



ANTIOXIDANT PROPERTIES OF THE BESTSELLING SLOVAK RED WINES

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ABSTRACT

Antioxidants are specific substances that oxidize themselves and in this way they protect other sensitive bioactive food components against destruction. At the same time they restrict the activity of free radicals and change them to less active forms. Large group of antioxidants are polyphenols, which affect sensory properties of fruit, vegetable and some drinks, like colour (anthocyanins), taste (flavonoids) or odour (phenols). The significant source of polyphenolic compounds are wines. Polyphenols (in optimal amount and combination), found mainly in red wines, have very complex (positive) effects on organism. The aim of this work was to determine chosen antioxidant properties of the best-selling quality red wines - Blaufränkisch and St. Laurent, originating from different Slovak vineyard areas. Total polyphenols content was determined with phenol Folin-Ciocalteu's reagent and antioxidant activity was determined using DPPH stable free radical. Both parameters were determined by UV-VIS absorption spectrometry. The determined total polyphenol contents in observed wines were within the interval 1579 – 2734 mg.L⁻¹ (Blaufränkisch), respectively 1409 – 3276 mg.L⁻¹ (St. Laurent). Antioxidant activity in wines was within the interval 80.2 – 86.4 % (Blaufränkisch), respectively 71.0 – 84.8 % (St. Laurent). The differences between results of measured antioxidant properties (total polyphenol contents and antioxidant activities) of the wines originating from some vineyard Slovak areas were statistically significant.

Keywords: phenolic compound, antioxidants, antioxidant activity, red wine

INTRODUCTION

At present days predominate the consumption and drinking of energetically rich and non-healthy foodstuffs and beverages while there is no regard on healthy foodstuffs. The intake of beneficial substances has declined, but our body has been continually under negative influence of so-called free-radicals. Free radicals pose a permanent burden for our cells. Toxicants in environment, smoking, higher level of UV radiation, unsuitable nutrition, alcohol misuse, and stress belong to mentioned negative effects. Protection of human body against free radicals is provided through antioxidants (**Mudrončíková, 2011**).

In recent years healthy effects of moderate consumption of wine have been discussed by scientific as well as laic community. Drinking of wine has a lot of positive effects on health of human population, while wine becomes the part of healthy life style. More than 500 various compounds (saccharides, acids, tannins, vitamins, phenolic compounds,...) are present in wine (**Slezák, 2007**). Wine is considered to be an important source of antioxidants among beverages. Polyphenolic compounds are very monitored and discussed group of antioxidants in wine that exert bio-protective effects and have strongly positive effect on human health. Their importance is in reducing of cardiovascular and carcinogenic diseases incidence.

Phenolic compounds, as secondary metabolites, rank among phytochemicals groups, and have physiological and morphological importance for plants. From the standpoint of structure phenolic compounds consist of minimally one aromatic ring with one or more substitution –OH groups and form numerous and subsequently diversified group of substances including substances from simple phenolic to polymerized phenolic compounds. This is the reason why they are called polyphenols. Plant polyphenols are amorphous substances occurring almost in all plants, especially in leaves, flowers, seeds, fruits, in pathologic formations, as well as in products of plant origin, honey, propolis and wine. They are present mainly in form of conjugates of saccharides molecules in plants, with one or more phenolic molecules or they occur in form of functional derivatives, such as esters or metylesters (**Balasundram et al., 2006; Vollmanová et al., 2009; Timoracká, 2010**).

Globally, red wines contain more phenolic compounds than white wines. It is caused by the technology of winemaking, when making white wines the grapes' skin is removed before fermentation (**Beer et al., 2006**). The total polyphenols in wine besides variety of grapes, locality of growing, climatic conditions, is affected also by procedure of winemaking: length of contact of stum with grapes's skin, mixing, temperature, content of SO₂, pH value, content of alcohol (**Villano et al., 2006; Lachman and Šulc, 2006**).

Blafränkisch is an old variety whose origin is still not cleared. Its origin is connected with Frank's viticulture. Another opinion is that it derives from Lower Austria. Blafränkisch is typical central-european variety spread in Austria, Hungary, Slovenia, Croatia, and partly also in Serbia and Germany. It is the most cultivated variety for production of red wines in Slovakia; it represents 7.78 % of area of all vineyards, i.e. 1176 ha of cultivating. In Czech Republic it is the second most widely grown red grape variety and occupies 1307.5 ha of vineyards area (**Šimonovič, 2009a**).

The origin of Saint Laurent is not clear till present times, but its homeland is France. Its name probably derived from term of grapes ripening in period of Saint Laurent holiday. In mid 19st century Saint Laurent wine has been spread from France to Germany and Austria. In Czech Republic it is grown from the beginning of 20st century and at present times it is the most cultivated red variety there. In other countries with wine history it is less known variety. It has been imported to our country about 80 years ago from Morava. Apart from Blafränkisch it is the most cultivated red variety in Slovakia (**Šimonovič, 2009b**).

The aim of our work was mainly to determine total content of phenolic compounds with antioxidant activity of two best-selling, varietal, red wines in Slovakia - Blafränkisch and Saint Laurent. Bottled, quality, red wines made from grapes grown in various vineyard areas in Slovakia were analysed.

MATERIAL AND METHODS

Analysed, bottled, quality, red wines and their characteristics are mentioned in Tables 1 and 2. Samples of wine were purchased in retail network, to provide that analysed samples of wine would have the same properties as wines that are consumed by common consumers (properties of wine affected by various factors, such as period and conditions of storage, or distribution of wine). Mainly wines of vintage years 2007 to 2010 were analysed with origin in various Slovak vineyard areas (VA). Samples of wine after obtaining till analyses were (app. 1 week since purchase) stored in horizontal position, by temperature 20 °C, without light irradiation.

Total polyphenols content and antioxidant activity in wines were assessed spectrophotometric analysis (spectrophotometer Shimadzu UV/VIS – 1240, *Shimadzu, Japan*).

Table 1 Characteristics of analysed wine – Blaufränkisch

Sample	Producer	Vineyard area	Vintage	Wine type ^A	The content of alcohol in %
F-M1	Villa Víno Rača, a.s., Bratislava	Little Carpathian	2009	dry	12.5
F-M2	Vitis Pezinok, s.r.o.	Little Carpathian	2009	dry	11.5
F-M3	Víno Rimavská Sobota, s.r.o.	Little Carpathian	2009	dry	11.5
F-M4	Malokarpatská vinohradnícka spol., a.s., Pezinok	Little Carpathian	2009	dry	10.5
F-J1	Vinárske závody Topoľčianky, s.r.o.	South slovak	2009	dry	12.0
F-J2	Vinohradnícko vinárske družstvo, Dvory nad Žitavou	South slovak	2008	dry	12.0
F-J3	Virex, s.r.o., Nesvady	South slovak	2009	dry	11.0
F-N1	Víno Nitra, s.r.o.	Nitra	2009	dry	10.5
F-N2	Vinárske závody Topoľčianky, s.r.o.	Nitra	2009	dry	12.5
F-N3	Víno Nitra, s.r.o.	Nitra	2009	semi- sweet	10.5
F-V1	Pivnica Tibava	East slovak	2009	dry	11.0
F-V2	J&J Ostrožovič, Veľká Tŕňa	East slovak	2007	dry	11.0
F-V3	Tokaj Vín, s.r.o.	East slovak	2010	dry	11.0
F-V4	Pivnica Tibava	East slovak	2008	dry	11.5
F-V5	J&J Ostrožovič, Veľká Tŕňa	East slovak	2010	dry	12.0
F-S1	Agro Movino, s.r.o., Veľký Krtíš	Central slovak	2009	dry	11.5
F-S2	Agro Movino, s.r.o., Veľký Krtíš	Central slovak	2010	dry	11.0

Legend: ^A – wine type by the residual sugar content

Total polyphenols content (TP) was assessed by method of **Faitová et al. (2003)**. 1 cm³ of wine sample was pipetted into 50 cm³ flask and diluted with 5 cm³ of distilled water. To diluted mixture 2.5 cm³ Folin-Ciocalteu reagent was added and after 3 minutes 7.5 cm³ of 20 % aqueous solution of Na₂CO₃ was added. Then the sample was filled with distilled water

to volume 50 cm³ and after mixing left by laboratory temperature for 2 hours. By the same procedure the blank and calibration solutions of gallic acid were prepared. Absorbance of samples solutions was measured against blank at 765 nm. Total polyphenols content in wines was calculated as amount of gallic acid (GA) in mg per 1 litre of wine.

Table 2 Characteristics of analysed wine - Saint Laurent

Sample	Producer	Vineyard area	Vintage	Wine type	The content of alcohol in %
S-M1	Víno Matyšák, s.r.o. Pezinok	Little Carpathian	2009	dry	13.0
S-M2	Hubert J.E. s.r.o. Sered'	Little Carpathian	2008	dry	11.0
S-M3	Vitis Pezinok, s.r.o.	Little Carpathian	2007	dry	12.0
S-M4	Limbašské vinohradnícke družstvo, Limbach	Little Carpathian	2009	dry	12.5
S-J1	Villa Víno Rača, a.s., Bratislava	South slovak	2008	dry	12.5
S-J2	Virex, s.r.o., Nesvady	South slovak	2008	dry	11.0
S-J3	Vinohradnícko vinárske družstvo, Dvory nad Žitavou	South slovak	2008	dry	12.0
S-J4	Vinárske závody Topoľčianky, s.r.o.	South slovak	2009	dry	12.0
S-N1	Vinárske závody Topoľčianky, s.r.o.	Nitra	2008	dry	12.5
S-N2	Vinárske závody Topoľčianky, s.r.o.	Nitra	2010	dry	12.5
S-V1	Pivnica Tibava	East slovak	2008	dry	11.0
S-V2	Pivnica Orechová, Regiatt, s.r.o.	East slovak	2009	dry	11.5
S-V3	Pivnica Orechová, Regiatt, s.r.o.	East slovak	2008	dry	11.0
S-S1	Agro Movino, s.r.o., Veľký Krtíš	Central slovak	2009	dry	11.0
S-S2	Agro Movino, s.r.o., Veľký Krtíš	Central slovak	2010	dry	11.5

Antioxidant activity (AA) was assessed by method of **Brand-Williams et al. (1995)** using of DPPH (1,1-diphenyl-1-picrylhydrazyl) radical. Absorbance was read at 515.6 nm and antioxidant effectiveness was expressed as % inhibition of DPPH (quantitative ability of tested compound to remove in certain period a part of DPPH radical). All analyses were performed as four parallels.

RESULTS AND DISCUSSION

Total polyphenols content in Blaufränkisch was in range from 1579 to 2734 mg GA.l⁻¹ (Tab. 3). Average content of CP was 2003 mg GA.l⁻¹.

According to the average content value of TP an order for Blaufränkisch could be as following: wines from Central slovak VA > wines from Little Carpathian VA > wines from South Slovak VA > wines from Nitra VA > wines from East slovak VA. Gained results exerted statistically significant differences (at significance level P = 0.01) between total polyphenols content in wines made in Central slovak VA and total polyphenols content in wines made in East slovak VA, Nitra and South slovak VA.

The results were are similar to results reported by **Slezák (2007)** and **Čižmárová (2009)**, who found out the content of TP in Blaufränkisch in range from 1646 to 2290 mg GA.l⁻¹. An average value of TP content was 1854 mg GA.l⁻¹, what wine – Blaufränkisch ranks among wines with the lowest content of TP from varietal wines made in Slovakia.

Antioxidant activity in wine – Blaufränkisch was in range 80.2 - 86.4 % inhibition of DPPH (Tab. 3). An average value of AA was 83.8 % inhibition of DPPH. On the basis of value of AA an order could be as following: wines from Central slovak VA > wines from South slovak VA > wines from Nitra VA > wines from Little Carpathian VA > wines from East slovak VA. Gained results did not exert statistically significant differences (at significance level P = 0.05) between values of antioxidant activity in wines made in various vineyard areas in Slovakia.

Our results were slightly higher than those reported by **Slezák (2007)** and **Čižmárová (2009)**, who in slovak red wines - Blaufränkisch found out values of AA in range 77.3 - 79.5 % inhibition of DPPH. An average value was 78.7 % inhibition of DPPH, what wine - Blaufränkisch ranks among wines with the highest content of TP from varietal wines made in Slovakia.

In tested wines – Saint Laurent the total polyphenols content was in range 1409 - 3276 mg GA.l⁻¹ (Tab. 4). An average TP content in wines was 2297 mg GA.l⁻¹. According to average value of TP content an order could be as following: wines from Little Carpathian VA > wines from Central slovak VA > wines from Nitra VA > wines from South slovak VS > wines from East slovak VA. Gained results exerted statistically significant differences between total polyphenols content in wines made in South slovak VA and total polyphenols content in wines from Little Carpathian VA (at significance level P = 0.05), Nitra and Central slovak VA (at significance level P = 0.01).

Results were discrepant from results found out by Slezák (2007) and Čížmarová (2009), who reported higher contents of TP (in range 2890 - 4246 mg GA.l⁻¹) in slovak red wines - Saint Laurent. An average content value of TP was 3600 mg GA.l⁻¹, what wine – Saint Laurent ranks among varietal wines with the highest content of TP from varietal wines made in Slovakia.

Table 3 The content of total polyphenols (in mg gallic acid .l⁻¹) and antioxidant activity (in % inhibition of DPPH) in wine – Blaufränkisch

Sample	Content TP ^B	AA ^B
F-M1	2734 ± 48	84.1 ± 2.2
F-M2	2044 ± 54	86.0 ± 1.8
F-M3	1845 ± 37	84.2 ± 1.9
F-M4	2525 ± 39	80.2 ± 1,1
Average – LCVA	2287 ± 432	83.6 ± 2.8
F-J1	2064 ± 82	83.2 ± 2.5
F-J2	1837 ± 28	85.8 ± 2.4
F-J3	1776 ± 33	85.8 ± 1.7
Average – SSVA	1892 ± 170	84.9 ± 1.5
F-N1	1668 ± 64	85.5 ± 3.0
F-N2	2026 ± 33	84.7 ± 2.3
F-N3	1806 ± 34	81.8 ± 1.8
Average – NVA	1833 ± 212	84.0 ± 2.2
F-V1	1796 ± 85	84.0 ± 2.0
F-V2	2031 ± 45	80.3 ± 1.5
F-V3	1724 ± 67	81.8 ± 1.2
F-V4	1684 ± 38	83.5 ± 1.7
F-V5	1579 ± 52	83.1 ± 2.2
Average – ESVA	1914 ± 194	82.2 ± 1.6
F-S1	2463 ± 54	84.3 ± 2.5

F-S2	2447 ± 36	86.4 ± 3.1
Average – CSVA	2455 ± 14	85.4 ± 1.9
Average – SR	2003 ± 342	83.8 ± 1.9

Legend: ^B – contents of TP and values of AA are expressed as arithmetic average ± standard deviation
 LCVA – Little Carpathian vineyard area, SSVA – South slovak vineyard area, NVA – Nitra vineyard area,
 ESVA – East slovak vineyard area, CSVA – Central slovak vineyard area, SR – Slovak republic

In tested wines – Saint Laurent antioxidant activity was in range 71.0 - 84.8 % inhibition of DPPH (Tab. 4). An average value of AA was 81.2 % inhibition of DPPH. On the basis of values AA following order could be done: wines from Central slovak VA > wines from South slovak VA > wines from East slovak VA > wines from Nitra VA > wines from Little Carpathian VA. Gained results exerted statistically significant differences (at significance level P = 0.05) between values of antioxidant activity in wines made in South slovak VA and Little Carpathian VA.

Table 4 The content of total polyphenols (in mg gallic acid .l⁻¹) and antioxidant activity (in % inhibition of DPPH) in wine – Saint Laurent

Sample	Content TP ^B	AA ^B
S-M1	2839 ± 26	76.8 ± 1.8
S-M2	2145 ± 27	84.1 ± 2.2
S-M3	2422 ± 24	78.2 ± 1.9
S-M4	3276 ± 47	71.0 ± 0.7
Average – LCVA	2671 ± 554	77.5 ± 6.4
S-J1	2136 ± 41	83.8 ± 2.4
S-J2	1881 ± 50	83.2 ± 2.9
S-J3	1936 ± 49	83.5 ± 1.7
S-J4	2033 ± 24	81.8 ± 1.2
Average – SSVA	1997 ± 125	83.1 ± 1.0
S-N1	2353 ± 5	82.1 ± 2.0
S-N2	2579 ± 53	80.0 ± 1.6
Average – NVA	2466 ± 200	81.1 ± 1.9
S-V1	1409 ± 4	78.7 ± 2.5
S-V2	2224 ± 19	83.5 ± 1.8
S-V3	2184 ± 64	84.3 ± 1.1
Average – ESVA	1939 ± 457	82.2 ± 3.3
S-S1	2506 ± 65	82.4 ± 3.2
S-S2	2526 ± 33	84.8 ± 2.4
Average – CSVA	2516 ± 18	83.6 ± 2.1

Average – SR	2297 ± 437	81.2 ± 3.7
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Legend: ^B – the contents of TP and values of AA are expressed as arithmetic average ± standard deviation

Our results are slightly higher than those published by Slezák (2007) and Čižmarová (2009), who found out values of AA in range 75.1 – 76.5 % inhibition of DPPH in slovak red wines – Saint Laurent. An average value was 75.6 % inhibition of DPPH, what ranks wine – Saint Laurent among varietal wines with medium values of AA from varietal wines made in Slovakia.

Statistical evaluation of our results showed that between antioxidant activity and total content of polyphenols there are highly significant negative (content of TP vs. AA: $r = -0.484$) correlations (at significance level $P < 0.01$), what is not in agreement with our expectations, while we assumed that with increasing content of polyphenols also antioxidant activity will increase /Fig 1/. These results are in agreement with the results of Slezák (2007) and Čižmariková (2009), similarly also with previous investigation of other authors (Roginsky et al., 2006; Giovanelli, 2005).

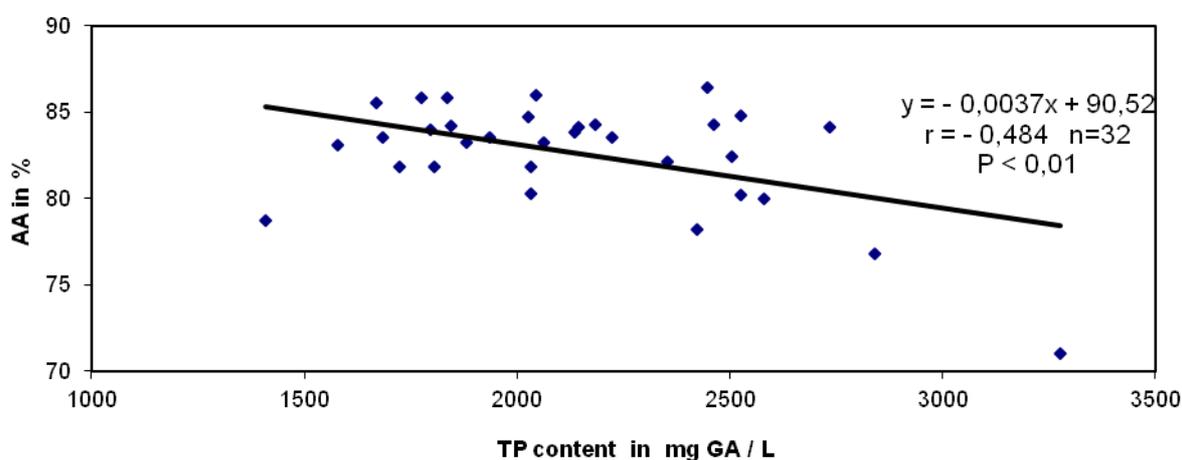


Figure 1 Linear regression between total polyphenols content and antioxidant activity values in wines

CONCLUSION

Last two decades biological effects of polyphenolic compounds have been intensively studied, especially due to their exceptional antioxidant properties. Moderate consumption of wine that contains a lot of polyphenolic compounds is beneficial to human

health and can help in prevention of many lifestyle diseases. Our work was focused on determination of total polyphenols content and antioxidant activity of two bestselling, varietal, red wines /Blaufränkisch and Saint Laurent/. The quality, bottled wines made in various vineyards regions of Slovakia were studied. Total polyphenols content in mentioned wines was in range from 1579 to 2734 mg.L⁻¹ (Blaufränkisch), and 1409 – 3276 mg.L⁻¹ (Saint Laurent), respectively and antioxidant activity in interval 80.2 - 86.4 % as inhibition of DPPH (Blaufränkisch), and 71.0 - 84.8 % inhibition of DPPH (Saint Laurent), respectively. Results showed statistically significant differences between studied antioxidant properties (total polyphenols content and antioxidant activity) in wines made in some vineyard areas of Slovakia. On the basis of statistical evaluation of our results we can state that among antioxidant activity and total content of antioxidatively acting substances there were highly significant negative correlations (content of TP vs. AA: $r = -0.484$). Our study revealed that our best-selling slovak, varietal, red wines have remarkable content of phenolic compounds and high antioxidant activity. Thus by adequate consumption of our red wines it is possible not only to prevent many diseases, but also to support slovak viticulture and viniculture with their products that can with their quality compete and surpass wines from abroad.

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