Enological characteristics of red dessert wines produced with innovative technology

Nana Ebelashvili, Inessa Kekelidze, Murman Japaridze
Georgian Agrarian University, Institute of Viticulture and Oenology, Tbilisi, Georgia
nana-ebelashvili@hotmail.com

Abstract

An increased demand for red wines in the world market for today is determined just by their antioxidant activity. At the same time, proceeding from positive correlation existing between antioxidant effect and phenolic compounds, only those red wines have antioxidant effect in which their concentration is high. The amount of phenolic compounds in wine depends on the vine growing place, grape cultivar, techniques of fermentative maceration. We have developed fermentative maceration innovative technology for red dessert wine with the aim of enrichment with phenolic compounds (our "know-how"). The objects of research were red dessert wine samples made from Saperavi grape: test sample – using the innovative technology developed by us; control sample– using the existing (standard) technology. The purpose of this work is determination of the main conditioning indices, monophenolics amount, Sensory properties and their comparison in test and control wines.The main conditioning indices (volatile and titric acidity, the total amount of phenolic compounds, color) were determined using standard international methods. By means of the HPLC analysis determined the amount of flavonoids and non-flavonoids. There have been established that compared with control in test samples is high: the total amount of phenolic compounds by 59.9%, color - by 27.7%, the concentration of the total catechins- – 2.7–times; Total of flavonols – 5.9–times, Total phenolic acids – 2.7-times. The results of wine tasting assessment are higher compared with the control.

1. Introduction

Wine presents rich product by its composition. It is known scientifically that it consists of more than 1000 compounds. Phenolic compounds are one of the main characteristics of red wine. they take part in the formation of structure, color, transparency and stability of wine [1]. Phenolic compounds inhibit free radicals development, generated in a wide range in human body [2-4], significantly reduce cardiovascular disease [5-7], diabetes 2 [8, 9], various types of cancer [10, 11] and variety of other diseases development risk [12-15]. Phenolics in wines have attracted more interest from researchers in both food science and medicine. The intensive investigations of red wines in have started since 1991 when it became known about the „French Paradox". According to this phenomenon, in France, where regular and moderate consumption of red wines is traditional, in spite of cholesterol-rich food intake, the percentage of cardiovascular diseases is low and the duratio of life is high. Regular and moderate consumers of red wines are at 20–30% less predisposed to the cardiovascular disease [15]. Among the phenolic compounds of red wines with high antioxidant activity, there are outlined: (+)–catechin, (–)–epicatechin, caffeic, chlorogenic, protocatechic, syringic and ferulic acids, resveratrol, kaempferol, quercetin, and myricetin [14-17].

At the same time, proceeding from positive correlation existing between antioxidant effect and phenolic compounds, only those red wines have antioxidant effect in which their concentration is high. The amount of phenolic compounds vary considerably in different types of wines depending on the grape variety, soil and atmospheric conditions, environmental factors in the vineyard, agronomical techniques used, the process berry maturation, the health of grapes, wine processing techniques [18-21].

Dessert wines – is a popular special type of wines, produced in the world [22]: Portugal, Italy, Hungary, Spain, France, Argentina, Germany, Moldova, Bulgaria, Russia, etc.(tabl.1).

Dessert wines production in the Soviet Georgia was intensive “Kvareli №29” and others, nowadays – their production is stopped, but has the potential of recovery. We have developed fermentative maceration innovative technology for red dessert wine with the aim of enrichment with phenolic compounds (our “know-how”).

Wine production (excluding juice and musts)

Table 1.

Unit: 1000 hl	**2010**	**2011**	**2012**		**2013**	**2014 Provisional**	**2015 Forecast**
Italy*	48 525	42 772	45 616		54 029	44 229	48 800
France*	44 381	50 757	41 548		42 134	46 804	47 373
Spain*	35 353	33 397	31 123		45 308	38 211	36 600
USA	20 887	19 140	21 650		23 590	22 020	22 140
Argentina*	16 250	15 473	11 778		14 984	15 197	13 358
Chile	8 844	10 464	12 554		12 820	10 500	12 870
Australia	11 420	11 180	12 259		12 310	12 020	12 000
South Africa	9 327	9 725	10 569		10 982	11 316	11 310
China	13 000	13 200	13 511		11 780	11 178	11 178
Germany*	6 906	9 132	9 012		8 409	9 202	8 788
Portugal*	7 148	5 622	6 327		6 231	6 195	6 703
Russia*	7 640	6 980	6 220		5 290	4 880	4 880
Romania	3 287	4 058	3 311		5 113	3 750	4 069
Hungary*	1 762	2 750	1 818		2 618	2 555	2 873
Brazil	2 459	3 460	2 967		2 710	2 732	2 732
Greece	2 950	2 750	3 115		3 343	2 900	2 650
Austria	1 737	2 814	2 125		2 392	1 999	2 350
New Zealand	1 900	2 350	1 940		2 484	3 204	2 350
Serbia	2 382	2 244	2 175		2 306	2 332	2 332
Bulgaria*	1 224	1 237	1 442		1 755	747	1 538
Moldova*	840	1 520	1 470		2 570	1 630	1 630
Georgia	1 034	1 108	830		997	1 134	1 134
OIV World Total	**264 188**	**267 803**	**258 211**		**292 218**	**270 234**	**275 665**

*Dessert wines producer countries

2. Material and Methods

The objects of research were red dessert wine samples made from Saperavi grape: test sample – using the innovative technology developed by us; control sample– using the existing (standard) technology [1]. The purpose of this work is determination of the main conditioning indices, monophenolics amount, Sensory properties and their comparison in test and control wines.

The main conditioning indices (volatile and titric acidity, the total amount of phenolic compounds, color) were determined using standard international methods. By means of the HPLC analysis determined the amount of flavonoids and non-flavonoids on the apparatus Infinity 1200, Agilent Technologies, USA with UV-VIS detector. Separation of components was performed on chromatographic column with reversed-phase sorbent Microsorb 100-S C18 (250mm x 4.6 mm x 5.0 mm). Elution was performed in gradient mode at the rate of mobile phase feed equal to 1 ml/min. The following solutions were used: Solution A – water/phosphoric acid (in the ratio of 99.5/0.5); solution B – acetonitrile/water/phosphoric acid (in the ratio 50/49.5/0.5). The wine samples were diluted five times with methanol and filtered through membrane filter (pore diameter 0.22 μm). The solvents and commercial standards used during the analysis were purchased from Sigma-Aldrich (Germany).The detection was performed at wavelengths: 280 nm (catechins, phenolcarbonic acids), 360 nm (flavonols and ellagic acid) and 310 nm (resveratrol). Identification was conducted by comparison of retention time of standard substances and defined components as well [23].

3. Results and Discussion

The obtained data are illustrated in the tab. 2, 3.

In the test samples in comparison with the control is higher: the total amount of phenolic compounds by 59.9% (4139 vs 2588 mg/l), titric acidity – by 53.3% (7.56 vs 4.93 g/l), color - by 27.7% (48.15 vs 37.7).

In the research objects we have identified and quantified: catechins: (+)-catechin and (-)-epicatechin; flavonols**:** quercetin, quercetin-3-β-D-glucoside, kaempferol and myricetin; phenolcarbonic acids: gallic, caftaric, chlorogenic, syringic, vanillic, caffeic, p-coumaric, ferulic, sinapic, t-cinnamic and ellagic acids.

conditioning indices and tasting results

Table 2.

conditioning indices and Tasting results	Control	Test
Titric acidity g/l	4.93	7.56
Volatile acidity g/l	0.18	0.23
Ph	3.85	3.82
Total amount of phenolic compounds, mg/l	2588	4139
Color	37.7	48.15
Tasting results, in points	8.1	8.4

Phenolic compounds in the control and test samples

Table 3.

Phenolic compounds (mg/l)	Control	Test
caftaric acid	20.983	55.6083

(+)–catechin	25.167	35.442
caffeic acid	2.753	14.648
syringic acid	7.600	12.575
(–)–epicatechin	11.417	61.650
ellagic acid	1.483	6.721
quercetin–3–glucoside	5.233	31.008
Total catechins	36.584	97.092
Total phenolic acids	32.819	89.552
Total phenolic antioxidants	74.636	217.652

Among phenolic acids, caftaric acid was present most of all in our research objects. It should be noted that caftaric acid in red wines from Saperavi was identified for the first time by us.

In our samples, among flavonols quercetin-3-β-D-glucoside was present most of all.

In the research objects, cinnamic acid was present as traces; the amount of resveratrol in them was also low (1.5 mg/l).

The results of the study showed that, in comparison with the control sample, the test dessert wine one had higher phenolic content: the concentration of the total catechins – 2.7–times (97.092 vs 36.584mg/l); total of flavonols – 5.9–times (31.008 vs 5.233mg/l), total phenolic acids – 2.7-times (89.552 vs 32.819mg/l), total phenolic antioxidants - 2.9 - times (217.652 vs 74.636mg/l).

Total quantity of flavonols increases mainly due to the increase of the quercetin–3–glucoside. In test sample, in comparison with the control, concentration of the quercetin–3–glucoside is higher 5.9–times (31.008 vs 5.233 mg/l).

Total content of phenolic acids in the test sample in comparison with the control is higher mainly due to the quantitative increase in caftaric, caffeic, syringic and ellagic acids. Their amount in the test sample is as follows.

Concentration of the trans-caftaric acid in test samples in comparison with the control is higher: – 2.65–times (55.608 vs 20.983 mg/l); According to the literary sources, this acid is characterized with high antioxidant effect and is the main phenolic compound in curative plants [39].

Concentration of the caffeic acid in test samples in comparison with the control is high 5–times (14.648 vs 2.753 mg/l). According to the literature data, phenolcarbonic acids determine the sort peculiarities and influence on the formation and typicalness of the wine. Studies have shown that caffeic acid has antioxidant activity, anti-mutagenic, antibacterial and anti–carcinogenic properties [4 10 , 11,].

Concentration of the syringic and ellagic acids in test samples in comparison with the control is higher respectively in test– by 65% (12.575 vs 7.600 mg/l) and 4.5–times (6.721 vs 1.483 mg/l.)

Studies M. Kampa et. al [4] have shown that caffeic acid, syringic acid, sinapic acid, protocatechuic acid, ferulic acid and 3,4–dihydroxyphenylacetic acid has produce growth inhibition of cancer cells, in vitro, indicating an additional protective effect on hormone–dependent breast tumors.

The results of wine tasting assessment are higher compared with the control.

4. Conclusions

The indicated increase in the content of catechins, flavonols and phenolcarbonic acids, in the test red wine sample can be explained by the application of the technology we developed which provides far better extraction of these components from the grape pulp in the process of alcoholic fermentation as compared to the existing technology.

The high concentration of phenolics enhances the antioxidant and antibacterial effect of dessert wine, improves its quality, biological stability and nutritive value.

Acknowledgments

The research was carried by financial support of Shota Rustaveli National Science Foundation, 2013-2014yy. Doctoral Educational Programs Grant, № DO/363/10 – 160/14.

References

1. Валуйко Г. Г. Технология виноградных вин. Симферополь, Таврида, 2001, 616 с.
2. E.N. Frankel, A.L.Waterhouse, P.L. Teissedre, Principal phenolics phytochemicals in selected California wines and their antioxidant activity in inhibiting oxidation of human low-density lipoproteins, J. Agric. Food. Chem. 43 (1995) 890–894.
3. C.A. Rice-Evans, N.J. Miller, G. Paganga, Structure-antioxidant activity relationships of flavonoids and phenolic acids, J. Free Radic. Biol. Med. 20 (1996) 933–956.
4. M. Kampa, VI. Alexaki, G. Notas, AP. Nifli, A. Nistikaki, A. Hatzoglou, E. Bakogeorgou, E. Kouimtzoglou, G. Blekas, D. Boskou, A. Gravanis, E. Castanas, Antiproliferative and apoptotic effects of selective phenolic acids on T47D human breast cancer cells: potential mechanisms of action, J. Breast Canc. Res**.** 6 (2004**)** 63–74.
5. M. Nardini, D'Aquino M, G. Tomassi, V. Gentili, D.M. Felice, C. Scaccini, Inhibition of human low-density lipoprotein oxidation by caffeic acid and other hydroxycinnamic acid derivatives, J. Free Radic.Biol. Med. 19 (1995) 541–552
6. N.L. Kerry, M. Abbey, Red wine and fractionated phenolic compounds prepared from red wine inhibit low density lipoprotein oxidation in vitro, J. Atheroscler. 135 (1997) 93–102.
7. J.L. Donovan, J.R. Bell, S. Kasim-Karakas, J.B. German, R.L.Walzem, R.J. Hansen, A.L.Waterhouse, Catechin is present as metabolites in human plasma after consumption of red wine, J. Nutr. 129 (1999) 1662–1668.
8. A.E. Banini, L.C. Boyd, J.C. Allen, H.G. Allen, D.L.Sauls, Muscadine grape products intake, diet and blood constituents of non-diabetic and type 2 diabetic subjects, J. Nutr. 22 (2006) 1137–1145.
9. S.A. Palma-Duran, A. Vlassopoulos, M. Lean, L. Govan, E. Gombet, Nutritional intervention and impact of polyphenol on glycohemoglobin (HbA1c) in non-diabetic and type 2 diabetic subjects: Systematic review and nmeta-analysis, J. Critic. Rev. Food Sci. Nutrit. 57 (2017) 975–986.
10. G.J. Soleas, L. Grass, P.D. Josephy, D.M. Goldberg, E.P. Diamandis, A comparison of the anticarcinogenic properties of four red wine polyphenols, J. Clin. Biochem. 35 (2002) 119–124.
11. J.Yamada, Y.Tomita, Antimutagenic activity of caffeic acid and related compounds, J. Biosci. Biotechnol. Biochem. 60 (1996) 328–329.
12. A. Wattel, S. Kamel, R. Mentaverri, F. Lorget, C. Prouillet, J.P. Petit, P. Fardelonne, M. Brazie, Potent inhibitory effect of naturally occurring flavonoids quercetin and kaempferol on in vitro osteoclastic bone resorption, J. Biochem. Pharmacol. 65 (2003) 35–42.
13. A. Zoechling, E. Reiter, R. Eder, S. Wendelin, F. Liebner, A. Jungbauer, The Flavonoid Kaempferol Is Responsible for the Majority of Estrogenic Activity in Red Wine, Am. J. Enol. Vitic. 60 (2009) 223 232.
14. N.J. Kang, K.W. Lee, B.J. Shin , S.K. Jung , M.K. Hwang , A.M. Bode, Y.S. Heo, H.L. Lee, Z. Dong, Caffeic acid, a phenolic phytochemical in coffee, directly inhibits Fyn kinase activity and UVB-induced COX-2 expression, J. Carcinogen. 30 (2009) 321–330.
15. J. Guilford, J.M. Pezzuto, Wine and Health: A Review, Am. J. Enol. Vitic. 62 (2011) 471–486.
16. A. Prajitna, I.E. Dami, T.E. Steiner, D.C. Ferree, J.C. Scheerens, S.J. Schwartz, Influence of Cluster Thinning on Phenolic Composition, Resveratrol and Antioxidant Capacity in Chambourcin Wine, Am. J. Enol.Vitic. 58 (2007) 346–350.
17. I.G. Roussis, I. Lambroupoulos, P. Tzimas, A. Gkoulioti, V. Marinos, D. Tsoupeis, L. Boutaris, Antioxidant Activities of some Greek wines and wine phenolic extracts, J. of Food Compos. Anal. 21 (2008) 614–621.
18. J. Lachman, M. Sulc, M. Schilla, Comparison of the total antioxidant status of Bohemian wines during the wine-making process, J. Food Chem. 103 (2007) 802–807.
19. E. Anli, N. Vural, S. Demiray, M. Özkan, Trans-resveratrol and other phenolic compounds in Turkish red wines with HPLC, J. Wine Res. 17 (2006) 117–125. 20.
20. A. Prajitna, I. E. Dami, T. E. Steiner, D. C. Ferree, J. C. Scheerens, St. J. Schwartz, Influence of

Cluster Thinning on Phenolic Composition, Resveratrol and Antioxidant Capacity in Chambourcin Wine, Am. J. Enol. Vitic. 58 (2007) 346–350.
21. L.F. Casassa, Ch.W. Beaver, M. Mireles, R.C. Larsen, H. Hopfer, H. Heymann, J.F. Harbertson, Influence of Fruit Maturity, Maceration Length, and Ethanol Amount on Chemical and Sensory Properties of Merlot Wines, Am. J. Enol. Vitic. 58 (2013) 437–449.
22. International Organisation of Vine and Wine (OIV). Global Economic Vitiviniculture Data. 28 October 2015. http://www.oiv.int/, 2015.
23. D. Bonercz, M. Nikfarjam, G. Creazy, A New RP-HPLC Method for Analysis of Polyphenols, AnthocYanins and Indole-3-Acetic Acid in Wine, Am. J. Enol. Vitic. 59 (2008) 106–109.

ინოვაციური ტექნოლოგიით დამზადებული წითელი სადესერტო ღვინის ენოლოგიური მახასიათებლები

ნანა ებელაშვილი, ინესსა კეკელიძე, მურმან ჯაფარიძე
საქართველოს აგრარული უნივერსიტეტი, მევენახეობისა და მეღვინეობის ინსტიტუტი, თბილისი, საქართველო

დღეისათვის საერთაშორისო ბაზარზე წითელ ღვინოებზე მზარდი მოთხოვნა განპირობებულია მათი ანტიოქსიდანტური აქტიურობით. ამავდროულად, ანტიოქსიდანტურ ეფექტსა და ფენოლურ ნაერთებს შორის არსებული დადებითი კორელაციიდან გამომდინარე, მხოლოდ იმ წითელ ღვინოებს აქვთ ანტიოქსიდანტური აქტიურობა, რომლებშიც მაღალია მათი კონცენტრაცია. ღვინოში ფენოლური ნივთიერებების რაოდენობა დამოკიდებულია ვაზის ზრდის ადგილზე, ყურძნის ჯიშზე, ფერმენტული მაცერაციის ტექნოლოგიაზე. ფენოლური ნივთიერებებით გამდიდრების მიზნით, ჩვენს მიერ შემუშავებულია წითელი სადესერტო ღვინის ფერმენტული მაცერაციის ინოვაციური ტექნოლოგია (ჩვენი "know-how"). კვლევის ობიექტები იყო საფერავიდან დამზადებული წითელი სადესერტო ღვინის ნიმუშები: საცდელი – დამზადებული ჩვენს მიერ შემუშავებული ინოვაციური ტექნოლოგიით; საკონტროლო – არსებული (სტანდარტული) ტექნოლოგიით. სამუშაოს მიზანია სადესერტო ღვინის საცდელ და საკონტროლო ნიმუშებში ძირითადი კონდიციური მახასიათებლების, მონოფენოლების, სენსორული მახასიათებლების გამოკვლევა და მათი ურთიერთშედარება. ძირითადი კონდიციური მახასიათებლების (ტიტრული და მქროლავი მჟავიანობა, საერთო ფენოლური ნივთიერებების ჯამური რაოდენობა, შეფერვის ინტესიობა) გამოკვლევა ჩატარდა საერთაშორისო სტანდარტული მეთოდების გამოყენებით, ფლავანოიდებისა და არაფლავანოიდების – მაღალეფექტური სითხური ქრომატოგრაფიის მეთოდით. დადგენილია, რომ საცდელ ნიმუშში საკონტოლოსთან შედარებით მაღალია: საერთო ფენოლური ნივთიერებების ჯამური რაოდენობა 59.9%–ით, შეფერვის ინტენსიობა – 27.7%–ით, კატეხინების ჯამური კონცენტრაცია –2.7–ჯერ, ფლავანოლების ჯამური რაოდენობა – 5.9–ჯერ, ფენოლკარბონმჟავების ჯამური რაოდენობა – 2.7–ჯერ; საკონტროლოსთან შედარებით მაღალია მისი სადეგუსტაციო შეფასების შედეგი.

სამუშაო შესრულებულია შოთა რუსთაველის ეროვნული სამეცნიერო ფონდის ფინანსური მხარდაჭერით, 2013-2014წწ დოქტორანტურის საგანმანათლებლო პროგრამების საგრანტო კონკურსი, გრანტი № DO/363/10 – 160/14.