ISAH 2005 - Warsaw, Poland
Vol 2

THE INFLUENCE OF ENVIRONMENT ON ACCUMULATION OF TOXIC ELEMENTS IN HONEY BEES' BODY

Adam Roman

Agricultural University of Wroclaw, Institute of Animal Hygiene and Environment
Chelmonskiego 38 C, 51-630 Wroclaw; e-mail: adamr@ozi.ar.wroc.pl

Key words: foraging bees, toxic elements, concentration

Introduction

Industrial dusts and smokes, exhaust gases, toxic gases, pest control products contain toxic elements that through oversupply can accumulate in the environment (air, soil and water) and are transferred to plant and animal organisms.

Honey bee (*Apis mellifera L.*) is a specimen bred by man that directly depends on toxicological condition of the environment in which it lives, since its existence is directly associated with the natural environment. Therefore, if it functions in polluted environment, plant products used by honey bee may also be contaminated and as a result also a part of these pollutants will accumulate in an organism [Accorti et al., 1990, Balestra et al., 1992, Roman 1997, Roman 2003, Roman 2004b]. The additional reason for the increase of the content of toxic elements in an organism of a bee is partial removal of pollutants into honey crop, during its processing with the formation of honey, the effect of which a part of them accumulates in bees organs [Jedruszuk 1987, Roman and Demenczuk 2003, Roman 2004a, Roman 2004c].

The aim of the present work was to assess the content of the chosen trace elements possessing toxic properties in organisms of working bee having collecting (foraging) function, originating from two regions: agricultural-forest and industrialized.

Material and methods

The site surveys were performed in two regions of various degree of environmental pollution with trace elements:

1. agricultural-forest region – apiary located in Szydlowice region,
2. industrialized region – apiary located ca. 3 km from the center of Wroclaw.

The studied samples were taken in June and July 2003. Bees were caught on beehive outlet – ca. 100 heads from a beehive, 16 samples of bees were taken from each beehive (totally 32 samples).

The collected samples of bees were decapitated through freezing and afterwards dried (at temperature of ca. 50 ^{o}C), grinded and thoroughly mixed for unification. Afterwards, from

each sample of the material, a weight of 1000 mg each was sampled and was diluted in 20 ml of spectrally pure nitric acid and afterwards were digested in the microwave oven MARS 5 from CEM under elevated pressure, in which digestion occurred in closed Teflon vessels.

The quantitative analysis of biological material for the content of trace elements, such as: cadmium, chromium, nickel, lead and selenium was performed with the use of plasma spectrometer ICP-OES from Varian [Gorecka 1995].

The obtained results of laboratory analyses underwent statistical elaboration with the use of Statgraphics ver. 5.1 software.

Results and discussion

The studies showed that in organisms of bees, various quantities of toxic elements were accumulated. The level of accumulation depended on the region from which bees originated.

Among the chosen elements, the highest levels were found in the case of selenium, independently on the region from which samples originated. The average concentration of this element from the region of Wroclaw was 4.07 and from Szydlowice 2.11 $mg \cdot kg^{-1}$ d.m. It is necessary to point out that selenium level ranged from 0.80 to 8.53 $mg \cdot kg^{-1}$ d.m. in industrialized region and from 0.80 to 3.93 in agricultural-forest region.

The results of the own study showed that the average level of lead in organisms of bees from the region of Wroclaw was 0.83 $mg \cdot kg^{-1}$ d.m., but in the samples from the first sampling was lower (0.64 $mg \cdot kg^{-1}$ d.m.), however from the second sampling was relatively higher (on the level of 1.01 $mg \cdot kg^{-1}$ d.m.). In the case of bees from agricultural-forest region, the average levels of lead were ca. 70 % lower when compared with that from the region of Wroclaw (table 1). When comparing the results from the present study with the data reported by other authors it is necessary to point out that there is no conformity.

Szymanowska-Bielawska [1981] reported the content of lead in body of bee on the level 2.18 $mg \cdot kg^{-1}$ d.m., but Jedruszuk after Bacilek [1987] showed diversified levels of lead in bees: from 0.9 to 1.5 $mg \cdot kg^{-1}$ from ecological regions and from 12 to 185 $mg \cdot kg^{-1}$ from industrialized regions, and Müller and Aghte [1988] from 15.12 to 29,59 mg/kg. However Kump et al. [1996] showed that in tissues of bee, the level of lead was from 4.7 to 11$\mu g/g^{-1}$ (that is 4.7-11 $mg \cdot kg^{-1}$). On the basis of these data, the values obtained in the present study might be considered as low.

In the performed studies, it was shown that the level of nickel in organisms of bees was low and was averagely 0.43 $mg \cdot kg^{-1}$ d.m. in the industrialized region and 0.34 $mg \cdot kg^{-1}$ d.m. in agricultural-forest region with discrepancy between the data from 0.07 to 2.72 and from 0.14

to 0.65 mg·kg^{-1} d.m., respectively. Significantly higher concentrations of nickel in the tissues of bees were reported by Kump et al. [1996] that presented the values in the range from 2.1 to 7.0 μg/g^{-1} (2.1-7.0 mg·kg^{-1}), that was over 10-fold higher when compared with the data obtained in the present study.

The next element, the concentration of which in an organism of a bee was analyzed was chromium. Similarly, as in the case of selenium and lead, also the concentration of this element was higher in bodies of bees that originated from industrialized region, since averagely, the content was evaluated as 0.20 mg·kg^{-1} d.m. (maximally 0.68 mg·kg^{-1} d.m.). However, in agricultural-forest region, the average content of chromium was reported on the level 0.15 mg·kg^{-1} d.m. (maximally 0.23 mg·kg^{-1} d.m.).

The lowest content in bodies of bees was found in the case of cadmium. The highest level of this element was reported in the material from agricultural-forest region where its average content was on the level 0.15 mg·kg^{-1} d.m., and maximally was evaluated as 0.30 mg·kg^{-1} d.m. In the industrialized region, cadmium content was reported on the level 0.13 mg·kg^{-1} d.m. (table 1).

The data obtained in the present study concerning accumulation of cadmium and chromium fit within the range of values presented by Szymanowska-Bielawska [1981] – 0.26 mg Cd and 0.97 mg Cr/kg d.m. and Roman [1997], that reported the following levels of cadmium below 0.51 mg/kg d.m., and for Cr below 0m39 mg/kg d.m. of bees. Significantly higher values for Cd in bees were reported by Jedruszuk [1987] after Szkoda (1.63 mg/kg) and after Bornus from 6 to 20 mg/kg of body mass. Similarly, in the case of chromium Kump et al. [1996] showed significantly higher contents of this metal than reported in the present work, on the level of 1.4 to 16.5 μg/g^{-1} (1.4-16.5 mg·kg^{-1}) depending on an analytical method used.

When comparing the level of the studied elements in organisms of bees it is necessary to stress that it depended on the region from which the samples originated. This means that the level of accumulation of these elements in bees' organisms depended on toxicological condition of the region from which the samples of bees originated.

Conclusion

1. The level of the studied trace elements in bees depended on the region from which the samples originated.
2. In the case of bees from industrialized region, higher accumulation of selenium, lead, nickel and chromium was reported, however in the case of bees from forest-agricultural

region, higher content of cadmium (ca. 15% when compared with industrialized region) was observed.

Table 1. The average levels of trace elements in organisms of working bees originating from the two studied regions

Studied region	Subsequent sampling	The content of the studied elements in $mg \cdot kg^{-1}$ d.m.				
		Ni	Cr	Pb	Cd	Se
Szydlowice	Sampling 1	0,42**	0,18**	0,29	0,16	2,38
	SD	0,16	0,05	0,09	0,05	0,99
	Sampling 2	0,27**	0,12**	0,28	0,14	1,84
	SD	0,14	0,05	0,12	0,08	1,20
	Average from both samplings	**0,34** [a]	**0,15**	**0,28** [A]	**0,15**	**2,11** [B]
	SD	0,17	0,06	0,10	0,06	1,10
Wroclaw	Sampling 1	0,36	0,16	0,64	0,10**	5,98**
	SD	0,15	0,04	0,48	0,02	2,77
	Sampling 2	0,50	0,23	1,01	0,17**	2,16**
	SD	0,91	0,19	0,91	0,03	2,32
	Average from both samplings	**0,43** [a]	**0,20**	**0,83** [A]	**0,13**	**4,07** [B]
	SD	0,63	0,14	0,73	0,05	3,16

** - differences highly statistically significant on the level $P \leq 0.01$ between samplings,
a – differences statistically significant on the level $P \leq 0.05$ between the studied regions,
A,B – the same letters in pairs, differences highly statistically significant on the level $P \leq 0.01$ between the studied regions.

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