THE EFFECT OF LOCALITY ON THE GRAPE POMACE MINERAL CONTENT FROM THE DIFFERENT LOCATIONS OF SLOVAKIA

Milan Šimko*, Daniel Bíro, Branislav Gálik, Miroslav Juráček, Michal Rolinec, Ondrej Hanušovský

Department of Animal Nutrition, Faculty of Agrobiology and Food Resources, Slovak University of Agriculture in Nitra, Trieda A. Hlinku 2, 949 76 Nitra

Abstract

In general, grape pomace is known as good source of nutrients with higher antioxidant activity but higher concentration of lignin that can affect the digestion of nutrients. However, there is lack of experiments, that are focused on mineral content of grape pomace. Thus, the aim of the research was to compare the concentration of minerals in Pinot Blanc (Vitis vinifera sp.) pomace from two different localities of Slovakia (Vinohrady nad Váhom and Oponice). In the samples content of macroelements - calcium (Ca), phosphorus (P), magnesium (Mg), sodium (Na), potassium (K) and microelements - copper (Cu), iron (Fe), manganese (Mn), and zinc (Zn) were examined. In the case of macroelements statistically significant differences in Ca (19.21%; $p<0.01$), Na (43.78; $p<0.01$) and K (14.36, $p<0.01$) were found. Then, large differences was also in the concentration of Fe (29.54%; $p<0.01$) and Zn (43.35%; $p<0.01$). From the point of nutritional view are monitored rations between the Ca, P, Mg, K and Na. In this experiment differences in the ratio of Ca:P, Ca:Mg and K:Na were found. In general, it can be concluded that grape pomace is good source of macrolements and microelements - mainly K, Ca and Fe.

Keywords: *by-products, grape, macroelements, microelements, analysis*

1. INTRODUCTION

Increased efforts are now being directed towards a broader revaluation of polyphenol-rich residues from wine processing for obtaining high value by-products (grape pomace, seeds, skin and polyphenols) (Brenes et al., 2016). Ivanišová et al. (2018) found high antioxidant activity in grape samples with high content of total polyphenols. Samples reveal that the nutritional composition varies widely, depending on the variety of grape, the location and the conditions of fertilization (Brenes et al., 2016). Also, the proportion of seeds and pulps determinate the nutritive value of grape pomace (Guerrera-Rivas et al., 2016). The mineral content of grape seeds prior to the winemaking process and wine manufacturing residues has been shown to be an important source of nutrients and essential elements (Lutterodt et al., 2011). Minerals in grapes are usually classified in groups depending on their mobility in phloem. Potassium, phosphorus, sulfur, and magnesium show high mobility and are accumulated and mainly localized in the skin of the grape berry during ripening. In consequence, grape skins present higher levels than grape seeds, mainly due to their high content of potassium salts localized in grape skins, specifically in the hypodermal cells (Rogiers et al., 2006). In contrast, seeds are the strongest reservoir of calcium, phosphorus, sulfur, and magnesium (Coombe 1987; Gül et al., 2013; García-Lomillo et al., 2014). Grape pomace has been recommended mainly for ruminants as a fiber source to meet ruminants maintenance requirements (Baumgärtel et al., 2007) but the present study has shown that GP has moderate protein, crude fat and some minerals (potassium, calcium, phosphorus, copper, iron and sulfur), thus makes it a potentially good source of these nutrients for ruminants (Chikwanha et al. 2018). Dairy cattle require high levels of trace elements for milk production, and deficiencies in these elements are therefore more prevalent in organic dairy farming. Moreover, the lack of trace element supply will affect the health of the cattle and also lead to production of milk containing low levels of minerals (Blair, 2011). All nutrients including minerals have important role and may be the limited factor of successful breeding (Skalicka and Maskalova, 2013). Repeatedly, dairy cows may suffer events of hypocalcemia and hypomagnesemia, commonly known as milk fever and tetany. About 50% of cows in their second lactation and greater have blood Ca concentrations that fall below the threshold for subclinical hypocalcemia after calving (Reinhardt et

al., 2011). Moreover, trace minerals are critical for immune function, oxidative metabolism, nutrition and energy metabolism, and reproductive function in dairy cows (Spears and Weiss, 2008). Thus, several researches shown the good nutritional potential and mineral content of grape pomace addition, which can be affected by locality, the aim of the study was to compare mineral concentration of Pinot Blanc (*Vitis vinifera sp.*) pomace from two different localities of Slovak Republic.

2. MATERIALS AND METHODS

2.1. Materials

In overall, 8 dry grape pomace samples of Pinot blanc variety (*Vitis vinifera sp*.) from two different localities of Slovakia (Oponice and Vinohrady nad Váhom) were collected. After that, grape pomace characterised as a result of winemaking industry after juice pressing in Laboratory of Quality and Nutritive Value of Feeds at Department of Animal Nutrition, Faculty of Agrobiology and Food Resources, Slovak University of Agriculture in Nitra were analysed. Thus, grape pomace as a grape skin, seeds and bulbs was characterised as an analysed material.

2.2. Methods

After transportation to the Laboratory of quality and nutritional value of feeds of the Department of Animal Nutrition at the Slovak University of Agriculture in Nitra were samples prepared for nutrition analysis in accordance to standard analytical laboratory methods. The contents of mineral nutrients were determined by High Resolution Continuum Source Atomic Absorption Spectrometer ANALYTIK JENA contrAA 700 (Ca, Mg, Na, K, Zn, Cu, Fe, Mn) and 6400 Spectrophotometer (P). The determination of individual element content was based on the absorptions measured at the following wavelengths: Ca content was detected at 422.7 nm, P at 666 nm, Mg at 285.2 nm, Na at 589.0 nm, K at 766.5 nm, Zn at 213.9 nm, Cu at 324.7 nm, Fe at 248.3 nm and Mn at 279.5 nm.

2.2.1. Statistical analysis of results

Results were statistically evaluated with IBM SPSS v. 20.0. Descriptive statistics using One-way ANOVA were generated. Then, statistical significance of results were separated using Independent samples T-test.

3. RESULTS

In overall, the concentration of minerals in Location 2 was higher in comparison with Location 2 (Table 1). For example, difference between the locations in the Ca concentrations was 19.21% ($p<0.05$). On the other side, higher concentrations of P (0.94%) in the case of Location 1 were determined, but it was only one mineral, that was higher in Location 1 compared to Location 2. Smaller and statistically nonsignificant differences between the locations in the content of Mg (0.41%) were found. However, the Na concentrations difference between the locations was the largest among the minerals and statistically significant (43.78%, $p<0.05$). On the other side, difference between locations in the content of K was smaller (14.36%, $p<0.05$), but still statistically significant. Nonsignificant difference between the locations was found in the content of Cu, where in the Location 1 lower concentrations (6.56%) of Cu compared to Location 2 was found. Then, larger difference between the locations in the content of Fe was found. Moreover, this difference was larger (29.54%, $p<0.05$) in comparison with other minerals and statistically significant. On the other hand, in the concentration of Mn lower content of Mn by 8.55 % in Location 1 was found. However, the difference in the Zn concentrations was one of the largest (43.35%, $p<0.05$) and statistically significant. Different content of minerals between the locations resulted in differences between the minerals ratio. For example, the ratio between the Ca:P was widest in Location 2 (1 : 1.39 vs. 1 : 1.74). Wider ratio, but still larger in the Location 2 in the case of Ca:Mg was observed (1 : 3.71 vs. 1 : 4.58). In contrary, the ratio between K:Na in the Location 2 narrower in comparison with Location 1 (1 : 49.59 vs. 1: 32.55).

Table 1. Mineral composition of grape pomace from 2 different locations of Slovakia

Nutrient in mg.kg-1	Location								P*
	1				2				
	x	SD	min	max	x	SD	min	max	
Ca	4457.50	102.43	4330.00	4550.00	5517.50	322.63	5150.00	5840.00	0.00
P	3210.00	69.28	3150.00	3270.00	3180.00	326.80	2910.00	3570.00	0.86
Mg	1200.00	58.31	1140.00	1250.00	1205.00	54.47	1140.00	1250.00	0.90
Na	260.00	8.16	250.00	270.00	462.50	181.91	300.00	620.00	0.07
K	12892.50	85.00	12850.00	13020.00	15055.00	365.29	14660.00	15500.00	0.00
Cu	13.24	1.74	11.68	14.85	14.17	0.93	13.26	15.39	0.38
Fe	68.22	2.55	66.17	71.82	96.82	1.51	95.97	99.07	0.00
Mn	11.44	0.10	11.35	11.58	12.51	1.46	11.00	14.01	0.19
Zn	16.42	2.11	14.34	18.24	28.99	3.62	24.84	32.03	0.00

Abbreviations: $mg.kg^{-1}$ - milligram per 1 kilogram of DM, x - mean, SD - standard deviation, min - minimal value, max - maximal value, P* - statistical significance (independent sample T-test), Ca - Calcium, P - Phosphorus, Mg - Magnesium, Na - Natrium, K - Potassium, Cu - Copper, Fe - Iron, Mn - Manganese, Zn - Zinc

As is shown in the Figure 1, location did not have strong effect on the proportions of minerals. In both localities, the largest ratio of minerals in ash was in the case Na (58.26 and 58.87%). Then, the second largest ratio in K content was determined. However, the ratio of Ca 1(14.51 vs. 12.44%) and P (5.42 vs. 4.71%) was higher in the Locality 1 in comparison with Locality 2. On the other side, higher ratio of Mg (1.17 vs. 1.81%) and microminerals (0.49 vs. 0.60%) in Locality 2 was found. From microminerals, the highest ratio of microminerals by Fe content was formed in both localities (62.40 and 63.49%). Then, the second highest ratio from microminerals in the case of Zn was found, with higher ratio in Locality 2. In contrary, higher ratio of Cu in Locality 1 (12.11%) compared to Locality 2 (9.29%) was observed. The lowest ratio of microminerals by Mn in both localities was formed. However, the ratio of Mn was higher in Locality 1 (10.46%) in comparison with Locality 2 (8.20%).

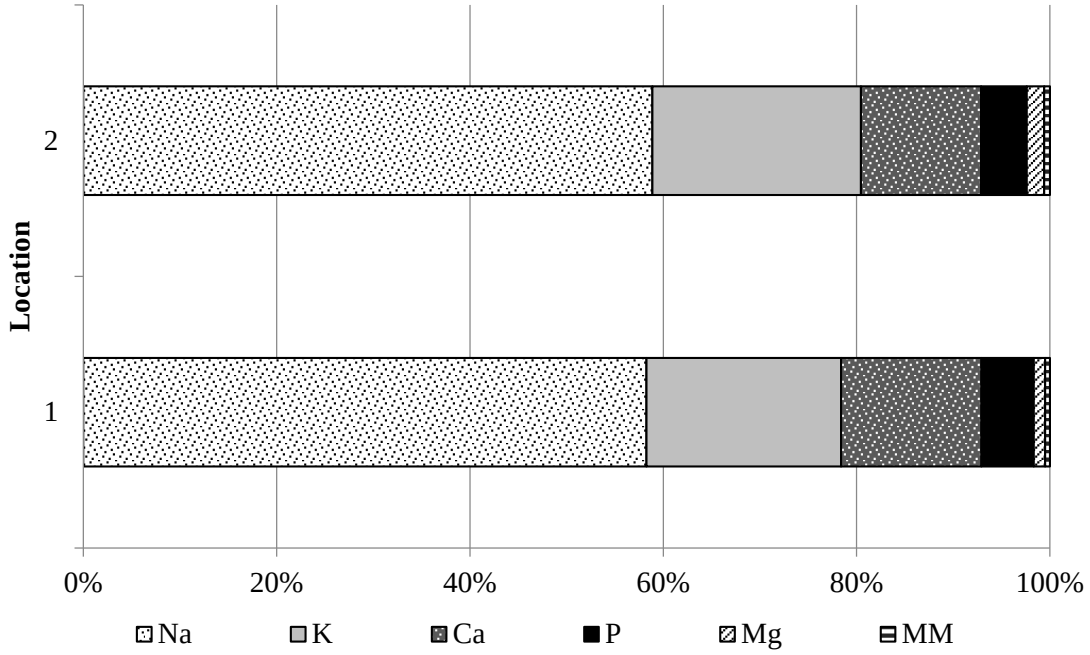


Figure 1. Grape pomace minerals ratio in ash from 2 different locations
abbreviations: Na - Natrium, K - Potassium, Ca - Calcium, P - Phosphorus, Mg - Magnesium, MM – microminerals

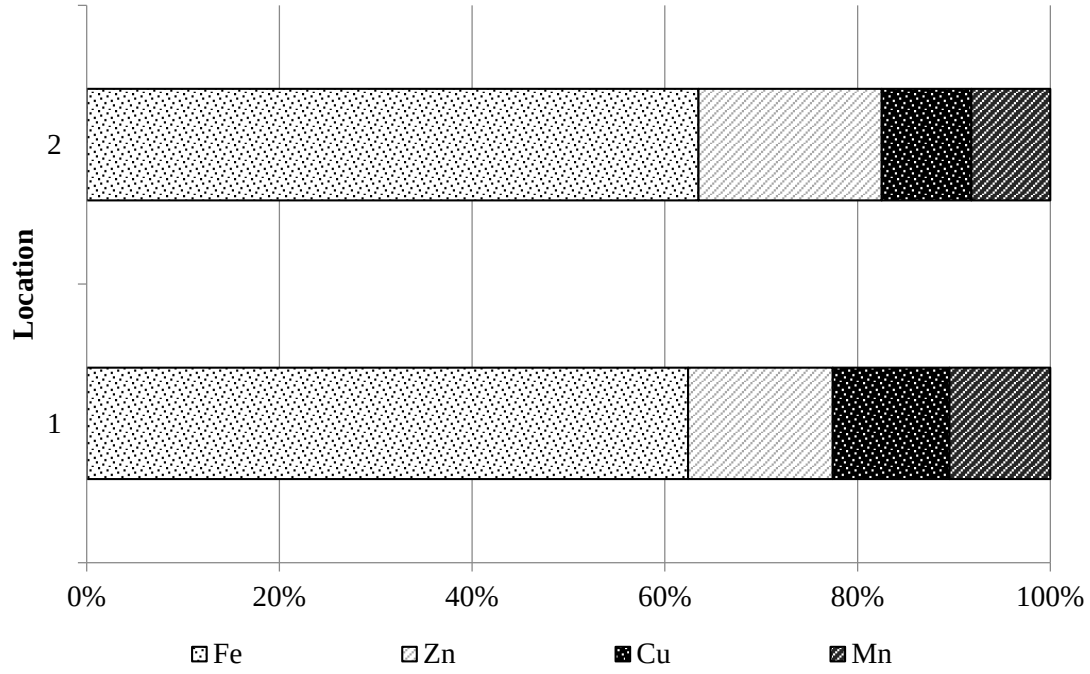


Figure 2. Grape pomace minerals ratio from microminerals from 2 different locations
abbreviations: Fe - Iron, Zn - Zinc, Cu - Copper, Mn - Manganese

4. DISCUSSION

Grape pomace nutrition difference can be caused by grape origin and grape processing during (Baumgärtel et al., 2007). Corbin et al. (2015) found in their research lower content of Ca from 2170 mg.kg-1 to 3867 $mg.kg^{-1}$ in comparison with our results. Chikwanha et al. (2018) found also lower concentration of Ca in grape pomace compared to recent study (2290 - 3730 $mg.kg^{-1}$). However, Botelho et al. (2018) observed almost the same level of Ca, but still lower content in comparison with our research (1580 – 4295 $mg.kg^{-1}$). The content of P in the research of Corbin et al. (2015) was from 2367 to 2733 $mg.kg^{-1}$, thus lower in comparison with our findings. However, Chikwanha et al. (2018) determined the P concentration up to 3420 $mg.kg^{-1}$, which was higher compared to our analysed samples. On the other side, the concentrations of P in the grape pomace was lower (330.5 - 497.6 $mg.kg^{-1}$) in the research of Bennemann et al. (2016). Higher content of Mg in grape pomace found Chiwkanha et al. (2018) from 950 to 1370 $mg.kg^{-1}$ and also Bennemann et al. (2016) from 587.3 to 1547 $mg.kg^{-1}$ compared to this study. In contrary, in the research of Corbin et al. (2015) the concentration of Mg in comparison with our findings was lower (710 – 987 $mg.kg^{-1}$). On the other side, the content of Na in the study of Chikwanha et al. (2018) compared to recent study was higher (328 - 1210 $mg.kg^{-1}$). In contrary, Corbin et al. (2015) observed the content of Na only from 58 to 61 $mg.kg^{-1}$. High variability in the concentration of K is observed between the studies. Thus, Corbin et al. (2015) determined higher content of K (20267 – 27333 $mg.kg^{-1}$) in comparison with our findings. Then, Chikwanha et al (2018) observed K concentrations from 15000 to 25300 $mg.kg^{-1}$, that was comparable with Location 2 on the lower level. However, Botelho et al. (2018) observed close interval in the concentrations of K in the grape pomace from 59.6 to 258.2 $mg.kg^{-1}$. On the other side, wide interval in the Cu content from 92.5 to 2964.2 $mg.kg^{-1}$ during last years were observed (Bonnemann et al., 2016; Botelho et al., 2018). Thought, the concentration of Cu in our study in comparison with these studies was lower. In the study of Corbin et al. (2015) similar content of Fe from 60 to 85 $mg.kg^{-1}$ was found. In contrary, in other research higher Fe (587.3 - 2865.0 $mg.kg^{-1}$) and Mn concentrations (90.2 - 366.4 $mg.kg^{-1}$) in comparison with our results were found (Bennemann et al., 2016; Botelho et al., 2018). However, the content of Zn in the Location 1 was in the observed interval of Corbin et al. (2015), where concentrations of Zn from 9 to 15 $mg.kg^{-1}$ were determined. In the Location 2, higher content of Zn compared to Corbin et al. (2015) was found. Finally, Bennemann et al. (2016) and Botelho et al. (2018) observed Zn content from 0.8 to 335.9 $mg.kg^{-1}$, that was comparable with our minimal Zn concentrations.

5. CONCLUSIONS

The concentrations of minerals in grape pomace can be affected by locality of origin. Generally, regardless of origin, grape pomace is good source of minerals, mainly K, Ca and Fe. However, the highest and statistically significant differences between the locations mainly in the content Na, Zn, Fe, Ca and K were observed. Different mineral content also resulted in different ratios between the minerals. On the other hand, origin of grape pomace does not have effect on the proportions of minerals from the ash and microminerals content. Thus, small differences between the locations in the mineral proportions from 0.61 (Na) to 3.99 (Zn) percentage points were observed.

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