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COMPARISON OF THE CONTENT OF SELECTED MINERAL SUBSTANCES IN CZECH LITURGICAL AND COMMON WINES

Jiří Mlček, Sabina Trágeová, Anna Adámková, Martin Adámek,
Martina Bednářová, Soňa Škrovánková, Eva Sedláčková

ABSTRACT

The article deals with the content of selected mineral substances in Czech liturgical wines and compares them with common wines. Sulphur, phosphorus, boron, potassium, calcium, magnesium, iron, cadmium and lead were selected as evaluated minerals, and they were all found in all the analyzed varieties – Pinot Noir, Red Traminer and Chardonnay. Mineral substances were determined using a quadrupole mass spectrometer in the inductively coupled plasma variant of the Thermo Scientific ICAP Q ICP-MS. Generally, measured results did not show significant differences between the mineral content in liturgical and common wines. Therefore the influence of specific production technologies of liturgical wines on the mineral contents was not proved either. One of the highest mineral concentration was in communion Red Traminer, which, besides beneficial minerals, also contained a high amount of toxic elements. On the contrary, common Red Traminer had one of the lowest concentrations of toxic compounds. The content of permitted lead levels was exceeded in a single case, namely in the Chardonnay kosher sample. For cadmium, no sample exceeded the allowed limit.

Keywords: communion wine; kosher wine; mineral substances; mass spectrometry; cadmium

INTRODUCTION

Plutarch (c. 46 – c. 127), Greek writer, historian and philosopher said that, the wine is "the most useful of all beverages, the tastiest of all medications, and the most pleasant of all food". Wine has been used since time immemorial in various religious ceremonies for worshipping a deity in the ritual of a given church. For the Christian religion in the **Bible** the wine symbolizes the blood of Jesus Christ. According to the Torah, wine, along with bread, "gladdens the living" and "brings joy to the God and man" **(Torah, Psalm 104:15; Torah, Koheles 10:19; Torah, Pesachim 109a; Divecký, 2005; Bondyová and Sliva, 2008)**.

Liturgical wine, used for religious purposes, must meet the conditions of a particular religion and must be approved by a given ecclesiastical authority. The rules for the production of communion wine used in the Eucharist as the "blood of the Lord" for the Czech Republic are set up by the Czech Bishops' Conference **(Koudelka, 2010)**. The Congregation for Worship and the Sacrament states that, the communion wine must be only of natural origin, made from grapevine, unaltered, unmixed with other ingredients, chemically untreated, and according to the Czech Bishops' Conference, the grapes have to come from Bohemia or Moravia. Production is similar to organic farming. Other conditions include the prohibition of the use of additives such as dyes or flavorings, and at least 20 degrees of the sugar content of the grapes used. The content of alcohol in wine is not limited, so it may vary **(Železný, 2010)**.

In the Jewish religion, wine is used much more than in the Christian religion. For example, during Tu BiShvat, the feast of trees, it is obligatory to drink gradually white, pink, light red and a bold red wine **(Tvarůžek, 1948)**. On Purim, celebrating the rescue of the Jews in Persian exile by Queen Ester, the Talmud commands the orthodox Jew to get drunk so much to "not being able to distinguish Mordecai from Haman" (two adversaries). Wine is divided into several groups - cooked or pasteurized ("yayin mewushal"), uncooked or unpasteurised ("yayin lo mewushal"), wine for Pesach, which must not come in contact at all with grain, bread or dough, and wine "mehadrin" for ultra-orthodox Jews **(Nádeníčková, 2014)**. In order to preserve kosher quality, the wine must not be touched or opened by a non-Jew, except for the boiled wine. Strict rules also apply to the cultivation and processing of such wine, e.g. the vineyard is left to rest every seventh year (sabbatical year) as commanded in the Third Book of Moses.

Wine is an interesting source of biologically active substances, such as polyphenols, antioxidants and minerals **(Bajčan et al., 2016; Škrovánková et al., 2017)**. The soil and its geological origin, the fertilization, the variety, the weather in the given year and the processing technology all have a great influence on the content of minerals in grapes and wine. The influence of nutrition in the conditions of a particular vineyard is also significant. The roots of the vine receive minerals with water from the soil. The mineral content of the must is reduced by their crystallization, precipitation and utilization by yeasts **(Jedlička, Novotná, et Valšíková, 2014)**. The total amount of minerals determined as the ash content in the wine is 1500 – 4000 mg.L^{-1} **(Steidl, 2010)**. Sulphur, phosphorus, boron, potassium, calcium and magnesium are the basic minerals evaluated in this article. Harmful for the aroma, color and taste of the wine are mainly iron, copper, nickel, tin, aluminium, zinc and toxic metals. This work focused on iron and toxic metals - arsenic, chromium, lead and cadmium. Mass spectrometry was used to determine them. Mass spectrometry methods used for analyzing elements in the wine can detect not only the content of individual elements, but also determine the authenticity of the wine or the dilution of the wine with water **(Čížková et al., 2012)**.

Scientific hypothesis

Scientific hypothesis is: The content of the selected minerals evaluated by the mass spectrometry is different in Czech liturgical and common wines.

The aim of the work was to compare the content of selected minerals in Czech liturgical and common wines. The samples were chosen with regard to the comparability of vintage, sub-area and special attributes.

MATERIAL AND METHODOLOGY

Wine samples

To analyze the selected minerals in the communion wines, Pinot Noir and Red Traminer was chosen. Chardonnay was used to compare the minerals in kosher wine. For each variety, 2 samples of common wine and 2 samples of liturgical wine were tested. Samples were chosen to ensure the highest comparability possible (vintage, sub-area and attribute), but different producers.

Due to the difficulty of acquiring the comparable samples, their gathering took 15 months. Samples were bought gradually in the common market, specialized wine shops and directly from the producers. Two bottles of each wine were bought and analyzed. The samples in **Table 1** were tested.

Chemicals

There were used:

- HNO_3 p. a., Mr. 63.01, Penta, Praha, CZ,
- Deionized water, 18.2 MOhm.cm, Millipore.

All chemicals were of analytical reagent grade or equivalent analytical purity.

Evaluation of the mineral content

The quadrupole mass spectrometer in an inductively coupled plasma variant of Thermo Scientific iCAP Q ICP-MS (Thermo Scientific, MA, USA) was used to determine the mineral elements. The device is computer controlled by Thermo Scientific ™ Qtegra ™ Intelligent Scientific Data Solution ™ (ISDS) platform software (Thermo Scientific, MA, USA).

1 mL of sample with 1 mL of nitric acid was put into a 100 mL volumetric flask and refilled up to the mark with pure deionized water. For each sample the measurement was repeated 3 times. The content of individual elements is expressed in mg.L^{-1}.

Statistical analysis

The data were analyzed using Excel 2013 (Microsoft Corporation, USA) and STATISTICA Cz version 12 (StatSoft, Inc., USA). Results were expressed by average ± standard deviation. Comparison of the results was

Table 1 Wine origin and category.

Sample	Category	Vintage	Sub-area, village, track	Quality
Pinot Noir				
PN1	M	2012	Znojemská, Stošíkovice na louce, U tří dubů	VB
PN2	M	2012	Velkopavlovická, Havraníky, Staré vinice	VH
PN3	B	2012	Znojemská, Miroslavské Knínice, Stará hora	VH
PN4	B	2012	Velkopavlovická, Velké Bílovice	VH
Red Traminer				
TR1	M	2013	Velkopavlovická	VH
TR2	M	2013	Znojemská, Stošíkovice na louce, U tří dubů	VH
TR3	B	2013	Znojemská, Bzenec,	PS
TR4	B	2013	Znojemská, Sedlec, Nad Nesytem	PS
Chardonnay				
CH1	K	2010	Izrael, Samson	Q
CH2	K	2011	Slovácká, Hýsly / Moštěnsko	PS
CH3	B	2010	Mikulovská, Perná, Purmice	PS
CH4	B	2011	Znojemská, Bzenec,	VH

Note: K – kosher wine, M – communion wine, B – common wine, VB – special selection of berries, VH – special selection of grapes, PS – Late harvest, Q - quality.

performed using a Kruskal-Walllis test (α = 0.05). The samples of individual varieties were compared to each other. Furthermore, all samples of individual varieties of liturgical wines were compared against common wines.

RESULTS AND DISCUSSION

Sulphur

The sulphur content in the wine may range from 400 to 1000 mg.L^{-1}. The greatest amount of sulphur comes into the wine in the form of sulphur dioxide during the sulfation of the must or wine. The first references regarding the use of antimicrobial effects of sulphur are found not only in the Bible, but also in Greek and Roman literature **(Amâncio et al., 2009)**. Furthermore, sulphur can be found in the wine as a residue of nitrogenous or magnesium fertilizers in the form of sulphates.

In Pinot Noir the sulphur content varied between 60.30 ±1.62 mg.L^{-1} and 62.69 ±3.26 mg.L^{-1}. Red Traminer contained 66.05 ±1.79 mg.L^{-1} to 69.14 ±3.63 mg.L^{-1}. In Chardonnay the values ranged from 66.97 ±0.51 mg.L^{-1} to 71.24 ±5.83 mg.L^{-1} of sulphur. Other results are shown in **Table 2**. There was no statistically significant difference (p >0.05) in sulphur content between liturgical and common wines. No statistically significant difference was found either between individual samples of individual varieties (p >0.05).

According to **Annex IB of the Commission Regulation (EC) No 606/2009** of 10 July 2009, laying down certain detailed rules for implementing Council Regulation (EC) No 479/2008 as regards the categories of grapevine products, oenological practices and the applicable restrictions, the maximum content of SO_2 in red wine is 150 mg.L^{-1} and 200 mg.L^{-1} in white wine. For selected Czech wines with special attributes, there is an exception for up to 400 mg.L^{-1} (special election of berries, special selection of botrysided berries, ice wine or straw wine).

In this research, the content of sulphur varied from 60.30 mg.L^{-1} to 71.24 mg.L^{-1}. **Sandler et al. (2003)** states, that to make the sulfation effective, the dose must be high enough to ensure the content of SO_2 in the final product at least 30 mg.L^{-1}. Doses higher than 70 – 80 mg.L^{-1} are not recommended because of influencing the taste properties of wine. This was the case of the sample CH2, which may be considered slightly too much sulfated, which can influence its taste properties. There is no other significant difference between liturgical or common wines.

Phosphorus

Phosphorus is one of the key elements for cultivating grapevine. It gets into the soil as a part of phosphate fertilizers. However, it is also included in the soil as a part of the parent rocks. This mineral is found in the wine both in inorganic and organic forms, such as glycerofosphates, phosphorus esters or pectin compounds. Another important role of phosphorus is during the fermentation, when it is utilized by yeast. There are soils rich in phosphorus in the Czech Republic. The content of phosphorus in wine is from 60 mg.L^{-1} to 1000 mg.L^{-1} **(Fic, 2015)**.

In Pinot Noir the content of phosphorus varied from 982.39 ±19.57 mg.L^{-1} to 1389.32 ±5.27 mg.L^{-1}. Red Traminer had the value of 974.89 ±5.69 mg.L^{-1} to 1460.46 ±27.07 mg.L^{-1}. For Chardonnay the content of phosphorus was from 862.20 ±20.46 mg.L^{-1} to 1493.15 ±25.51 mg.L^{-1}. Unlike with sulphur, a statistically significant difference (p <0.05) in the content of phosphorus was found between samples of liturgical and common wines for all the varieties analyzed. Comparison of the individual samples of the different varieties revealed a statistically significant difference (p <0.05) for the Pinot Noir variety samples PN2 and PN4, for the Red Traminer variety between TR1 and TR4 samples and for the

Table 2 The content of selected mineral substances (boron, magnesium, phosphorus, sulphur, potassium) in czech liturgical and common wines (Pinot Noir, Red Traminer, Chardonnay) in mg.L^{-1}.

Sample	Boron		Magnesium		Phosphorus		Sulphur		Potassium	
	M	SD	M	SD	M	SD	M	SD	M	SD
Pinot Noir										
PN1	84.86	2.24	2335.60	17.10	1342.86	23.97	61.47	2.51	20494.84	440.7
PN2	105.46	1.20	2428.03	38.92	1389.32	5.27	60.49	1.35	12052.24	251.4
PN3	83.23	1.15	2462.59	0.85	1329.18	10.92	62.69	3.26	15373.05	144.3
PN4	99.63	1.40	2569.93	67.84	982.39	19.57	60.30	1.62	18051.27	523.3
Red Traminer										
TR1	107.87	0.37	3064.03	31.32	1460.46	27.07	66.05	1.79	17927.10	183.0
TR2	79.98	1.30	2147.20	23.20	1417.65	9.52	68.75	2.32	7081.77	69.4
TR3	71.26	0.93	2122.85	17.22	1251.15	7.22	69.14	3.63	9561.64	53.7
TR4	76.96	1.25	2338.48	30.10	974.89	5.69	67.48	2.44	6658.59	149.3
Chardonnay										
CH1	66.49	0.83	2463.27	11.56	1493.15	25.51	69.51	1.54	4148.21	67.0
CH2	83.42	1.08	1949.67	15.77	1087.55	22.60	71.24	5.83	10367.63	135.2
CH3	77.98	1.49	2147.99	14.12	1075.18	5.63	70.04	1.80	9439.80	57.1
CH4	151.24	0.34	2055.87	47.88	862.20	20.46	66.97	0.51	9115.07	238.1

Chardonnay variety between CH1 and CH4 samples. No statistically significant difference was found between the other samples (p >0.05).

Table 2 shows different content of phosphorus in wine samples, ranging from 862.20 mg.L^{-1} to 1493.15 mg.L^{-1}. In liturgical wine the content is higher than in the common wine. The reason may be the using of phosphate fertilizers in some vineyards, or the high concentration in Czech soils. However, the results are higher than the range stated by **Fic (2015)**.

Boron

Boron is a very important microelement in grapevine nutrition. It participates in pollination, fertilization of inflorescences, photosynthesis and transport of glycides. Its content is lower in toxic or calcareous soils. It is most commonly found in the form of boric acid, which content in wine can be 10 – 120 mg.L^{-1} **(Fic, 2015)**.

In Pinot Noir the content of boron was between 83.23 ±1.15 mg.L^{-1} and 105.46 ±1.20 mg.L^{-1}. Red Traminer contained from 71.26 ±0.93 mg.L^{-1} to 107.87 ±0.37 mg.L^{-1}. In Chardonnay the content of boron varied from 66.49 ±0.83 mg.L^{-1} to 151.24 ±3.44 mg.L^{-1}. A statistically significant difference (p <0.05) in the content of boron was found between samples of liturgical and common wines in the Red Traminer variety. Comparison of the individual samples of the different varieties revealed a statistically significant difference (p <0.05) between PN2 and PN3 samples of the Pinot Noir, between TR1 and TR3 samples of Red Traminer and between CH1 and CH4 samples of Chardonnay. No statistically significant difference was found between the other samples (p >0.05).

The content of boron in wines was 66.49 – 151.24 mg.L^{-1}, as can be seen in the **Table 2**. **Fic (2015)** states the content of boron is influenced by calcareous and toxic soils. It was supposed, that due to the contamination of soil with toxic elements and the high content of calcium in the soil within the observed area, the content of boron would be lower. Despite this fact, the content of boron is approaching rather the upper limits of the range 10 – 120 mg.L^{-1}, or even exceeds it (in the last sample).

Potassium

Potassium plays an important role in the exchange of K^+ ionts for H_3O^+ oxonium ionts and it is quite mobile in the soil. The grape vine is most absorbing it during the lush growth. It occurs in must mostly as potassium hydrogen tartrate or potassium sulphate. Higher quantities occur in red wines and varieties of dry white wines such as Chardonnay or Pinot Blanc. During ripening, its concentration in grapes increases in relation to the accumulation of sugars. Potassium also affects the acid content and the pH of must and wine. This mineral element softens the taste of the wine, and its higher quantity can also indicate the age of the wine. Low-potassium wines taste sour and bitter. By precipitating "wine stone" (potassium hydrogen tartrate) through fermentation the potassium content can be reduced by up to 1000 mg.L^{-1}. Wines contain potassium in the range of 160 – 2500 mg.L^{-1} **(Fic, 2015)**.

In Pinot Noir the potassium content ranged within 1205.22 ±25.14 mg.L^{-1} and 2049.48 ±44.07 mg.L^{-1}. Red Traminer contained from 665.86 ±14.93 mg.L^{-1} to 1792.71 ±18.30 mg.L^{-1} of potassium. In Chardonnay the level of potassium was between 414.82 ±6.70 mg.L^{-1} and 1036.76 ±13.52 mg.L^{-1}. For potassium, no statistically significant difference (p >0.05) was found between the liturgical and common wines. Comparison of the individual samples of different varieties revealed a statistically significant difference (p <0.05) between the PN1 and PN2 samples of Pinot Noir, between the TR1 and

Table 3 The content of selected mineral substances (calcium, iron, cadmium, lead) in czech liturgical and common wines (Pinot Noir, Red Traminer, Chardonnay) in mg.L^{-1}.

Sample	Calcium		Iron		Cadmium		Lead	
	M	SD	M	SD	M	SD	M	SD
				Pinot Noir				
PN1	771.24	10.95	3.54	0.11	0.0036	0.0002	0.0289	0.0004
PN2	1177.55	7.81	9.33	1.65	0.0047	0.0001	0.0965	0.0019
PN3	1194.80	10.51	13.35	1.11	0.0034	0.0006	0.0369	0.0010
PN4	1069.77	23.87	13.06	0.17	0.0023	0.0001	0.0259	0.0005
				Red Traminer				
TR1	1872.26	20.01	18.32	0.52	0.0056	0.0001	0.1387	0.0009
TR2	1152.93	12.81	9.84	0.09	0.0064	0.0003	0.1115	0.0021
TR3	1282.98	17.50	9.81	0.32	0.0051	0.0004	0.0815	0.0010
TR4	691.03	8.70	12.39	0.43	0.0059	0.0005	0.1025	0.0012
				Chardonnay				
CH1	1048.66	14.01	10.05	0.21	0.0101	0.0011	0.0371	0.0011
CH2	1091.78	4.82	9.43	0.17	0.0023	0.0001	0.0557	0.0009
CH3	833.32	2.25	9.50	0.21	0.0033	0.0004	0.0713	0.0009
CH4	1063.36	12.85	6.80	0.03	0.0076	0.0008	0.1054	0.0023

TR4 samples of Red Traminer and between the CH1 and CH2 samples of the Chardonnay variety. No statistically significant difference was found between the other samples (p >0.05).

Table 2 shows the content of potassium in samples, which was between 414.82 mg.L^{-1} and 2049.48 mg.L^{-1}. The concentration of potassium in wine reflects its content in the final stages of berry ripening, which may explain the big difference between the values. High potassium levels affect the stability of the wine with regard to its precipitation in the form of potassium hydrogen tartrate. Higher levels of potassium, especially in the formation of these crystals, may indicate the age of the wine. This aspect was relatively well observable in red wines, which were 4 years old at the time of measurement. As stated by **Stafilov and Karadjova (2009)**, red wines usually have higher content of potassium than white wines. This is suggested also in this research (**Table 2**). The results are within the range declared by **Fic (2015)**.

Calcium

Calcareous soils are very abundant in the Czech Republic‘s wine-growing sub regions, thus the Czech wines contain enough calcium. However, excess calcium in the soil may result in chlorosis of the vine. Calcium has a positive influence on the taste and aroma of the wine. The amount of calcium increases when deacidated. It must also be expected that it will "fall out" in the form of calcium hydrogen tartrate. The wine may be in the range of 100 – 220 mg.L^{-1} **(Fic, 2015)**.

In Pinot Noir the calcium content was between 771.24 ±10.95 mg.L^{-1} and 1194.80 ±10.51 mg.L^{-1}. Red Traminer contained from 691.03 ±8.70 mg.L^{-1} to 1872.26 ±20.01 mg.L^{-1} of calcium. In Chardonnay the values ranged between 833.32 ±2.25 mg.L^{-1} and 1091.78 ±4.82 mg.L^{-1} of calcium. There was no statistically significant difference (p >0.05) in the content of calcium between the liturgical and common wine. Comparison of the individual samples of each of the varieties revealed a statistically significant difference (p <0.05) between the PN1 and PN3 samples of Pinot Noir, between the TR1 and TR4 samples of the Red Traminer, and between the CH2 and CH3 samples of Chardonnay. No statistically significant difference was found between the other samples (p >0.05).

Content of calcium in wine was between 691.03 mg.L^{-1} and 1872.26 mg.L^{-1}, as shown in **Table 3**. Higher content of calcium in TR1 sample can be caused by long term storage in concrete tanks, where the calcium could permeate from the walls into the wine. This was mentioned by **Jackson (2008)**. High level of calcium can cause crystal formation in the wine. The results are highly above the values declared by **Fic (2015)**. This may be due to the difference between values declared by different authors. E.g. **Rupasinghe and Clegg (2007)** declared the content of calcium 620 mg.L^{-1}.

Magnesium

Magnesium’s most important role is as the part of chlorophyll. This mineral may be deficient in calcareous and sandy soils. In high concentration, magnesium may cause bitter taste of the wine. Wine can content 50 – 2000 mg.L^{-1} of magnesium **(Fic, 2015)**.

In Pinot Noir the content of magnesium varied from 2335.60 ±17.10 mg.L^{-1} to 2569.93 ±67.84 mg.L^{-1}. Red Traminer contained between 2122.85 ±17.22 mg.L^{-1} and 3064.03 ±31.32 mg.L^{-1}. Chardonnay contained from 1949.67 ±15.77 mg.L^{-1} to 2463.67 ±11.56 mg.L^{-1} of magnesium. For magnesium, a statistically significant difference (p <0.05) was found between samples of liturgical and common wines only for the Pinot Noir variety. Comparison of the individual samples of the different varieties revealed a statistically significant difference (p <0.05) between the samples PN2 and PN4 of Pinot Noir, between the TR1 and TR4 samples of Red Traminer and between the CH1 and CH4 samples of the Chardonnay variety. No statistically significant difference was found between the other samples (p >0.05).

Table 2 shows different magnesium content in wine samples, which varied from 1949.67 mg.L^{-1} to 3064.03 mg.L^{-1}. As declared by **Avram et al. (2014)** the level of magnesium depends on the similar conditions as potassium, and it is possible to claim that, the content of magnesium could correlate with content of potassium. This can be supported by comparison of the **Table 2**. Higher level of magnesium can also indicate the use of the different fertilizers and production processes. Furthermore, the samples come from areas known to be rich in magnesium. All of the above may be the reason why the results are not within the range stated by **Fic (2015)**.

Iron

This mineral causes turbidity, thus the higher concentration of iron in wine is undesirable. It can be removed by clarifying (fining), but the content can significantly increase due to contact with iron tools during processing or storage. In Czech Republic the iron occurs especially in soils in Znojmo and Brno Districts. The content is around 0.3 – 10 mg.L^{-1} **(Kraus, 1999)**.

In Pinot Noir the iron content ranged from 3.54 ±0.11 mg.L^{-1} to 13.35 ±1.11 mg.L^{-1}. Red Traminer contained between 9.81 ± 0.32 mg.L^{-1} and 18.32 ±0.52 mg.L^{-1} of iron. Content of iron in Chardonnay varied from 6.80 ±0.03 mg.L^{-1} to 10.05 ±0.21 mg.L^{-1}. A statistically significant difference (p <0.05) in the content of iron was found between samples of liturgical and common wines only for the Pinot Noir variety. Comparison of the individual samples of all the varieties revealed a statistically significant difference (p <0.05) for the Pinot Noir variety between the samples PN1 and PN4 and for the Chardonnay variety between samples CH1 and CH4. No statistically significant difference was found between the other samples (p >0.05).

Iron level in samples was 3.54 – 18.32 mg.L^{-1}, as shown in **Table 3**. The significantly higher content of iron in the sample of white communion wine could be the result of wine contact with a corroded winery device. Besides causing turbidity, the higher iron content can catalyze oxidative reactions, e.g. conversion of ascorbic acid to dehydroascorbic acid, or cause wine browning. Higher iron content may also promote polymerization of phenolic compounds with acetaldehyde, as reported by **Jackson (2008)**. Analyzed samples of the common red wines, first white communion wine and the second white communion wine can be considered problematic for long-term storage regarding the higher content of iron. The results are within the range declared by **Kraus (1999)**.

Cadmium

Cadmium occurs in nature as a part of the minerals and organic compounds of the soil solution. In Czech soil the common content is 0.2 – 1.5 $mg.kg^{-1}$ soil. During the last 150 years its content has increased by 55 %. The main limiting factor for cadmium content in the soil is the chemical composition of the mother rock. High doses of cadmium can damage soil microflora **(Fic, 2015)**.

The content of cadmium in Pinot Noir was between 0.0023 ±0.0001 $mg.L^{-1}$ and 0.0047 ±0.0001 $mg.L^{-1}$. Red Traminer contained from 0.0051 ±0.0004 $mg.L^{-1}$ to 0.0064 ±0.0003 $mg.L^{-1}$ of cadmium. The content of cadmium in Chardonnay varied from 0.0023 ±0.0001 $mg.L^{-1}$ to 0.0101 ±0.0011 $mg.L^{-1}$. A statistically significant difference ($p < 0.05$) in the content of cadmium was found between samples of liturgical and common wines only for the Pinot Noir variety. Comparison of the individual samples of the different varieties revealed a statistically significant difference ($p <0.05$) for the Pinot Noir variety between the samples PN2 and PN4, for the Red Traminer variety between the TR2 and TR3 samples and for the Chardonnay variety between the CH1 and CH2 samples. No statistically significant difference was found between the other samples ($p >0.05$).

Table 3 shows the content of cadmium in wine samples, which was between 0.023 $mg.L^{-1}$ and 0.0101 $mg.L^{-1}$. In the first kosher wine and the second common wine (Chardonnay) the content of cadmium was higher than in the rest of the samples. This may be due to the air pollution, postfermental contamination or the contact of wine with stainless steel during the process, as declared by **Dehelean and Voica (2012)** and **Stafilov and Karadjova (2009)**. OIV (International Organization of Vine and Wine) set the limit of cadmium in wine 0.01 $mg.L^{-1}$. All analyzed samples fulfilled this requirement.

Lead

The natural lead content in the soil is 2 – 300 mg per kilogram of soil in the form of Pb_2^+ in acidic igneous rocks. As a result of anthropogenic activity, the amount of lead in the soil increases above the limit value set by the Ministry of Agriculture **(Fic, 2015)**.

In Pinot Noir the content of lead ranged from 0.0259 ±0.0005 $mg.L^{-1}$ to 0.0965 ±0.0019 $mg.L^{-1}$. Red Traminer contained between 0.0815 ±0.0010 $mg.L^{-1}$ and 0.1387 ±0.0009 $mg.L^{-1}$ of lead. In Chardonnay the content of lead varied among 0.0371 ±0.0011 $mg.L^{-1}$ and 0.1054 ±0.0023 $mg.L^{-1}$. For lead, a statistically significant difference ($p <0.05$) was found between samples of liturgical and common wines only for the Red Traminer and Chardonnay. Comparison of the individual samples in the different varieties revealed a statistically significant difference ($p <0.05$) for the Pinot Noir variety between the samples PN2 and PN4, for the Red Traminer variety between the TR1 and TR3 samples, and for the Chardonnay variety between the CH1 and CH4 samples. No statistically significant difference was found between the other samples ($p >0.05$).

The range of lead content in the samples was 0.0259 – 0.1387 $mg.L^{-1}$, as shown in **Table 3**. Lead is a contaminant that could get into the wine from the soil. The most frequent reasons are emissions, agricultural chemicals and industrial pollution. In the more traditional manufacturers the contamination may be caused by brass fittings and faucets that wine comes into contact with during the secondary fermentation. In rare cases, due to long-term storage in crystal containers that release lead into the wine. This is also declared by **Jackson (2008)**. Although lead is a toxic metal, it precipitates together with other metals and is excluded during fermentation with turbidities. The OIV set the lead content in wine to 0.15 $mg.L^{-1}$ **(OIV, 2016)**. All analyzed sample meet this criteria.

CONCLUSION

This study dealt with content of mineral substances in communion and kosher wines, compared to content in common wines. Generally, mass spectrometry analysis did not prove that the liturgical wines have better composition regarding the mineral content than the common wines. A statistically significant difference between samples of liturgical and common wines was found in only one third of the analyzed samples. A statistically significant difference between the samples of individual varieties was proved in only one sample of the whole set for the individual variety. There was no statistically significant difference between the other samples. Therefore, this study demonstrates that no significant influence of the specific technology of the production of liturgical wines has been proved for the selected samples. Communion wine Red Traminer (sample TR1), had one of the highest content of beneficial minerals, but also contained high amounts of toxic elements, which however, did not exceed any legally set limit. On the contrary, the limit for lead content was exceeded in a single case, by Chardonnay kosher (sample CH1). None of the samples exceeded the limit for cadmium. It would be suitable to conduct further research on this issue, as the up to date sources or analyses, which would cover this issue with complexity, is scarce.

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Contact address:

Jiří Mlček, Tomas Bata University in Zlin, Faculty of Technology, Department of Food Analysis and Chemistry, Vavreckova 275, 760 01 Zlin, Czech Republic, E-mail: mlcek@ft.utb.cz

Sabina Trágeová, Tomas Bata University in Zlin, Faculty of Technology, Department of Food Analysis and Chemistry, Vavreckova 275, 760 01 Zlin, Czech Republic

Anna Adámková, Tomas Bata University in Zlin, Faculty of Technology, Department of Food Analysis and Chemistry, Vavreckova 275, 760 01 Zlin, Czech Republic, E-mail: aadamkova@ft.utb.cz

Martin Adámek, Brno University of Technology, Faculty of Electrical Engineering and Communication, Department of Microelectronics, Technická 3058/10, 616 00 Brno, Czech Republic, E-mail: adamek@feec.vutbr.cz

Martina Bednářová, Mendel University in Brno, Department of Information Technology, Zemědělská 1, 613 00 Brno, Czech Republic, E-mail: bednarova@mendelu.cz

Soňa Škrovánková, Tomas Bata University in Zlin, Faculty of Technology, Department of Food Analysis and Chemistry, Vavreckova 275, 760 01 Zlin, Czech Republic, E-mail: skrovankova@ft.utb.cz

Eva Sedláčková, Tomas Bata University in Zlin, Faculty of Technology, Department of Food Analysis and Chemistry, Vavreckova 275, 760 01 Zlin, Czech Republic, E-mail: sedlackova@ft.utb.cz