Changes in the antioxidant activity of red dry wines depending on the production method

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Abstract. It is found that a production method affects the antioxidant activity of researched red dry wines made grapes produced in Kuban area. According to results of multivariate analysis of variance, grape variety (59% of influence), production method (27%) and usage of antioxidants during must extraction (7%) influenced on antioxidant activity values.

Introduction

There were detected organic compounds with antioxidant properties in red wines made of different grape varieties. They are located mostly in skin, seeds and stems [1,2].

According to the last researches, composition of polyphenols and phenolic complexes, their amount and antioxidant and antiradical properties depend on some factors. They are grape variety, vineyard location, climate, soil and winemaking technology [3-13].

Many phenolic compounds are natural antioxidants as they are able to bind heavy metals in stable complexes eliminating catalytic effect. By the way, phenolic compounds can be acceptors of compounds formed during self-oxidation of free radicals (phenolic compounds are able to inhibit free-radical processes [14-17]. Antioxidant properties of phenolic compounds are more powerful (4-5 times more) than antioxidant potential of vitamins C and E.

The amount of antioxidant activity (AOA) is determined by the ability of wine to resist against oxidation. AOA indicates the presence of natural components with antioxidant properties, the amount of which is determined by varietal characteristics.

Thereby, the aim of the research was to determine the content of antioxidant substances in the studied wines produced from Dostoinyy, Secimler and Cabernet Sauvignon grape varieties, grown in Kuban area, depending on the production technology (method of maceration of the pulp, the action of antioxidants). The topic is considered as relevant.

Study objects and methods

For the purpose of the study, two main methods for the production of dry red wine materials were selected, which differed in the technique of maceration of the pulp.

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The first production method (schema № 1) table red dry wines included these steps: crushing and destemming, addition of sulfates into the must (80-100 mg/kg), addition of antioxidant agents ("Tannin SR Terroir" (T), ascorbic acid (AA), "Glutarom" (GL)) (table 1). After that producers were warming up the must 45-55 °C (2-3 hours), cooling it down till 20-30 °C. After separation of must by gravity, the drained pulp was pressed, then ascorbic acid, Glutar, was added to the must. Then the must was clarified and fermented by adding prepared active dry yeasts in the dosage recommended by the yeast producers. Further operations were carried out according to the generally accepted technological scheme.

Table 1. Deciphering the technological scheme for the production of red wines from grapes grown in the Krasnodar Territory

Name of the step	Schema № 1 (maceration t 45-55°C during 2 hours)				Schema № 2 (fermentation with solid part)			
	option 1/1	option 1/2	option 1/3	option 1/4	option 2/1	option 2/2	option 2/3	option 2/4
	Applying antioxidant agents							
After crushing and destemming	SO_2 80 mg/dm^3	SO_2 80 mg/dm^3 T 100 mg/dm^3	AA 50 mg/dm^3	SO_2 80 mg/dm^3 AA 50 mg/dm^3	SO_2 80 mg/dm^3	SO_2 80 mg/dm^3 T 100 mg/dm^3	AA 100 mg/dm^3 GL 250 mg/dm^3	SO_2 80 mg/dm^3 AA 100 mg/dm^3 GL 250 mg/dm^3
After separating must with gravity and pressing	-	-	AA 50 mg/dm^3 +GL 250 mg/dm^3	AA 50 mg/dm^3 +GL 250 mg/dm^3	-	-	-	-

In the second production method of red dry wines the main operations were crushing, destemming, adding sulfates (80-100 mg/kg), adding antioxidant agents: T, AA, GL, fermentation with floating cap with prepared dry yeasts (table 1). During fermentation punch downs were performed 3-4 times per day by specific instruments. Further operations were carried out according to the generally accepted technological scheme.

Grapes in a good condition were used for production. Grape varieties: Cabernet Sauvignon, Dostoynyy and Secimler were used, grown in Krasnodar region. Schemas of production described above, experiment was performed in three repetitions in a micro-winemaking workshop of NCFSCHVW. Analytical work was carried out at the Scientific Center "Winemaking" and the Center for Collective Use "Instrument and Analytical" NCFSCHVW.

The amount of antioxidant activity (AOA, mg/ dm^3) was determined by the voltammetric method on the instrument "Tsvet-Yauza-01-AA" (JSC NPO "Khimavtomatika", Moscow). The potential of the working electrode was set to "+1.3V", an aqueous solution of gallic acid was used as a standard, samples of wine materials were diluted 200 times (table 2). The mass concentration of the sum of phenolic compounds was determined by the colorimetric method using the Folin-Ciocalteu reagent.

Statistical processing of the research results was carried out using the computer program Statistica 6.0 for Windows, with a confidence interval of P=0.95.

Results and discussion

The results of the study of the phenolic complex of wine materials produced from Cabernet Sauvignon, Dostoynyy and Satsimler grape varieties indicate the presence of compounds exhibiting antioxidant properties in them (table 2). These are components containing a large number of hydroxyl groups, which allows them to exhibit antioxidant properties and absorb atomic oxygen.

Table 2. Changing in antioxidant activity (AOA) (in terms of gallic acid), mass concentration of phenolic compounds (PC) in wine materials from the studied grape varieties, mg/dm^3

Index	Schema № 1				Schema № 2				Least significant difference
	option 1/1	option 1/2	option 1/3	option 1/4	option 2/1	option 2/2	option 2/3	option 2/4	
Grape variety Cabernet Sauvignon									
AA, mg/dm^3	624	627	610	677	453	466	441	561	44
PC, mg/dm^3	2876	2864	2814	2556	1962	1317	1368	1401	173
Grape variety Dostoynyy									
AA, mg/dm^3	697	801	714	755	647	661	681	701	44
PC, mg/dm^3	2937	3532	3279	3391	2735	2612	2612	2668	173
Grape variety Satsimler									
AA, mg/dm^3	494	599	516	592	435	507	454	555	44
PC, mg/dm^3	1827	1878	2052	1861	1519	1626	1614	1508	173

The highest concentration of antioxidants in the range of 661-801 mg/dm^3 among the studied samples was recorded in wine materials from the Dostoynyy grape variety. At the same time, the lowest AA value was observed in wine materials from the Satsimler grape variety and amounted to 435-555 mg/dm^3. We consider this to be natural, since a lower content of total phenols was previously found in wine materials from this variety compared to the others. It should be noted that the heat treatment of the pulp, provided for according to scheme №1, contributed to the accumulation of a larger amount of antioxidants. On average, this excess was 8-20%.

At the same time, it was found that the value of AA in wine materials prepared with the addition of Tannin SR Terroir was higher than in control variants from grapes of all studied varieties. An increase in AA was also noted with the addition of a complex - sulfur dioxide, ascorbic acid and Glutar - in wine materials prepared according to two technological schemes from grapes of all studied varieties. With the introduction of a complex of antioxidants - ascorbic acid and Glutar - an increase in the AA value up to 20% was observed. Based on the

results of the studies, statistical processing of the data on the value of antioxidant activity (AA) was carried out (table 3, figure 1, figure 2).

Table 3. Results of multivariate analysis of variance of the obtained data on AOA (in terms of gallic acid, mg/dm^3)

Variability	Sum of squares *SS*	Degree of freedom *df*	Medium squares *mS*	Fisher criterion calculation *F*	Dispersion σ	Shares of influence, *P, %*
General	8481969	1	-	-	21767	100
Option number for the introduction of antioxidants (respectively) technological schema)	25655	3	8552	7**	1615	7
Grape variety	158036	2	79018	62**	12956	59
Number of the technological schema	54502	1	54502	42**	5913	27
Residual	21815	17	1283	-	1283	7

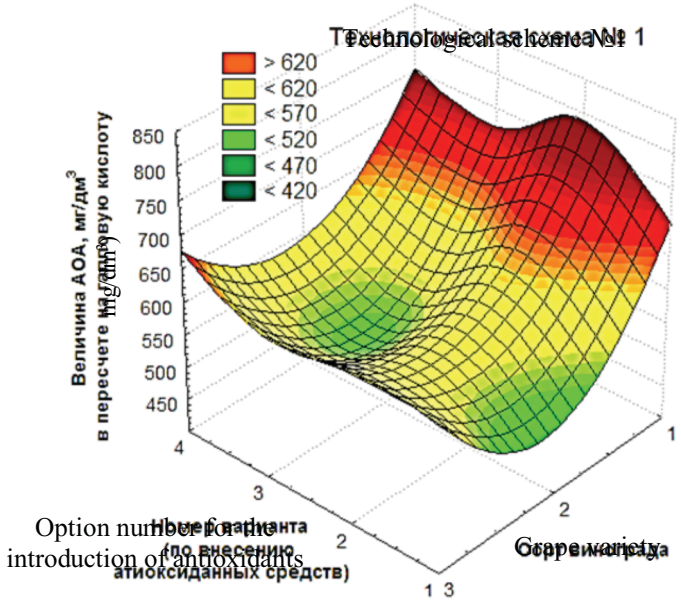

Fig. 1. Change in the AOA value depending on the type of antioxidants used, the grape variety and the scheme for the production of dry red wines, where 1 - Dostoynyy; 2 - Satsimler; 3 - Cabernet Sauvignon

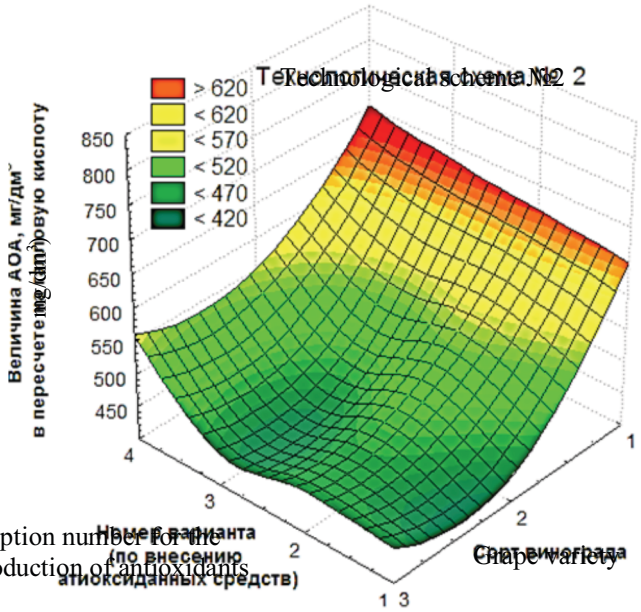

Fig. 2. Change in the AOA value depending on the type of antioxidants used, the grape variety and the scheme for the production of dry red wines, where 1 - Dostoynyy; 2 - Satsimler; 3 - Cabernet Sauvignon.

Based on a multivariate analysis of variance, it was found that the formation of the value of antioxidant activity was influenced by the grape variety (with a share of influence of 59%), production technology (27%), and the introduction of antioxidants at the stage of pulp production (7%).

Conclusion

Thus, an increase in the value of antioxidant activity is favored by heat treatment of the pulp and the introduction of a complex of antioxidant agents that enhance the antioxidant profile and preserve compounds with antioxidant properties.

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References

1. M. Kharadze, I. Japaridze, A. Kalandia, M. Vanidze, Annals of Agrarian Science, **16,** 181-184 (2018) https://doi.org/10.1016/j.aasci.2018.04.006.
2. I. Garaguso, M. Nardini, Food Chemistry, **179,** 336-342 (2015) https://doi.org/10.1016/j.foodchem.2015.01.144.

3. I.F. Strati, and el., Current Research in Food Science, **4,** 937-945 (2021) https://doi.org/10.1016/j.crfs.2021.11.017.
4. I. Kekelidze, N. Ebelashvili, M. Japaridze, B. Chankvetadze, L. Chankvetadze, Annals of Agrarian Science, **16,** 34-38 (2018) https://doi.org/10.1016/j.aasci.2017.12.005.
5. M. Gabriele, and el., Food Chemistry, **245,** 1105-1112 (2018) https://doi.org/10.1016/j.foodchem.2017.11.060.
6. D. Sun, X. Chen, C. Zhu, International Journal of Biological Macromolecules, **158,** 1239-1247 (2020) https://doi.org/10.1016/j.ijbiomac.2020.05.052.
7. A.M. Milat, and el., Journal of Functional Foods, **59,** 138-147 (2019) https://doi.org/10.1016/j.jff.2019.05.025.
8. F. Bahut, and el., Food Chemistry, 325, 126941 (2020) https://doi.org/10.1016/j.foodchem.2020.126941.
9. R. Romero-Díez, and el., Food Chemistry, **259,** 188-195 (2018) https://doi.org/10.1016/j.foodchem.2018.03.119.
10. L. González-Arenzana, and el., Food Chemistry, **319,** 126569 (2020) https://doi.org/10.1016/j.foodchem.2020.126569.
11. G. Gerardi, and el., Journal of Functional Foods, **66,** 103794 (2020) https://doi.org/10.1016/j.jff.2020.103794.
12. S. Motta, M. Guaita, C. Cassino, A. Bosso, Food Chemistry, **313,** 126045 (2020) https://doi.org/10.1016/j.foodchem.2019.126045.
13. A. Wojdyło, J. Samoticha, J. Chmielewska, Food Chemistry, **339,** 127888 (2021) https://doi.org/10.1016/j.foodchem.2020.127888.
14. Ó.A. Muñoz-Bernal, and el., Food Research International, **140,** 110069 (2021) https://doi.org/10.1016/j.foodres.2020.110069.
15. M. Perra, and el., Biomedicine & Pharmacotherapy, **142,** 111959 (2021) https://doi.org/10.1016/j.biopha.2021.111959.
16. Y. Sato, and el., Livestock Science, **241,** 104217 (2020) https://doi.org/10.1016/j.livsci.2020.104217.
17. Crina Vicol, Free Radical Biology and Medicine, **177,** 111 (2021) https://doi.org/10.1016/j.freeradbiomed.2021.08.170.