Prevention of non-enzymatic browning of white grape wines by activated carbons Granucol

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Abstract. The relevance of the conducted research is regulation of reactive phenolic compounds content in grape wines – as those reactive phenolic compounds induce the non-enzymatic oxidative browning, which can be prevented by using sorption substances, in particular, activated carbon. The purpose of the research is to study the effect of activated carbons Granucol on the chromatic and organoleptic properties of dry grape wine materials from Crystal variety grapes at various dosages. As a result of the conducted research, the expediency of using Granucol activated carbons to increase the sensory properties of grape wines and to increase the wines shelf life has been proved. The chromatic properties were studied in accordance with the current guidelines of the International Organization of Vine and Wine (OIV, France). As an additional indicator for assessment of the wines color, the calculated value of the wine yellowness was used. It has been shown that treatment of wine with activated carbons Granucol allows efficient regulation the wines color properties and major elimination of undesired tones in wines flavor, thus improving the harmony of wines in whole.

1. Introduction

In among all biochemical reactions that occur during formation of the organoleptic properties of wines, the oxidation of phenolic substances leads to the most significant changes in the visual appearance of white grape wines and is known as non-enzymatic browning. It is necessary to take into consideration that non-enzymatic oxidation of polyphenols in wine technology can occur only in absence of polyphenol oxidases [1]. As a result of non-enzymatic oxidation of polyphenols, a brown color (browning) of ranging intensity is formed and oxidation tones often appear in the flavor (for example, woody, resinous) [2]. The dark tones in the color may indicate not only the peculiar methods of technology (for example, for production of sherry wines, dessert wines), but also the depth of non-enzymatic browning processes in the wine [3].

Traditionally it is considered that pale color is typical of good quality young wines, sparkling wines and champagnes. To eliminate the consequences of non-enzymatic browning of wines, bentonite clay, casein, polyvinylpolypyrrolidone and gelatin are traditionally applied [4], but their application is not...
capable for complete elimination of undesired shades of color in white grape wines. There is a number of literary data on use of activated carbons for grape and fruit wines processing [5-9], however, its high adsorption capacity leads to retention of not only phenolic substances (which in major scale are responsible for formation of dark color shades), but also retention of proteins, fatty acids, compound ethers, higher alcohols which are involved for formation of the flavor (taste and aroma profile) of the wine.

Nowadays the specialized activated carbons have been developed, which possess certain selectivity and allow due correcting the visual appearance of wine without deteriorating its flavor properties [10, 11].

The purpose of this research was to study the effect of Granucol activated carbons at varying dosages on the chromatic and organoleptic properties of dry grape wine materials obtained from Crystal grapes.

2. Material and methods
The object of the research was dry grape wine material from Crystall variety of grape (the harvest of 2019), obtained by fermenting a mixture of free run-juice and the first press mash wort with a preliminary correction of its composition according to production technology of fruit wines to sugars content – 200 g/dm3 and titratable acids (expressed in terms of wine) - 7.0 g/dm3. To exclude the action of polyphenol oxidase, the mash wort was heated to a temperature of 70±2 °C immediately after pressing. The mash wort was fermented with LALVIN EC1118 ™ yeast (LALLEMAND Inc., Canada). These yeasts have a killer factor (interspecific hybrid Saccharomyces cerevisiae var. bayanus) in relation to foreign microorganisms of the mash wort, and these yeasts do not affect the varietal smell of the wine. They feature high fermentation rate of mash wort with short lag phase and an optimal fermentation temperature of 10 to 30 °C. At the end of fermentation, the wine material was clarified with GranuBent PORE-TEC bentonite (ERBSLOEH Geisenheim AG, Germany) at a dosage of 2.0 g/dm3 and filtered through Seitz-K 100 filter-cardboard (Pall Corporation, USA). The wine material was sulfitized with Kadifit (Döhler, Germany) at a dosage of 80 mg/dm3. Activated carbons Granucol BI, Granucol GE, and Granucol FA (ERBSLOEH Geisenheim AG, Germany) were also used in the study.

The mass concentration of total phenolic substances was determined by Folin-Chocaltreu reagent [12] on a UV-1800 spectrophotometer (Shimadzu, Japan) with preliminary dilution of the samples by a factor of 100. The optical and chromatic properties of the studied samples were determined the same way [9].

To study the effect of activated carbons of the Granucol brand on prevention of non-enzymatic browning processes, the various doses of activated carbon of the above-mentioned brand was added to the treated wine material, and then the material was kept for 2 hours under stirring. At the end of the wine treatment, the carbon was separated by filtration. In the obtained samples the mass concentration of total polyphenols was determined, the optical properties of wine materials were also calculated, and the wine was transferred for storage at a temperature of 20±2 °C and a humidity of 75% under day/night natural conditions.

3. Results and discussion
Figure 1 shows the dynamics of the phenolic compounds content of total in the wine material under study, depending on concentration and type of the applied Granucol carbon.

From the data in figure 1, it is clear that the use of Granucol activated carbons has a positive effect on reducing of polyphenols concentration in the wine material, while the best results are achieved when using Granucol BI activated carbon. In general, the treatment of the wine with carbon of this type reduces the total content of phenolic substances by 1.57 times in case of maximum dosage of carbon. The use of Granucol FA and Granucol GE carbons also leads to reducing of polyphenols content, but it is less efficient – by 1.38 and 1.44 times, respectively.
Figure 1. Dependence of the mass concentration of phenolic substances wine material on the concentration and type of coals Granucol.

In the treated wine materials, the optical density was measured using the Shimadzu UV-1800 spectrophotometer in cuvettes with a distance between the working faces of 10 mm. To obtain the parameter of color intensity and color shade of the wine material, the optical density was measured at wavelengths of 420 and 520 nm. To calculate the trichromatic parameters, the transmission coefficient was measured at 445, 495, 520 and 650 nm. According to empirical data, diagrams were drawn to show the dependence of color intensity, shade (figure 2) and yellowness index (figure 3) on concentration of carbons of Granucol series.

Figure 2. Dependence of color intensity (a) and tint (b) of wine material on the concentration and type of coals Granucol.

After treatment of wine with Granucol activated carbons, the wine color intensity index decreased; as the mass of the introduced activated carbon Granucol BI increased, the color of the wine material
changed from greenish-straw to light yellow. The carbons of Granucol FA and Granucol GE also contribute to a decrease in color intensity, but the wines treated with these brands of carbons visually retain unattractive tones in their color.

It is necessary to note that the most expressed effect on correction of the wine color properties is achieved with the application of activated carbon Granucol BI, which are capable to eliminate various flaws or disadvantages of the wine material, leading to a change in the wine appearance. The results of application of activated carbons Granucol to adjust the flavor properties of white wines (figure 4) are quite interesting.

The introduction of activated carbons allows general elimination of the undesired taste (excessive astringency) and aromatic (yeast tone, earthy aroma) properties, while the harmony of the wines as a whole is improved.

**Figure 3.** Dependence of the yellowness indicator of the color of the wine material on the concentration and type of Granucol coals.

**Figure 4.** Influence of Granucol coals on the taste and aroma characteristics of wine.
Figure 5 shows the dynamics of the color intensity parameter when storing the wine for 12 months. It can be concluded that the treatment of grape wine with Granucol activated carbons prevents the occurrence of deep processes of non-enzymatic browning of wine, primarily due to chemosorption and removal of phenolic reactive substances. According to the results of the study, the introduction of Granucol carbons reduces the speed of the browning process of processed wines from 15 to 20%, but due to the preliminary removal of brown pigments from the wine, even after one year of storage the visual properties of the wine do not change significantly.

Figure 5. Dependence of the color intensity of wine material treated with Granucol coals on the storage duration.

4. Conclusion
Thus the good perspectives of using the activated carbons of the Granucol series to improve the organoleptic properties of white grape wines, in particular – their color and aroma, are shown. The dependence of chromatic properties of the wine material on concentration of carbons is experimentally defined. It is proven that the oxidative browning of white grape wines is reduced in the most efficient way by activated carbon Granucol BI, while in general the application of activated carbon Granucol GE improves the organoleptic perception of taste and aroma (flavor). In general, the use of Granucol activated carbons allows stabilizing the changes in the wines appearance during their shelf life for 12 months.

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