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The content of two toxic heavy metals in Bulgarian bee pollen

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Abstract

In the study were presented results from toxic heavy metals Pb and Cd in fresh and dry flower bee pollen, harvested in bee apiaries from 8 regions from Bulgaria. There were tendencies for similar values in analyzed regions and in almost all cases not found statistically significant difference between fresh and dried bee pollen. With respect to product safety a laboratory analysis of Pb and Cd content of dried bee pollen is recommended.

Keywords

Flower bee pollen
Pb
Cd

Introduction

Contaminants from environmental sources can reach the raw materials of bee products (nectar, honeydew, pollen, plant exudates) by air, water, plants and soil and then be transported into the bee hive by the bees. Air and soil contain heavy metals, mainly from industry and traffic, which can also contaminate the bee colony and its products. Lead (Pb) and cadmium (Cd) are considered the principal toxic heavy metals and are thus most frequently studied. Lead, contained in the air and originating mainly from motor traffic can contaminate air and then directly nectar and honeydew. Generally, Pb is not transported by plants. Pb contamination is expected to diminish, due to the increased worldwide use of carengine catalysts. In most studies Pb and Cd can be both from natural sources (soil, plants) and anthropogenic sources especially. Cd originating from metal industry and incinerators is transported from the soil to plants and can then contaminate nectar and honeydew. Only a small portion of Cd might reach bee products by air, mainly in the vicinity of incinerators (Bogdanov, 2006).

Flower bee pollen should be safe for consumers and of natural quality characteristics. According to the Bulgarian industry standard introduced in 1991, dried bee pollen should contain up to 13% moisture (Central Cooperative Union, 1991). Ordinance 9/2005 has stipulated additional requirements to drying and an allowance of up to 12% humidity of end product (Ordinance №9 of 22 June 2005).

Nowadays, industrial pollution increases at a global scale resulting in higher trace and macro element levels and hence, higher total mineral content of the soil. It is known that bees and bee pollen are a kind of bioindicators of anthropogenic pollution of the environment (Zhelyazkova *et al*., 2001; Bogdanov, 2006). That is why the certification of bee pollen for human consumption assuring a safe level of toxic heavy metals is of primary importance. As per Bulgarian norms, the total mineral content should be up to 3.5% (Central Cooperative Union, 1991), while international quality standards from 2008 propose maximum levels up to 6% (Campos *et al*., 2008).

In the present years all over the world it is actual question about applying of organic beekeeping. The some regions in Bulgaria have unique environmental factors and thus could be possible to collect flower bee pollen without high levels of toxic heavy metals and with especial quality. To this moment it is the lack of recent data from Pb and Cd in fresh and dried flower bee pollen from large regions and countries. Thus, the aim of our study was to investigate the content of two toxic heavy metals (Pb and Cd) in Bulgarian bee pollen by technological processing. Also comparison by data of bee pollens from 8 different regions and these from other studies were done.

Materials and Methods

In June 2014, a total of 32 samples fresh and dried bee pollen were collected from 8 different regions

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Table 1. Content of Pb and Cd and total mineral content of bee pollen (P<0.01 – [1; 3; 4]; P = 0. 0145- [2]).

Strandzha		Sliven		Vrat-sa	Shoumen		Stara Zagora	Lo-vech	V.Tar-novo	Kar-lovo
Fresh (n=4)	Dried (n=4)	Fresh (n=1)	Dried (n=1)	Fresh (n=2)	Fresh (n=6)	Dried (n=6)	Dried (n=2)	Dried (n=1)	Dried (n=3)	Dried (n=2)
0.468 ± 0.000082[1] Min 0.467 Max 0.469	0.488 ± 0.000080[1] Min 0.487 Max 0.489	0.482	0.481	0.483 0.482	0.4775 ± 0.00105[2] Min 0.476 Max 0.479	0.4625 ± 0.00124[2] Min 0.454 Max 0.479	0.493 0.494	0.454	0.473 0.472 0.473	0.451 0.450
Pb content by technological processing,%										
Fresh (n = 13) 0.4756923± 0.00057;Min 0.467; Max 0.483						Dried (n = 19) 0.4720526±0.0016; Min 0.45;Max 0.494				
Cd content by regions, %										
0.0225 ±0.00005 Min 0.022 Max 0.023	0.023 ± 0.00005 Min 0.022 Max 0.023	0.028	0.028	0.029 0.028	0.0253 ± 0.000136 Min 0.023 Max 0.027	0.0258 ± 0.0000752 Min 0.025 Max 0.027	0.025 0.024	0.030	0.020 0.021 0.020	0.019 0.020
Cd content by technological processing,%										
Fresh (n = 13) 0.0251±0.0024;Min 0.022;Max 0.029						Dried (n = 19) 0.0238±0.0030;Min 0.019;Max 0.030				
Total mineral content by regions, % (Dinkov *et al.*,2014)										
2.45 ± 0.05 Min 2.4 Max 2.5	1.64 ± 0.45 Min 0.9 Max 1	3.4	2.3	2.4 2.5	2.35 ± 0.36[3] Min 2 Max 2.8	1.76± 0.05[3] Min 1.7 Max 1.8	1.2 1.8	2.3	1.8 2 2	0.91 0.92
Total mineral content by technological processing,% (Dinkov *et al.*,2014)										
Fresh (n = 13) 2.47± 0.36[4]; Min 2; Max 3.4						Dried (n = 19) 1.56±0.48[4]; Min 0.90; Max 2.3				

of the country: Strandzha (n=8), Sliven (n=2), Stara Zagora (n=2), Shoumen (n=12), Lovech (n=1), Vratsa (n=2), Veliko Tarnovo (n=3) and Karlovo (n=2). Flower bee pollens were from bee families not feed with sugar solutions and were not treated with antibiotics. The honey production areas were more than 3 km away from the nearest village.

The analyses for total mineral content were performed as stated in the national legislation (Central Cooperative Union, 1991). Before analyzes for Pb and Cd all samples were heated with 550°C, diluted with 6n HCl and twice heated, diluted and filtrated. After that, received solution was tested to content of Pb and Cd by Atomic Absorption Spectrophotometer (Model 380, PERKIN ELMER) in laboratory of Trakia University, Stara Zagora, Bulgaria. The statistical analysis was done via the Student's t-test (StatmostTM for Windows). Results are presented individually for small samples (n=1, 2, 3), or as means ± standard deviations, minimum and maximum values for larger samples (n=4, 6, 13 and 19), (Table 1).

Results

The highest Pb content of fresh pollen was detected in a samples from the Stara Zagora region (0.493 - 0.494 mg/kg), followed by dry pollens from Strandzha (0.488 ± 0.000080 mg/kg), Vratsa (0.482-0.483 mg/kg), Sliven (0.481-0.482 mg/kg) etc. There were statistically significant differences between Pb content of samples of fresh and dried pollen from Strandzha (P<0.01) and Shoumen (P=0.0145), and not found a trend for considerable difference in samples from other regions (Table 1).

The highest Cd content of fresh bee pollen was observed in samples from the region of Lovech (0.030 mg/kg), followed by those from Vratsa (0.028-0.029 mg/kg), while the lowest were detected in Strandzha (0.0225 – 0,023 mg/kg), Veliko Tarnovo (0.020-0.021 mg/kg) and Karlovo (0.019-0.020 mg/kg). There were not found statistically significant difference between Cd content of fresh and dried bee pollen and tendency for marked difference between investigated regions (Table 1).

The highest total mineral content of fresh bee pollen was observed in samples from the region of Sliven (3.4%), followed by those from Strandzha (2.45±0.05%), while the lowest were detected in Vratsa (2.4%; 2.5%) and Shoumen (2.35±0.36%). The highest mineral concentrations were established in dried pollen from Sliven and Lovech (2.3%), and the lowest – from Shoumen (1.76±0.05%), Stara Zagora (1.2%; 1.8%), Strandzha (1.64±0.45%) and Karlovo (0.91; 0.92). There were statistically significant difference between the total mineral content of fresh and dried bee pollen from Shoumen (P<0.01), (Dinkov *et al.*, 2014). This finding was confirmed by the analysis of data for the total mineral content of pollen from all regions (P<0.01; Table 1).

Discussion

The total mineral content of studied dried pollen was compliant to criteria set in the national legislation (Central Cooperative Union, 1991) and shows lower content than Thailand pollen – 3.96±0.08% (Saeheng *et al*., 2012), but comparable values to reports from Brazil – 2.2% (Almeida-Muradian *et al*., 2005), Columbia – 2.5±0.4 % (Fuenmayor *et al.*, 2014).

According to literature data, the content of Pb in fresh bee pollen has to be not above 0.5 mg/kg (Campos *et al.*, 2008). The higher values of Pb established for pollen originating from the Stara Zagora region (0.493-0.494 mg/kg) could be attributed to harvesting of pollen in region with possible anthropogenic pollution. We agree that bee products are less suitable to serve as indicators for the measurement of Pb and Cd pollution due to considerable natural variation. Bees themselves seem to be better candidate for this purpose (Porrini *et al*., 2002). Investigations in Bulgaria by feeding of bees with sugars, containing heavy metals were with compliance with this opinion (Zhelyazkova *et al*., 2001).

Conclusions

From our data we could conclude that the great majority of Cd and Pb values presented in Bulgarian's bee pollen are bellow the MRL (Maximum Residue Limit) values of 0.03 mg/kg and 0.5 mg/kg has been suggested for bee pollen (Campos *et al.*, 2008). With respect to product safety a laboratory analysis of Pb and Cd content of dried flower bee pollen is recommended.

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References

Almeida-Muradian, L. B., Pamplona, L. C., Coimbra, S. and Barth, O. M. 2005. Chemical composition and botanical evaluation of dried bee pollen pellets, Journal of Food Composition and Analysis 18(1): 105-111.

Bogdanov, S., Zimmerli, B. and Erard, M. 1986. Schwermetalle in Honig. Mitteilungen aus dem Gebiete der Lebensmittel-untersuchung un Hygiene 77: 153–158.

Bogdanov, S. 2006. Contaminants of bee products, Review article. Apidologie, INRA/DIB-AGIB/ EDP Sciences, DOI: 10.1051/apido:2005043, 37: 1-18.

Bogdanov, S. 2014. Pollen: Production, Nutrition and Health: A Review: www.bee-hexagon.net (20 June 2014, date last accessed).

Campos, M.G.R., Bogdanov, S., Almeida-Muradian, L.B., Szczesna, T., Mancebo, Y., Frigerio, C. and Ferreira, F. 2008. Pollen composition and standardization of analytical methods. Journal of Apicultural Research and Bee World 47(2): 156-163.

Central Cooperative Union. 1991. Industry standard (IS) 2567111-91, Bee Pollen, 1-7 (BG).

Dinkov, D., Balkanska, R., Stratev, D. and Mateev, St. 2014. Water and mineral content of Bulgarian bee pollen. Bulgarian Journal of Veterynary Medicine 17(1): 99-100.

Fuenmayor, C. A., Zuluaga-Domínguez, C. M., Díaz-Moreno, A. C., Quicazán, M. C., Cosio, M. S. and Mannino, S. 2014. Evaluation of the physicochemical and functional properties of Colombian bee pollen. Revista MVZ Córdoba 19(1): 4003-4014.

Ordinance №9 of 22 June 2005 on the Ministry of Agriculture and Forest, Issued by the Ministry of Agriculture and Forestry, Official Gazette 54 of 1.07.2005, Bulgaria.

Porrini, C., Ghini, S., Girotti, S., Sabatini, A.G., Gattavecchia, E. and Celli, G. 2002. Use of honey bees as bioindicators of environmental pollution in Italy, in: Devillers J., Pham-Delègue M.H. (Eds.), Honey bees: Estimating the environmental impact of chemicals, Taylor & Francis, London and New York, 186–247.

Saeheng, S., Wongnawa, M. and Purintavaragu, Ch. 2012. Chemical constituents and antioxidant activity of *Borussus flabellifer, Elaeis guineensis, Mimosa diplotricha* and *Mimosa pigr*a. Medicinal Chemistry and Drug Discovery 3(1): 52-57.

Zhelyazkova, I., Marinov, M. and Peneva, V. 2001. Honeybee and their products as bio-indicators for environmental pollution. I. Study on mineral content of body of bee-workers received different doses of microelements with their food. Zhivotnov'dni Nauki 38: 37-40.