine.

Laboratory analyzes do not always give a complete picture of wine a quality, a special role is given to organoleptic analysis. Wines with the same indicators in terms of the content of sugars, acids and alcohol may differ significantly in aroma and taste.

All the studied physicochemical indicators of the wines were within the normal range (allowed by Russian Standard), had a good supply of extractive, phenolic, coloring substances, a harmonious combination of sugars and acids, as a result it made it possible to obtain wines of good quality, which were highly appreciated. The assessment of wines was carried out according to a 10–point system (Table 5).

Table 5. Accumulation of sugars in berry juice and wine tasting evaluations (2000-2019).

Years of research	Sugar content of berry juice, g/100 cm ³		Wine tasting score in points	
	Krasnostop Zolotovskiy	Cabernet Sauvignon	Krasnostop Zolotovskiy	Cabernet Sauvignon
2019	25.8	22.9	8.8	8.6
2018	23.1	24.3	8.8	8.8
2017	24.5	20.8	8.8	8.6
2016	26.0	20.8	8.9	8.7
2015	22.0	21.5	8.8	8.6
2014	25.0	22.0	8.9	8.7
2013	24.2	20.0	8.7	8.6
2012	26.0	19.0	8.9	8.6
2011	24.4	22.8	8.7	8.6
2010	23.5	20.7	8.9	8.6
2009	24.6	19.5	8.7	8.8
2008	23.4	19.4	8.9	8.7
2007	28.2	24.7	8.9	8.9
2006	22.3	21.0	8.8	8.6
2005	25.6	19.8	8.8	8.6
2004	21.9	19.1	8.6	8.5
2003	22.9	21.2	8.8	8.8
2002	25.6	23.4	8.9	8.9
2001	22.9	19.6	8.8	8.8
2000	25.3	20.6	8.7	8.6
the average	24.4	21.1	8.8	8.7
LSD _{0,95}	0.89			

Wine from the variety Krasnostop Zolotovskiy was rated at 8.8 points, had a dark ruby color, dense in structure. The aroma is complex with tones of black currant, cherry and blackthorn. The taste is extractive with a pleasant aftertaste. The wine from Cabernet Sauvignon was rated slightly lower than the studied variety – 8.7 points, characterized by ruby color, bright typical aroma, with light morocco notes. The taste is full, intense, spicy bitterness.

To produce quality wines, grapevine varieties must meet the requirements of the modern market not only as highly productive, adapted to growing conditions, with a good accumulation of sugar, but also as sources of biologically active substances that have a beneficial effect on human health. The qualitative and quantitative composition of vitamins,

phenolic compounds and other biologically active substances in wine determines their biological value.

In studied wines, the concentrations of the following acids were determined: ascorbic, chlorogenic, nicotinic, orotic, coffee, gallic and protocatechuic (Table 6).

Table 6. Content of biologically valuable components in studied wines.

Indicators (mg/dm ³)	Cabernet Sauvignon	Krasnostop Zolotovskiy
Resveratrol	3.65	4.36
3,5-tridiglycoside malvidin	5.59	5.46
Ascorbic acid	15.56	9.56
Chlorogenic acid	29.59	8.21
Nicotinic acid	2.48	19.51
Orotic acid	56.17	37.91
Caffeic acid	137.8	145.1
Gallic acid	0.89	3.71
Protokachetic acid	46.19	41.39

The content of these acids has a beneficial effect on human health, they are involved in vital processes in the body – the synthesis of collagen and carnitine, the absorption of iron, protect against the harmful effects of ultraviolet rays, prevent the development of cancer, help to strengthen the immune system, etc.

Recently, more and more data in the literature have been found about the positive effect of regular consumption of red wine containing resveratrol. According to scientists from a number of countries, resveratrol is a strong antioxidant that slows down the process of vascular sclerotization, prevents the occurrence of malignant tumors, the development of diseases of the cardiovascular system, neurological disorders, and protects against the effects of free radicals [21-23]. In the studied wine samples, the content of the resveratrol component was noted at the level of 3.65–4.36 mg/dm³.

In the control variety Cabernet Sauvignon, an increased content of ascorbic, chlorogenic, orotic, protokachetic acids was noted in comparison with the studied variety. However, the concentration of a nicotine acids, coffee acids, and gall acid was higher in wine materials from the Krasnostop Zolotovskiy variety.

In the wine materials of the studied varieties, the content of 3.5–tridiglycoside malvidin is determined at the level of 5.46–5.59 mg/dm³, which does not exceed the standards (European Union Directive No 883/2001 the malvidin content in exported wines must not exceed 15 mg/dm³).

4 Conclusions

The results of many years of research on the agrobiological characteristics of the Krasnostop Zolotovskiy grape variety allow us to draw conclusions about the high adaptability of the variety, over 20 years of study it has proven itself as stable with high quality of wine production. The wine made from the Krasnostop Zolotovskiy variety surpasses in many respects the wine from the widely known and widespread variety Cabernet Sauvignon. The wine is rich in biochemical components with dietary and medicinal properties and can compete with wines that have become famous in the world market. Due to its high adaptability, the Krasnostop Zolotovskiy variety may be of interest for wide distribution in other countries both for the production of wine products and for use in breeding for the quality of the crop.

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