Mineral content as an aspect of nutrition marketing: case study of honey market in Slovakia

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Summary

The aim of this study was to evaluate mineral content of various samples of honey produced in Slovakia and, at the same time, to study the consumer behaviour and knowledge on nutritional aspects of honey. Twenty-four honey samples were analysed by inductively coupled plasma optical emission spectrometry (ICP-OES) and contents of nine minerals was determined (Ca, Cu, Fe, K, Mg, Mn, Na, Se, Zn). Consumer research was conducted via a questionnaire survey and 501 honey consumers were involved. The results showed that honey samples contained minerals (in descendent order) K > Ca > Mg > Na > Fe > Cu > Zn > Mn > Se. Average total content of minerals according to types of honey decreased in the order honeydew honey > linden honey > multifloral > sunflower. Selenium was detected only in sunflower honey. Consumer research revealed that only 27 % of respondents knew about minerals and mostly stated these minerals in the following descending order: Ca > K > Fe > Mg. The interdisciplinary insight provided important information for nutrition marketing, which can be used by beekeepers who are selling honey directly to consumers. Moreover, higher awareness of the nutritional value of honey may help to increase its consumption in the society.

Keywords

honey; marketing; consumer behaviour; nutrition; mineral analysis

Nutrition marketing represents any food marketing that promotes nutrition information, such as nutrient content or nutrition facts panel, health aspects and health claims on food labels [1]. Health claims are related to disease risk reduction, while nutrient content claims include levels of nutrient (increase, reduction, absence or presence) such as minerals, vitamins, fibre, protein, total fat, cholesterol, *trans*-unsaturated fatty acids, saturated fat or sugar. In general, nutrition labelling provides the consumers with important information on nutritional content of alimentary products and allows them to select the ones better for their health [2]. Nutrition marketing or nutritive marketing can be defined as a concept dealing with nutritional values related to health issues. The main aim is to improve awareness of nutritive food by emphasizing nutritive qualities and benefits provided by its consumption. As marketing itself uses a marketing mixture consisting of various components (product, price, place, promotion, people, process, physical environment), nutritive marketing distinguishes the following components: nutritive quality, nutritive benefits, nutritive strategy and nutritive integration [3]. Many consumers believe that consumption of certain food products can prevent diseases, therefore health claims can alter consumer product perception in a positive direction [4, 5]. In addition, in order to attain health effects from consumption of certain commodity, consumers should be aware of the recommended doses [6].

Honey is a food with both nutritive values and healing properties, which provide a great opportu-

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nity to apply the concept of nutrition marketing. Nutritive qualities and quality would involve the rich composition of honey. In general, honey consists of approximately 70 substances, such as carbohydrates, enzymes, organic acids, amino acids, minerals, vitamins and many volatiles compounds [3, 7–14]. Nutritive benefits would be represented by the healing effect of honey based on its antibacterial, antiviral, antifungal and antioxidant activities [3]. In fact, honey is perceived as a tasty product with healing effects [15]. Nutritive strategy of honey deals with the analysis of the marketing environment regarding the sector of health-promoting food and its advantages for consumers. Furthermore, it covers marketing communication and campaigns focusing on informing, convincing and reminding nutritive qualities. The last component, nutritive integration of honey, includes the exchange of ideas, opinions and news at international level with focus on current situation on the honey market [3]. For example, by segmenting the honey market, producers can better understand consumers' needs and tailor marketing strategies more effectively [16]. Only a limited amount of comprehensive surveys on nutritional and health aspects of honey is available [17], as well as consumer surveys focused on overall knowledge about honey properties in the society.

The objective of this study was to analyse the mineral content (Ca, Cu, Fe, K, Mg, Mn, Na, Se, Zn) in various samples of Slovak honey as well as to investigate consumers' awareness, knowledge and behaviour towards nutritional aspects of honey.

MATERIALS AND METHODS

Sample collection

Twenty-four honey samples were collected in 2019 from several apiaries owned by local beekeepers situated in the city of Nitra (Slovakia) and surrounding areas. All samples were collected in 250 ml plastic bottles, labelled with codes and stored in a dark place at 4 °C from one to three months depending on the time of sampling. Analysed samples included the following honey types: linden honey (6 samples), sunflower honey (6 samples), honeydew honey (3 samples) and multifloral honey (9 samples). Samples were collected in June (linden honey and multiflower honey) and in July (sunflower honey and honeydew honey).

Sample preparation and mineral analyses

As the first step, a pre-analytical procedure was applied. All chemicals used during the sample preparation were of purity compatible with trace analysis. Weight of the experimental samples ranged from 0.9 g to 1.1 g and it was reflected in the measurement.

The samples were mineralized in a high performance microwave digestion system Ethos UP (Milestone; Sorisole, Italy) in a solution of 5 ml HNO_3 (≥ 69.0 %; TraceSELECT; Honeywell Charlotte, North Carolina, USA) and 2 ml of ultrapure water (18.2 MΩ cm^{-1}, 25 °C, Synergy UV; Merck, Darmstadt, Germany). The samples as well as the blank were mineralized by the method designated for animal tissue, which was developed by the manufacturer and recommended for optimum results. The method consists of heating and cooling phases. During the heating stage, the samples were warmed up for 15 min to 200 °C and this temperature was maintained for another 15 min. Afterwards, during the cooling phase, the samples underwent 15 min of active cooling to reach the temperature of 50 °C. The digestates were filtered through filter discs (grade 390; Sartorius, Göttingen, Germany) into volumetric flasks and filled up with ultrapure water to a volume of 50 ml [18].

The content of selected elements (Ca, Cu, Fe, K, Mg, Mn, Na, Se and Zn) was analysed by inductively coupled plasma optical emission spectrometer ICP OES 720 (Agilent Technologies, Santa Clara, California, USA) with axial plasma configuration and with auto-sampler SPS-3 (Agilent Technologies). Details of the instrumental operating conditions are listed in Tab. 1. In the experiment, multielement standard solution V (Ag (10 $mg\cdot l^{-1}$), Al (10 $mg\cdot l^{-1}$), Ba (10 $mg\cdot l^{-1}$), Be (10 $mg\cdot l^{-1}$), Bi (10 $mg\cdot l^{-1}$), Ca (100 $mg\cdot l^{-1}$), Cd (10 $mg\cdot l^{-1}$), Co (10 $mg\cdot l^{-1}$), Cr (10 $mg\cdot l^{-1}$), Cs (10 $mg\cdot l^{-1}$), Cu (10 $mg\cdot l^{-1}$), Fe (100 $mg\cdot l^{-1}$), Ga (10 $mg\cdot l^{-1}$), In (10 $mg\cdot l^{-1}$), K (100 $mg\cdot l^{-1}$), Li (10 $mg\cdot l^{-1}$), Mg (10 $mg\cdot l^{-1}$), Mn (10 $mg\cdot l^{-1}$), Mo (10 $mg\cdot l^{-1}$), Na (100 $mg\cdot l^{-1}$), Ni (10 $mg\cdot l^{-1}$), Pb (10 $mg\cdot l^{-1}$), Rb (10 $mg\cdot l^{-1}$), Sr (10 $mg\cdot l^{-1}$), Tl (10 $mg\cdot l^{-1}$), V (10 $mg\cdot l^{-1}$), Zn (10 $mg\cdot l^{-1}$) and single selenium standard (1 000 $mg\cdot l^{-1}$) for ICP-OES (Agilent Technologies) was used. The legitimacy of the whole method was verified using the certified reference material CRM–ERM CE278 K (Sigma-Aldrich, Saint Louis, Missouri, USA).

Consumer research

The research was conducted via an online questionnaire distributed through electronic mails and social media during a period of 2 months (November–December 2019). In total, 501 honey consumers participated in the survey. Research samples included honey consumers of various age categories, living in both urban and rural areas, with different levels of education and income (specified in Tab. 2). The survey was focused on consumer and purchasing behaviour as well as on knowledge of consumers about nutritional aspects regarding honey.

Statistical analysis

Analyses of major and trace minerals were carried out in duplicate and the results were expressed as mean values. Descriptive statistics were applied for the results of mineral content. Kruskal-Wallis and Dunn-Bonferroni post hoc method were applied to study significance of differences in mineral contens among different types of honey. Cluster analyses (CA) using Ward's method was applied to determine potential classification into groups among honey samples based on their mineral content. In case of consumer research, non-parametric tests were applied, namely, Pearson's χ^2-test, Friedman test and Nemenyi's procedure. Purchasing criteria of honey were analysed by applying categorical principal component analyses (CATPCA). Statistical analysis was carried out by SPSS version 25 (IBM, Armonk, New York, USA) and XLSTAT software (Addinsoft, New York, New York, USA).

RESULTS AND DISCUSSION

Results of mineral analysis

Nine minerals were analysed in each honey sample (K, Ca, Mg, Na, Se, Mn, Fe, Zn, Cu). Summarized results with descriptive parameters including total mineral content divided according to different honey types are presented in Tab. 3. The average total mineral content was obtained in the following descending order: honeydew honey 3 160.17 mg·kg^{-1} > linden honey 1 353.58 mg·kg^{-1} > multifloral honey 979.53 mg·kg^{-1} > sunflower honey 835.54 mg·kg^{-1}. The results demonstrated that honeydew honey contained higher amounts of minerals in comparison to blossom honey. Mineral content in floral honey was previously found to be 1 000–2 000 mg·kg^{-1}, while in honeydew honey can exceed 10 000 mg·kg^{-1} [19, 20]. The minerals were found in all tested samples of honey in a descending order as follows: potassium 884.01 mg·kg^{-1} > calcium 303.33 mg·kg^{-1} > magnesium 66.52 mg·kg^{-1} > sodium 47.24 mg·kg^{-1} > iron 4.53 mg·kg^{-1} > copper 1.67 mg·kg^{-1} > zinc 1.49 mg·kg^{-1} > manganese 0.75 mg·kg^{-1} > selenium 0.41 mg·kg^{-1}. These elements were previously frequently found in several studies on the mineral

Tab. 1. Operating parameters of determination of elements by inductively coupled plasma optical emission spectrometry.

Parameter	Value
Radio Frequency Power	1.30 kW
Plasma flow	15.00 l·min^{-1}
Auxiliary flow	1.50 l·min^{-1}
Nebulizer flow	0.85 l·min^{-1}
Replicated read time	5.00 s
Instrument stabilization	15 s
Sample uptake delay	25 s
Pump rate	0.25 Hz
Rinse time	10 s
Wavelength	
Ca	315.887 nm
Cu	324.754 nm
Fe	234.350 nm
K	766.491 nm
Mg	383.829 nm
Mn	257.610 nm
Na	589.592 nm
Se	196.026 nm
Zn	206.200 nm

Tab. 2. Socio-demographic profile of the research sample.

Characteristic	Proportion [%]
Gender	
Male	34.9
Female	65.1
Age	
18–30 years	18.2
31–40 years	36.3
41–50 years	26.1
≥ 51 years	19.4
Education	
Primary education	1.2
Secondary education	44.1
Higher education	54.7
Place of residence	
Rural area	34.1
Urban area	65.9
Monthly income netto	
Up to 400 EUR	13.4
401–600 EUR	12.8
601–800 EUR	22.0
801–1 000 EUR	19.6
More than 1 000 EUR	32.3

content in honey samples. [21–25]. On average, the most abundant mineral was potassium (approximately 68 % of the average total mineral content) and the highest average content was determined in honeydew honey (2 663.67 mg·kg^{-1}) and in linden honey (930.78 mg·kg^{-1}). The second most abundant mineral was calcium (23 % of the average total mineral content) with a range from 293.92 mg·kg^{-1} to 320 mg·kg^{-1}, which was twice higher than reported in another study [26].

Other abundant minerals were magnesium and sodium (5.1 % and 3.6 % of the average total mineral content). The low content of sodium could be explained by geographical location because high levels of this mineral are common for honey originating in coastal areas rather than inlands [27]. All above-mentioned minerals represent 99.4 % of honey mineral content.

The next analysed trace element was selenium, which plays an important role in body metabolism. Certain types of honey, namely, sunflower, heather and lavender, may represent a dietary source of selenium [28]. In our study, selenium was detected only in case of sunflower honey samples. Similar results were obtained previously in a Turkish study with samples of sunflower honey [21]. Similar mineral contents were found in several samples of Slovak honey examined in two previous studies [29, 30].

In general, the content of minerals in honey is influenced by various factors such as geographical and botanical origin, soil composition, specific melliferous vegetation, climate conditions, bee species, floral type and its density, nectar and pollen composition [22, 31]. Moreover, the mineral content of honey is not necessarily directly correlated to their presence in soil due to different bioaccumulation properties of flora, which was confirmed by a study conducted in Serbia [23].

Using Kruskal-Wallis test, we identified significant differences among honey types (linden, multifloral, honeydew and sunflower) in case of

Tab. 3. Content of major and trace minerals in honey samples.

Honey type	Content in a sample [mg·kg^{-1}]									
	K*	Ca	Mg*	Na*	Se	Mn	Fe*	Zn	Cu*	Total minerals
Linden honey (n = 6)										
Minimum	916.10	273.70	55.40	48.89	ND	0.36	4.57	0.68	1.52	1 301.22
Maximum	953.01	331.33	73.42	51.08	ND	2.76	6.48	3.70	1.67	1 423.45
Mean	930.78^{ac}	298.48	64.19^{ab}	49.77^{ab}	–	1.49	5.20^{c}	2.09	1.58^{ab}	1 353.58
SD	15.92	21.69	8.74	0.81	–	1.25	0.72	1.37	0.05	29.41
Multifloral honey (n = 9)										
Minimum	479.61	246.57	50.16	37.91	ND	0.27	3.42	0.55	1.38	819.87
Maximum	691.37	435.56	75.68	52.58	ND	0.85	4.32	1.72	1.71	1 263.97
Mean	578.25^{cb}	293.92	56.56^{b}	43.90^{b}	–	0.45	3.88^{b}	1.11	1.46^{b}	979.53
SD	83.34	56.47	8.72	5.08	–	0.17	0.30	0.42	0.10	126.76
Honeydew honey (n = 3)										
Minimum	2638.81	292.42	118.19	55.89	ND	0.75	6.32	1.91	2.71	3 117.00
Maximum	2687.31	317.08	121.48	58.39	ND	0.78	6.49	2.23	2.78	3 196.54
Mean	2663.67^{a}	307.89	119.62^{a}	57.04^{a}	–	0.77	6.42^{a}	2.01	2.74^{a}	3 160.17
SD	24.27	13.48	1.69	1.26	–	0.02	0.09	0.18	0.03	18.55
Sunflower honey (n = 6)										
Minimum	173.81	240.55	40.92	38.46	0.21	0.17	3.74	0.81	1.45	500.12
Maximum	700.79	416.51	76.33	51.68	0.62	0.82	4.20	1.82	1.70	1 254.47
Mean	406.07^{b}	320.03	57.24^{ab}	44.83^{ab}	0.41	0.46	3.90^{bc}	1.20	1.54^{ab}	835.54
SD	255.19	69.37	16.31	5.69	0.17	0.30	0.18	0.34	0.12	344.30
All sample mean	884.01	303.33	66.52	47.24	0.41	0.75	4.53	1.49	1.67	1 309.96
LOD	0.0003	0.00001	0.00001	0.00015	0.002	0.00003	0.0001	0.0002	0.0003	

* – Significant differences between types of honey samples according to Kruskal-Wallis test ($p < 0.05$). Means in the same column with different superscript are statistically different according to Dunn-Bonferroni post hoc method ($p \leq 0.05$).
SD – standard deviation, *LOD* – limit of detection, ND – not detected.

potassium, magnesium, sodium, iron and copper. Dunn-Bonferroni post hoc method identified among which types were these differences found. Differences in mineral content were frequently identified between honeydew honey and multifloral samples (Tab. 3). Furthermore, clustering analysis (using Ward's method) was used in order to identify the similarities between different groups of honey samples based on their mineral content. Results revealed three clusters (Fig. 1). The first cluster involved all three samples of honeydew honey, which had higher contents of minerals except for calcium, manganese and zinc. The second cluster comprised all samples of linden honey, which had the highest content of manganese and zinc, together with a higher content of potassium. The third cluster involved all samples of sunflower honey and multifloral honey, which were characterized by lower contents of potassium.

All in all, the analysed Slovak honeys contained important macro-elements such as potassium, calcium, magnesium as well as small amounts of trace elements (manganese, zinc, iron, copper and selenium). Due to the rich mineral content, honey can be considered as an important product in human nutrition.

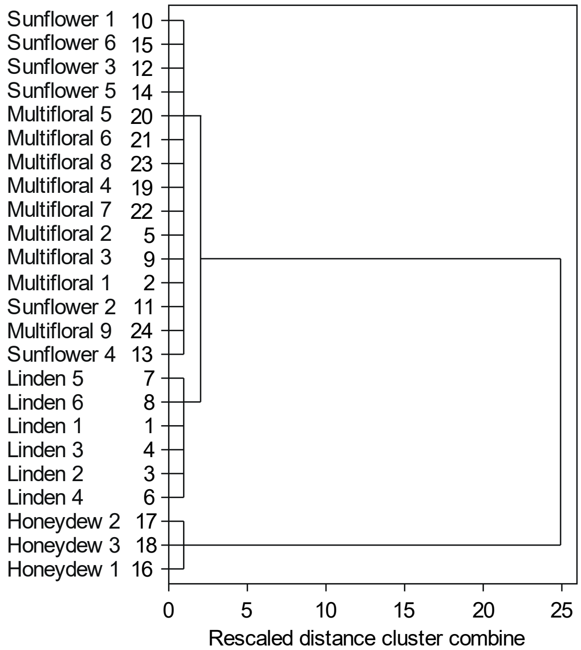

Fig. 1. Dendrogram of analysed honey samples constructed using Ward's method based on their mineral content.

Results of consumer research

The questionnaire survey showed that most respondents consume honey either a few times a week (35.3 %) or every day (32.5 %). Most respondents (60.3 %) yearly consume more than 1 kg of honey. For a deeper analysis, consumer habits were tested according to age categories. Respondents belonging to the age category 18–30 years mostly consume honey occasionally or a few times a month, with annual consumption lower than 1 kg. The older the respondents are, the higher and more frequent the honey consumption is. The oldest age category ≥ 51 years mostly consume honey daily and their annual consumption exceeds 4 kg. Moreover, the survey examined the purpose of honey consumption (food, medicine or cosmetics). The results of Pearson's χ^2 test showed that a dependence between respondent's age and the purpose of use. Fig. 2 shows that older respondents used honey more for its nutritional aspects. Younger respondents had the highest percentage in case of using honey mostly for treatment of illnesses such as cold, flu or other health problems. Despite the fact that nutritional aspects were the major reason for honey consumption, approximately 51 % of respondents did not know which nutritional substances are present in honey. Those who were able to answer this question mostly stated carbohydrates such as glucose and fructose, vitamins, proteins, enzymes or antioxidants. Minerals were mentioned only by 27 % and most of the respondents named the minerals in the following descending order: Ca > K > Fe > Mg. Based on the results, it could be stated that more than 2/3 of respondents were not aware of the mineral content in honey. Moreover, the respondents indicated also the source from which they acquire information about honey. In general, they gain information about honey from beekeepers, family members, acquaintances, friends or the internet (websites, blogs or vlogs).

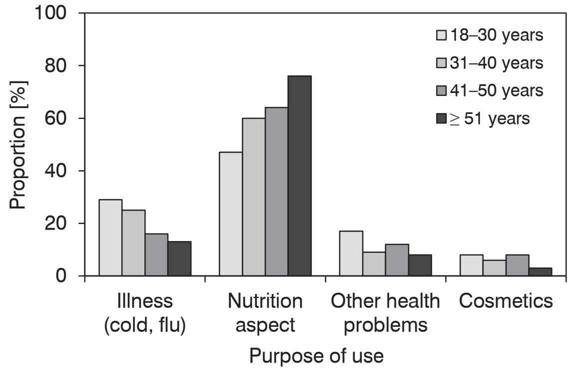

Fig. 2. Purpose of honey usage according to consumer's age segments.

Tab. 4. Results of Nemenyi's procedure.

Factors	Mean of ranks	Groups					
Quality	3.033	A					
Country of origin	3.600		B				
Taste	3.657		B				
Aroma	5.004			C			
Type	5.278			C	D		
Colour	5.465			C	D		
Consistency	5.564				D		
Price	6.257					E	
Packaging	7.142						F

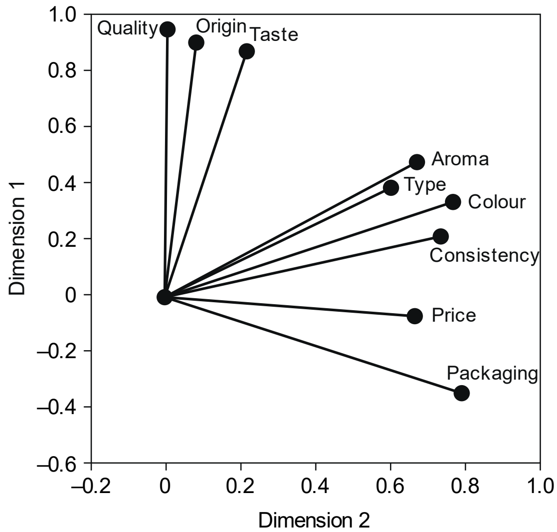

Fig. 3. Purchasing criteria analysed by categorical principal components analysis.

In addition, the survey examined also purchasing behaviour of respondents. Majority of them purchase honey directly from a beekeeper and are willing to pay from 7–8 EUR per kilogram of honey. According to a Polish study on honey consumers behaviour, respondents with a higher income, education and nutritional knowledge perceive price of honey with lower importance [32]. Purchasing criteria were evaluated by applying a 7-points scale, where 1 meant the most important and 7 the least important. The respondents evaluated nine factors including both intrinsic and extrinsic attributes of honey. Friedman test and Nemenyi's procedure were applied in order to determine differences in evaluation of purchasing criteria. The results of Friedman test showed statistically significant differences ($p < 0.001$). The most important factors when purchasing were as follows in descending order: quality > country of origin > taste > aroma > type > colour > consistency > price > packaging (Tab. 4).

CATPCA with Kaiser normalization and varimax rotation was applied to gain better insight and understanding of respondents' evaluation. Two latent components (Fig. 3) were extracted explaining 69.5 % of variance. Based on factor loadings, the first component included quality, country of origin and taste. Similar results were obtained in a previous study and this combination of criteria represented the overall quality of honey [33]. However, a better designation would probably be "factor of honey authenticity". Moreover, the taste of honey as the most important purchasing criterion was identified in a Hungarian study [34] and country of origin in a Czech study [35]. Interesting findings were presented in a consumer study of Polish honey consumers, where authors stated that consumers with higher nutritional knowledge (self-assessment) perceived flavour of honey with higher importance [32].

CONCLUSIONS

Mineral analysis showed that honey samples produced by Slovak beekeepers in 2019 contained the following major and trace minerals: Ca, Cu, Fe, K, Mg, Mn, Na, Se and Zn. The highest content of minerals was identified in samples of honeydew honey. The most abundant minerals was potassium followed by calcium and magnesium. Selenium was identified only in samples of sunflower honey. Consumer research identified a low level of knowledge regarding the nutritional aspects of honey among honey consumers. The study provided managerial implications for beekeepers who are not able to sell their honey production directly to consumers. The emphasis on the nutritive quality (mineral content) may play an important role in influencing the decision-making process at purchase and consumption of honey. Educating consumers about mineral composition of honey and their importance in human nutrition and health can be used in product positioning and promoting honey as an important staple product in consumers' minds. One of the study's limitations is not considering the influence of soil composition due to the short distance between beehives located in Nitra city and surroundings. Therefore, further research should be extended to mineral analysis of honey samples from various regions.

REFERENCES

1. Colby, S. E. – Johnson, L. – Scheett, A. – Hoverson, B.: Nutrition marketing on food labels. Journal of Nutrition Education and Behavior, *42*, 2010, pp. 92–98. DOI: 10.1016/j.jneb.2008.11.002.
2. Franco-Arellano, B. – Kim, M. A. – Vandevijvere, S. – Bernstein, J. T. – Labonté, M.-E. – Mulligan, C. – L'Abbé, M. R.: Assessment of packaged foods and beverages carrying nutrition marketing against Canada's food guide recommendations. Nutrients, *11*, 2019, article 411. DOI: 10.3390/nu11020411.
3. Gulevska, F. – Martinovski, S.: Nutritive marketing and analysis of consumption behaviour for honey. Journal of Hygienic Engineering and Design, *23*, 2018, pp. 72–80. ISSN: 1857-8489. <http://www.jhed.mk/filemanager/JHED%20Vol.%2023/03.%20FPP/03.%20%20Full%20paper%20-%20Fani%20Gulevska.pdf>
4. Bech-Larsen, T. – Grunert, K. G.: The perceived healthiness of functional foods. A conjoint study of Danish, Finnish and American consumers' perception of functional foods. Appetite, *40*, 2003, pp. 9–14. DOI: 10.1016/s0195-6663(02)00171-x.
5. Gilbert, L. C.: The functional food trend: what's next and what Americans think about eggs. Journal of the American College of Nutrition, *19*, 2000, pp. 5075–5125. DOI: 10.1080/07315724.2000.10718973.
6. Kubicová, L. – Predanocyová, K. – Kádeková, Z.: The importance of milk and dairy products consumption as a part of rational nutrition. Potravinárstvo Slovak Journal of Food Sciences, *13*, 2019, pp. 234–243. DOI: 10.5219/1050.
7. Lichtenberg-Kraag, B.: Saccharose degradation over time in stored honey: influence of time, temperature, enzyme activity and botanical origin. Journal of Food and Nutrition Research, *51*, 2012, pp. 217–224. ISSN: 1336-8672 (print), 1338-4260 (online). <http://www.vup.sk/download.php?bulID=1321>
8. Tezcan, F. – Kolayli, S. – Sahin, H. – Ulusoy, E. – Erim, F. B.: Evaluation of organic acid, saccharide composition and antioxidant properties of some authentic Turkish honeys. Journal of Food and Nutrition Research, *50*, 2011, pp. 33–40. ISSN: 1336-8672 (print), 1338-4260 (online).<http://www.vup.sk/download.php?bulID=387>.
9. Jánošková, N. – Vyviurska, O. – Špánik, I.: Identification of volatile organic compounds in honeydew honeys using comprehensive gas chromatography. Journal of Food and Nutrition Research, *53*, 2014, pp. 353–362. ISSN: 1336-8672 (print), 1338-4260 (online). <http://www.vup.sk/download.php?bulID=1632>.
10. Borutinskaite, V. – Treigyte, G. – Čeksteryte, V. – Kurtinaitiene, B. – Navakauskiene, R.: Proteomic identification and enzymatic activity of buckwheat (*Fagopyrum esculentum*) honey based on different assays. Journal of Food and Nutrition Research, *57*, 2018, pp. 57–69. ISSN: 1336-8672 (print), 1338-4260 (online). <http://www.vup.sk/download.php?bulID=1968>.
11. Kukurová, K. – Karovičová, J. – Kohajdová, Z. – Bíliková, K.: Authentication of honey by multivariate analysis of its physico–chemical parameters. Journal of Food and Nutrition Research, *47*, 2008, pp. 170–180. ISSN: 1336-8672 (print), 1338-4260 (online). <http://www.vup.sk/download.php?bulID=84>.
12. Bartáková, K. – Vorlová, L. – Titěra, D. – Lutzová, M.: Physicochemical parameters and botanical origin of Czech honeys. Journal of Food and Nutrition Research, *46*, 2007, pp. 167–173. ISSN: 1336-8672 (print), 1338-4260 (online).<http://www.vup.sk/download.php?bulID=52>.
13. Pažitná, A. – Janáčová, A. – Špánik, I.: The enantiomer distribution of major chiral volatile organic compounds in Slovakian monofloral honeys. Journal of Food and Nutrition Research, *51*, 2012, pp. 236–241. ISSN: 1336-8672 (print), 1338-4260 (online). <http://www.vup.sk/download.php?bulID=1315>.
14. Kružík, V. – Grégrová, A. – Ziková, A. – Čížková, H.: Rape honey: determination of botanical origin based on volatile compound profiles. Journal of Food and Nutrition Research, *58*, 2019, pp. 339–348. ISSN: 1336-8672 (print), 1338-4260 (online). <http://www.vup.sk/download.php?bulID=2038>.
15. Pocol, C. B. – Bolboacă, S. D.: Perceptions and trends related to the consumption of honey: A case study of North-West Romania. International Journal of Consumer Studies, *37*, 2013, pp. 642–649. DOI: 10.1111/ijcs.12046.
16. Šedík, P. – Pocol, C. B. – Horská, E. – Fiore, M.: Honey: food or medicine? A comparative study between Slovakia and Romania. British Food Journal, *121*, 2019, pp. 1281–1297. DOI: 10.1108/BFJ-12-2018-0813.
17. Bogdanov, S. – Jurendic, T. – Sieber, R. – Gallmann, P.: Honey for nutrition and health: A review. Journal of the American College of Nutrition, *27*, 2008, pp. 677–689. DOI: 10.1080/07315724.2008.10719745.
18. Kovacik, A – Tvrda, E. – Miskeje, M. – Arvay, J. – Tomka, M. – Zbynovska, K. – Andreji, J. – Hleba, L. – Kovacikova, E. – Fik, M. – Cupka, P. – Nahacky, J. – Massanyi, P.: Trace metals in the freshwater fish *Cyprinus carpio*: effect to serum biochemistry and oxidative status markers. Biological Trace Element Research, *188*, 2019, pp. 494–507. DOI: 10.1007/s12011-018-1415-x.
19. Seraglio, S. K. T. – Silva, B. – Bergamo, G. – Brugnerotto, P. – Gonzaga, L. V. – Fett, R. – Costa, A. C. O.: An overview of physicochemical characteristics and health-promoting properties of honeydew honey. Food Research International, *119*, 2019, pp. 44–66. DOI: 10.1016/j.foodres.2019.01.028.
20. Bogdanov, S. – Haldimann, M. – Luginbühl, W. – Gallmann, P.: Minerals in honey: environmental, geographical and botanical aspects. Journal of Apicultural Research, *46*, 2007, pp. 269–275. DOI: 10.1080/00218839.2007.11101407.
21. Citak, D. – Silici, S. – Tuzen, M. – Soylak, M.: Determination of toxic and essential elements in sunflower honey from Thrace Region,

Turkey. International Journal of Food Science and Technology, *47*, 2011, pp. 107–113. DOI: 10.1111/j.1365-2621.2011.02814.x.
22. Karabagias, I. K. – Louppis, P. A. – Kontakos, S. – Papastephanou, C. – Kontominas, M. G.: Characterization and geographical discrimination of Greek pine and thyme honeys based on their mineral content, using chemometrics. European Food Research and Technology, *243*, 2017, pp. 101–113. DOI: 10.1007/s00217-016-2727-8.
23. Jovetić, M. – Trifković, J. – Stanković, D. – Manojlović, D. – Milojković-Opsenica, D.: Mineral content as a tool for the assessment of honey authenticity. Journal of AOAC International, *100*, 2017, pp. 862–870. DOI: 10.5740/jaoacint.17-0145.
24. Laaroussi, H. – Bouddine, T. – Bakour, M. – Ousaaid, D. – Lyoussi, B.: Physicochemical properties, mineral content, antioxidant activities, and microbiological quality of *Bupleurum spinosum* Gouan honey from the Middle Atlas in Morocco. Journal of Food Quality, *2020*, 2020, article ID 7609454. DOI: 10.1155/2020/7609454.
25. Karabagias, I. K. – Louppis, A. P. – Kontakos, S. – Drouza, C. –Papastephanou, C.: Characterization and botanical differentiation of monofloral and multifloral honeys produced in Cyprus, Greece, and Egypt using physicochemical parameter analysis and mineral content in conjunction with supervised statistical techniques. Journal of Analytical Methods in Chemistry, *2018*, 2018, article ID 7698251. DOI: 10.1155/2018/7698251.
26. Conti, M. E. – Canepari, S. – Finoia, M. G. – Mele, G. – Astolfi, M. L.: Characterization of Italian multifloral honeys on the basis of their mineral content and some typical quality parameters. Journal of Food Composition and Analysis, *74*, 2018, pp. 102–113. DOI: 10.1016/j.jfca.2018.09.002.
27. Fermo, P. – Beretta, G. – Maffei Facino, R. – Gelmini, F. – Piazzalunga, A.: Ionic profile of honey as a potential indicator of botanical origin and global environmental pollution. Environmental Pollution, *178*, 2013, pp. 173–181. DOI: 10.1016/j.envpol.2013.03.029.
28. Costa-Silva, F.– Maia, M.– Matos, C. C. – Calçada, E. – Barros, A. I. R. N. A. – Nunes, F. M.: Selenium content of Portuguese unifloral honeys. Journal of Food Composition and Analysis, *24*, 2011, pp. 351–355. DOI: 10.1016/j.jfca.2010.09.019.
39. Šedík, P. – Zagula, G. – Ivanišová, E. – Kňazovická, V. – Horská, E. –Kačániová, M.: Nutrition marketing of honey: chemical, microbiological, antioxidant and antimicrobial profile. Potravinárstvo Slovak Journal of Food Sciences, *12*, 2018, pp. 767–774. DOI: 10.5219/988.
30. Kováčik, J. – Grúz, J. – Biba, O. – Hedbavny, J.: Content of metals and metabolites in honey originated from the vicinity of industrial town Košice (eastern Slovakia). Environmental Science and Pollution Research, *23*, 2015, pp. 4531–4540. DOI: 10.1007/s11356-015-5627-8.
31. de Alda-Garcilope, C. – Gallego-Picó, A. – Bravo-Yagüe, J. C. – Garcinuño-Martínez, R. M. – Fernández-Hernando, P.: Characterization of Spanish honeys with protected designation of origin "Miel de Granada" according to their mineral content. Food Chemistry, *135*, 2012, pp. 1785–1788. DOI: 10.1016/j.foodchem.2012.06.057.
32. Kowalczuk, I. – Jeżewska-Zychowicz, M. – Trafiałek, J.: Conditions of honey consumption in selected regions of Poland. Acta Scientiarum Polonorum Technologia Alimentaria, *16*, 2017, pp. 101–112. DOI: 10.17306/J.AFS.2017.2017.0446.
33. Šedík, P. – Horská, E. – Skowron-Grabowska, B. – Bálint Illés, C.: Generation marketing in strategic marketing management: case study of honey market. Polish Journal of Management Studies, *18*, 2018, pp. 326–337. DOI: 10.17512/pjms.2018.18.1.24.
34. Oravecz, T. – Kovács, I.: Sensory examination of honey and the effect of sensory characteristics on purchase decisions. Analecta Technica Szegedinensia, *13*, 2019, pp. 64–71. DOI: 10.14232/analecta.2019.1.64-71.
35. Šánová, P. – Svobodová, J. – Hrubcová, B. – Šeráková, P.: Segmentation of honey buyers' behaviour by conjoint analysis. Scientia Agriculturae Bohemica, *48*, 2017, pp. 55–62. DOI: 10.1515/sab-2017-0008.

Received 24 February 2020; 1st revised 8 May 2020; accepted 17 June 2020; published online 6 July 2020.