

New grape varieties for production of high-quality wines, and assessment methodology for varietal characteristics of the product

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Abstract. In recent years, Russian and international breeders have produced a great many of new varieties of *Vitis vinifera* grapes as well as interspecies hybrids, distinguished by a high quality of fruit and other useful economic and biological features. Having a big reserve of technologically important substances and hygienic factors of grapevine, the resistant varieties may prove especially efficient for the production of premium-class wines. The appearance of high-end Russian wines with protected geographical indication (PGI) and protected appellation of origin (PAO), first of all, fits in with the requirements of international markets. It is a necessary criterion for product quality and safety assurance at the highly competitive global market, and development of universally recognized brands. It also helps resolve a number of socio-economic issues, such as formation of winemaking culture, and production of wines of guaranteed quality from own grapes. This study is devoted to substantiating the necessity for development of methods of formation of single information databases on characteristic features of PGI and PAO wines, including their distinctive organoleptic, physical and chemical properties (extract components – the cation-anion composition, organic acids, total phenolic and anthocyanin content; unique colour characteristics), as well as the application of the system of organoleptic assessment of wines with the use of descriptive analysis of wine colour, flavour and taste. It is well-timed and relevant to determine the regularities of realization of the varietal potential of a grapevine plant in terms of climatic conditions of growing and geographical origin based on the study of the endogenous and exogenous components of wines with the use of the methods of high-performance capillary electrophoresis, spectral photometry, organoleptic analysis, and statistical techniques. This research generalizes and puts forth a contemporary view of varietal and geographical identification of wines. It is shown that the proposed research guideline is highly sought-after, and it is of fundamental and practical importance for the development of regional and national selection, genetic, viticultural and winemaking industries.

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Introduction

Some wine connoisseurs believe that it would be extremely difficult to surpass the Old World in classical varieties, like Merlot, Chardonnay or Pinot Noir, which is why they prefer autochthonous (indigenous, local) varieties.

Numerous research works are being done internationally by grape breeders to develop commercially locally created white and red wine grape varieties. The quality of Russian wine is constantly growing, which fact has been proved by awards received at national and international wine competitions.

As a result of grape hybridization, the North Caucasian Federal Scientific Centre for Horticulture, Viticulture and Winemaking and the Anapa Zonal Experiment Station of Viticulture and Winemaking have selected six promising wine grape varieties. Patents were obtained for some of them (Vladimir, Dmitri, Kurchansky, Pamiati Zotkinoi), while the others have been qualified for state variety testing (Gordy, and Pluton) (Table 1). Such new wines of European selection as Bačka, Solaris and Morava are also known internationally and recommended to produce organic (bio) wines in Russia [1].

Krasnodar region is one of the leading and fastest-growing Russian winemaking regions. In 2016–2020, eight natural zones were qualified in the region to produce PGI wines, and ten geographic features – to make PAO wines.

Analysis of international and national information about wine production proves that manufacture of wines of controlled appellation of origin enjoys special attention in the countries of the Old and New Worlds. The Lisbon Agreement for the Protection of Appellations of Origin and their International Registration signed in 1958 became a constituent part of the Paris Convention for the Protection of Industrial Property adopted in 1883, and wines of controlled appellation of origin received worldwide recognition. The winemaking countries in Europe and other parts of the world constantly increase the production of these wines, receiving economic profit. The positive experience of other countries gives us reasons to assume that launch of production of high-class wines in the Kuban region will improve the economy of the regional viticultural and winemaking industry.

Table 1. New wine grape varieties and hybrid forms

Variety	Sugar content of fruit juice, g/100 cm ³	Titration acidity of fruit, g/dm ³	Intended use	Tasting evaluation (in 2015–2020), points
Vladimir	22.8-23.5	6.0-7.3	Table and liqueur wines	8.0-8.7
Dmitri	21.8-22.3	9.3-9.5	Table and liqueur wines	8.4-8.9
Kurchansky	19.5-21.5	7.5-8.8	Table and liqueur wines	8.2-8.8
Pamiati Zotkinoi	18.7-20.0	7.4-8.5	Liqueur wines	8.4-8.8
Merkuri	20.0-22.0	6.0-6.8	Table and liqueur wines	7.7-8.0
Saturn	20.0-22.0	7.5-10.0	Table and liqueur wines	7.7-8.0
Morava	18.3-21.5	8.9-11.5	Table and bio wines	7.6-7.8
Solaris	18.3-21.5	8.1-8.3	Table and bio wines	7.7-7.8

Due to the fact that the PGI and PAO wine categories did not exist in Russia before, their manufacture and authenticity control shall be conditional on enhancement of the legislative basis and development of the regulatory documentation [2]. The development of quality control methods for wines of these categories and elaboration of the principles and mechanisms of their practical implementation need closer scrutiny and use of the advanced experience of Russian and foreign scholars from the world's leading winemaking countries [2-4].

The special features of such high-end products as PGI and PAO wines are determined by the soil, climatic, environmental and technological conditions and human resources peculiar for the respective geographical areas [2-8]. However, so far the list of wine quality parameters mainly responsible for the determination of these features has not been established by the Russian technical documentation (Product Specifications, Technical Regulations of the Eurasian Economic Union "On safety of alcohol products" (TR EAEU 047/2018), and the Federal Law No. 468-FZ "On viticulture and winemaking in the Russian Federation") [2]. This is why, implementation of projects on fundamental scientific research, acquiring new knowledge and application developments are considered an important and relevant issue of the day [7,8,9].

The observance of the above requirements guarantees that when buying a PGI wine, the consumers will be confident that the wine is crafted from grapes grown in that specified area defined by the natural conditions that are typical and distinctive for the concrete geographic feature. As far as the manufacturer is concerned, it protects itself against unfair competitors and fake products.

The purpose of the study was to generalize the contemporary concepts of the varietal and geographical identification of wines to address the development of the regional and national plant-breeding, genetic, viticultural and winemaking industries, and elaborate recommendations on evaluation and use of grape varieties for winemaking product quality control purposes.

The physical and chemical composition of wines differ by many factors: the grape variety, soil, climate, vineyard exposure, vineyard management techniques, and winemaking technologies [10-19]. The first five factors constitute what is called the terroir, or "the taste of this place." The identification of typical varietal peculiarities of wines depending on the climatic conditions of the vineyards and natural features of the terroir represents the biggest scientific interest [2,8].

The geographic origin of a wine may be closely related to the chemical composition of the grape juice and the base wine [2-6]; it may exert either positive or negative effect upon the wine and affect the organoleptic and varietal peculiarities of the wines under study [7-10].

Every country has its own classification for these wine categories, and own methods of their identification. These wine categories are considered higher than the category of table wines; over 40 parameters of wine composition are determinable there, including volatile components responsible for the formation of a wine's varietal flavour, as well as microelements and organic acids taking part in the formation of a wine [9].

Analyses of interrelations among the elements available in wine and soil were previously performed with varying degrees of success in various winemaking regions and countries, such as Argentina, South Africa, Canada, New Zealand, Australia, Slovenia, Romania, the Czech Republic, Germany, Switzerland, Portugal, Spain, Italy, and others [9-13].

However, there is speculation that the perceived quality of a wine is not affected by the type and chemical composition of the soil, or the geographic exposure of the vineyard [14].

For the purpose of analysis of the macro- and micronutrients, the organic profile (phenolic, anthocyanin and amino acid contents), the ratio of stable isotopes, and the methods of high-performance liquid chromatography with tandem mass-spectrometric detection and inductively coupled plasma mass-spectrometry (ICP-MS) are applied [4]. The correlation analysis combined with the methods of analysis of variance and cluster analysis demonstrated

a significant correlation ($r = 0.99$; $p < 0.001$) between the soil and the wine composition, which made it possible to identify the regional attribution of Argentine wines with high (up to 100%) confidence; however, wines with the similar chemical composition may be found in different regions [4].

The Italian scholars analyzed genuine Chianti wines from Tuscany vineyards, Italy, and samples from 18 different geographical regions, meaning to differentiate them from other Italian wines. The analysis of rare-earth elements and main microelements done by the ICP-MS method combined with chemometrics demonstrated its usefulness for wine authentication. However, despite the contemporary multielement analytical procedure and the studies of a big number of wines from different regions, the common model did not fit the task of differentiating the Chianti wines from the samples with same chemical characteristics, but coming from some other regions [6].

Earlier, the scholars of Federal State Budgetary Institution “North Caucasian Federal Scientific Centre for Horticulture, Viticulture and Winemaking,” Krasnodar contemplated the issue of geographic identification of wines worldwide [9]. The review of literature stated that most of contemporary studies deal with information databases and their statistical processing. The following modern techniques are applied to control the macro- and micronutrients in wines: inductively coupled plasma atomic-emission spectroscopy (ICP-AES), inductively coupled plasma mass-spectrometry (ICP-MS), atomic-emission spectroscopy (AES), and atomic-absorption spectroscopy (AAS) [9]. The compositional analysis of macro- (*K, Na, Mg, Ca*, etc.) and micronutrients (*Sr, Rb, Ti*, etc.) in wines originated from different countries showed that both high diversity of the elemental composition of wines and its substantial variability were also caused by the treatments performed during the winemaking process [9].

In order to determine the geographic origin of the wines from white grape varieties, scholars of the Kuban State University studied 153 wine samples, including Riesling, Chardonnay and Muscat produced by large local wineries in various geographical zones [7]. Similar studies were performed for red wines. The micronutrient concentration in the wines was determined using the ICP-AES technique. The chemometric research was performed with the use of neural networks of the STATISTICA software. Of the set of certain micronutrients and macronutrients, predictors were identified to build up a neural network model to successfully identify the wine brands. In order to identify the vine-growing area, a neural network model was built on the basis of six predictors: five micronutrients and a certain wine brand. A special software was developed for automation of necessary calculations [7].

It was revealed that the quantitative and qualitative characteristics of the carbohydrate-acid and phenolic complex of the grapes and wines depend essentially upon the soil and climatic parameters of their area of origin [8, 10-19].

A team of Crimean scholar have proposed a scientifically substantiated quality and origin control system along the “grapes – juice – base wine – wine” chain [8]. By the physical, chemical and biochemical properties of the grapes, base wines and wines originating from various viticultural areas in Crimea, the newly-developed databases reflected their characteristic features caused by the distinctive factors of the production process [8]. Thereby, the following differentiating factors as regards the geographical origin of grape varieties were established: a natural zone, a soil and climatic area, and a geographic feature. Based on the study results (E.V. Ostroukhova), the systems of interrelated values for the grapes, base wines and wines in Crimean conditions demonstrating their distinctive qualitative attributes caused by natural and anthropogenic factors, were identified [8].

It is known that the broad assortment of grapes used to make wine and the technological peculiarities of grape processing result in the finished products with various colour characteristics. The use of the CIELab system seems to be a promising way to add

quantitative expression to the wine colour for the purpose of its identification and further reproduction. The following works show the results of a test comparison of organoleptic and instrumental wine colour assessment techniques: [21-23].

In formalized compliance confirmation systems, e.g. a system governed by standards and GOSTs, food product tests are aimed at quality and safety control and allow to ascertain the compliance of a beverage to its commodity line [2]. Thus, mass concentrations of total dry extract and citric acid, ethyl alcohol by volume may be used as identification signs of a product, but only when assessing the compliance of its quality to the declared product type [9].

The identification systems established by the EU Regulations and OIV recommendations are, as a rule, based on scientific approach, which is why wines are tested for more than 40 criteria. Many of the similar international identification systems can also be recommended to ascertain the geographical area of origin of the product in Russia [9].

Bearing in mind the relevance and significance of the research and the contemporary state of the issue for the fast-developing Russian winemaking industry, particularly for PGI and PAO wines, it is necessary:

- to consider numerous developments on geographical identification of wines done by Russian and international scholars;
- to consider the ever-improving provisions about the manufacture and quality control of PGI and PAO wines, which must be precise and strictly specified by relevant documents;
- to make a list and precisely define the character and significance of all elements that can help ascribe any wine to the PGI and PAO wine class, in order to guarantee the required quality by performing organoleptic and analytic studies;
- to form a single information database on PGI and PAO wines in Krasnodar region.

Due to the above stated, we consider that the list of additional definable factors (in addition to the physical and chemical factors according to the regulatory documents) should include the following:

- cation-anion composition (cations of alkaline-earth metals (K^+ , Na^+ , Mg^{2+} , Ca^{2+}) and inorganic anions (Cl^- , SO_4^{2-}) with the use of the method of high-performance capillary electrophoresis (HPCE);
- micronutrients *Sr*, *Rb*, *Ti* with the use of the method of atomic-absorption spectroscopy;
- unique colour characteristics within the CIELab system (colour intensity and hue factors by method of current determinations and by reference method);
- organic acids according to GOST R 52841-2007 (with the use of HPCE method);
- total content of phenolic substances and anthocyanins;
- analysis of wines' organoleptic profiles with the use of descriptor assessment of wines (the list of descriptors must be formed considering the valid standards and professional terminology, including the values for appearance, flavour (bouquet) and taste).

Conclusion

Grapevine breeders have obtained a great many new varieties of *Vitis vinifera*, distinguished by high quality of the products and other useful economic and biological features that may prove especially efficient to craft premium-class wines.

Further development of the assessment methods for varietal characteristics of Kuban wines with due account for their geographical origin, as well as formation of universal information databases for PGI and PAO wines will provide background for the formation and perfection of a comprehensive system for varietal and geographic wine identification based on the detection and recommendation of new markers and predictive authenticity criteria, with the use of contemporary analytic techniques, including high-performance

capillary electrophoresis, atomic-adsorption spectrophotometry, descriptive sensory analysis, and statistical methods.

On the whole, the obtained data will expand our knowledge of the varietal potential of grapevine plant depending upon the natural and anthropogenic production factors by the example of the geographic features (geographical zones) of Krasnodar region, fit to manufacture wines with protected geographical indication and protected appellation of origin.

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