STUDIES ON THE CONTENT OF HEAVY METALS IN BEE HONEY IN ECOLOGICAL POLLUTION ZONES

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The fast development of industry and agriculture during the last 50 years of the 20th century led to serious ecological problems. Nowadays more than ever humankind faces hazards endangering life on the planet, such as the industrial pollution of air, water and soil, accumulation of toxic wastes (heavy metals, pesticides, radionuclids and others), acid rains, deforestation, soil erosion, formation of deserts, global heating, destruction of the ozone layer of the atmosphere, everyday and unconditional disappearance of many plant and animal species, etc. This is why the scholars' attention is directed towards clarifying and solving ecological problems (MLADENOV et al., 1984), (PETKOV et al., 1995), FEODOROV et al., 1995).

GULYAS, (1983) and some other researchers assuming that bees enter into an immediate contact with the environment and interact, include them in systems for ecological monitoring of heavy metals, chlororganic pesticides, radionuclids and other toxic products harmful to man, animals and plants. (VELIMINSKY et al., 1990) thinks that bee honey and the contained harmful products in it, due to the contamination of the environment, can be used as an objective criterion for the pureness of nature. Many world research programmes aim at increasing crops of agricultural plants through pollination by bees, regulation of the biological equilibrium and protection of nature (BEGON et al., 1986), (MAHMASHARIPOV, 1989). Particular attention is paid to the importance of bees and their ability to restore vegetation in ecologically polluted regions (STECHE, 1975).

In view of the mentioned literary data on one hand and the lack of similar studies in Bulgaria on the other hand, these became prerequisites to carry out monitoring of heavy metals and some chemical elements in bee honey, in order to disclose the role of bee families in ecologically affected regions and the possibility of restoring the vegetation with the purpose of ensuring harmlessness of food and including bee families in the contemporary ecobiological systems for control of the environmental purity.

Material and Methods

The investigation was carried out in 1994-1995 on 150 samples of multicoloured bee honey. Samples were taken in accordance to law. The country territory was divided into two regions for easier control of environment – North and South Bulgaria, where the level of industrial pollution is different. The samples of bee honey were sent for analysis to the Central Veterinary Research Institute.

The concentration of heavy metals and other chemical elements (Pb, Zn, Cu, Ni, Mn, As, Co, Cd, Se, S, P, Na, K, Mg, Ca) in the samples was measured in mg/kg be means of the atomic emission spectrometry with generator of inductive coupled plasma, ICP – AES. For this purpose we used Spectroflame from Spectro Analytical Instruments.

To elucidate the role of bee families, composed of *Apis mellifera*, for the restoration of wild greenery, investigations were carried out 10-15 km away from the industrial polluting sites in the ecologically affected regions – Kardjali, Plovdiv, district of Sofia, accounting for:

1. adaptation possibility to these ecological conditions;
2. protection of nature through pollination by bees of wild-growing plants and introducing variety into vegetation.

The results obtained for all determinations are processed by a variation-statistical method.

Results and Discussion

The results of the investigations on the contents of heavy metals and some other chemical elements in multicoloured bee honey, produced in the period 1994-1995, are shown in Table 1.

It is noticed that Pb average values in the samples of bee honey, taken from various regions in North Bulgaria, fluctuate in the limits of 0.02 mg/kg for Veliko Tarnovo to 0.08 mg/kg for the samples from Targovishte. The average concentration of this toxic element for the northern part of the country is 0.053 mg/kg.

We obtained similar results for the samples of bee honey from different regions in South Bulgaria, where the lowest Pb average value was found in the region of Blagoevgrad – 0.05 mg/kg and the highest – 0.14 mg/kg in Sofia district. The total average value of Pb for South Bulgaria is 0.08 mg/kg, or with 0.029 mg/kg more than the data obtained for North Bulgaria.

It makes an impression that in the tested total 150 samples the Pb values in 21.33% reach 0.1 mg/kg and in some cases exceed this limit and fluctuate from 0.21 mg/kg to 0.37 mg/kg.

Table 1

Concentration of heavy metals and other chemical elements

Regions		n	Mean values of heavy metals and other chemical elements mg/kg															
			Pb	Zn	Cu	Ni	Fe	Mn	As	Co	Cd	Se	S	P	Na	K	Mg	Ca
N.	Silistra	5	0.05	5.30	0.07	0.20	7.60	0.04	0.08	0.02	0.01	0.11	37.80	44.01	99.30	372.06	20.04	43.71
B	Vidin	8	0.06	7.23	0.53	0.09	7.61	0.02	0.01	0.02	0.03	0.05	29.90	43.45	97.60	376.71	22.12	44.35
U	Montana	7	0.05	6.50	0.15	0.12	12.00	0.02	0.006	0.01	0.007	0.05	33.19	39.78	101.42	394.69	20.59	38.18
L	Ruse	8	0.07	6.02	0.10	0.07	9.40	0.05	0.03	0.003	0.02	0.07	35.11	35.93	104.40	368.47	22.60	37.50
G	Pleven	9	0.06	5.30	0.18	0.22	8.50	0.02	0.10	0.04	0.01	0.13	23.47	29.95	62.95	255.76	25.30	57.29
A	Vraca	9	0.04	6.50	0.08	0.23	13.90	0.01	0.05	0.02	0.012	0.14	27.00	39.40	53.10	357.54	27.63	39.74
R	Targovishte	9	0.08	3.81	0.08	0.22	8.71	0.14	0.10	0.01	0.04	0.10	23.27	30.50	48.40	342.85	26.16	40.08
I	Dobritch	9	0.05	5.08	0.07	0.10	8.78	0.23	0.10	0.02	0.001	0.12	36.60	37.45	107.23	228.10	20.20	53.61
A	V. Tarnovo	8	0.02	4.43	0.07	0.01	10.62	0.19	0.08	0.01	0.006	0.14	25.51	39.00	109.76	340.28	36.23	51.15
S.																		
B	Burgas	5	0.06	10.32	0.14	0.24	11.64	0.57	0.10	0.02	0.02	0.14	14.95	29.92	97.00	227.60	24.07	71.25
U	Sofia district	12	0.14	7.30	0.25	0.24	10.99	0.62	0.10	0.03	0.02	0.12	33.20	44.50	106.20	354.90	21.60	45.90
L	Blagoevgrad	13	0.05	6.02	0.10	0.19	8.57	0.22	0.02	0.01	0.03	0.15	30.00	39.30	85.40	317.95	58.47	48.58
G	Jambol	12	0.09	7.14	0.09	0.20	10.19	0.33	0.10	0.05	0.005	0.15	37.07	38.68	86.99	386.70	26.95	59.40
A	Haskovo	6	0.06	4.13	0.08	0.17	9.30	0.23	0.06	0.02	0.01	0.15	33.04	46.19	81.87	429.94	55.97	50.26
R	Pernik	13	0.08	5.95	0.09	0.21	9.02	0.25	0.07	0.03	0.005	0.17	46.60	47.80	82.92	404.86	31.31	45.72
I	Plovdiv	11	0.08	7.48	0.42	0.24	10.64	0.32	0.10	0.03	0.02	0.12	31.50	29.90	97.00	232.10	26.80	71.25
A	Kardzali	6	0.10	4.02	029	0.50	15.02	0.57	0.10	0.05	0.03	0.12	35.80	37.30	118.15	419.80	21.16	53.08

Here we have to point out that the determined average Pb values are close to the data indicated by MLADENOV et al., (1984), representing 0.1 mg/kg. Our results are lower than the Limit Admissible Concentrations (LAC) accepted in our country for milk – 0.1 mg/kg – and considerably lower for the other animal origin foodstuffs.

Similar are our results obtained for the contents of Zn, Cu, Ni, Fe, As and Cd, whose mean values for North Bulgaria are 5.57 mg/kg, 0,15 mg/kg, 0.11 mg/kg, 9.68 mg/kg, 0.07 mg/kg and 0.015 mg/kg. Near values to these levels are the obtained results for these elements in the samples of bee honey from South Bulgaria, whose values are respectively 5.82 mg/kg, 0.18 mg/kg, 0.25 mg/kg, 10.67 mg/kg, 0.08 mg/kg and 0.017 mg/kg.

The established differences in the higher levels of these elements in the samples from South Bulgaria, compared with those from the north part of the country, are statistically unreliable and are in the frames of statistical error. The obtained values in our study for these chemical elements are considerably lower than those accepted in Bulgaria and abroad (LAC) for animal food. In similar investigations in our country MLADENOV et al., find Cu and Zn contents in the range 0.1-13.5 mg/kg.

We have to note that our data are lower than the results obtained by FIODOROV et al. In analogous studies. The mean values of Cu, Zn, Pb, Ca, Ni, Co, Cr, Fe and Mn indicated by the the authors for bee honey are, respectively 0.05 mg/kg, 1,24 mg/kg, 2.1 mg/kg, 0.4 mg/kg, 2.1 mg/kg, 2.1 mg/kg, 1.1 mg/kg, 2.1 mg/kg and 6.2 mg/kg.

The proven values by us for the contents of S, P, Na, K, Mg and Ca comply with the accepted norms in our country and abroad and are near to the data of TASHEV et al. (1975).

The results of our investigations into the possibilities for restoring the vegetation in some ecologically affected regions for the period 1992-1995 indicate that a positive tendency is observed in this direction.

Supporting these considerations are the data from investigations in the regions around the towns of Kardjali, Plovdiv and Sofia district, where owing to the precautions for reducing the emission of toxic elements from the industrial enterprises - heavy metals and others – and locating bee families in the area, a richer yield of wildgrowing fruit – strawberries, raspberries, blackberries, apples, pears, plums, wild rose and others has been found. The pollination by bees aids the propagation of plants, providing food in this way to wild animals and birds. The bee families, located about 10-15 km away from the industrial polluting enterprises, were vital without any apparent changes in their health status. After the toxic emissions were reduced the bees accommodated to the enviroment, adapting closely to it. The productivity of the bee families depended directly on the climatic factors and diversity of wildgrowing plants. A significant increase of the gathered wild fruit has been reported – strawberries, raspberries and others – as the variety of plant species compared with the places where bee families have not been located.

We are aware that the natural relationship of bees and environment is very complicated and could not be assessed exactly as is the case of laboratory experiment with cultivated plants.

Similar are the assertions of LOUVEAUX, who affirms that the knowledge of the ecological importance of bees is partial and limited, which is explained by the negligence of people.

The analysis of our results shows that the bee families, and respectively the bee honey yield, can serve as an excellent biological indicator for the pureness of the environment and should be included in monitoring systems for various toxic products in view of removal or optimising of ecological damages.

The investigations carried out by us allow us to consider that the bee families can adapt well to the ecologically polluted regions of the country, located some 10-15 km away from the industrial polluting

enterprises. Due to the bees activity the yield of wildgrowing plants is increased and a greater variety of plants is achieved, thus improving the ecological equilibrium.

Conclusions

1. It is established that the average values of the detected heavy metals and other chemical elements in the tested samples of multicoloured bee honey are within the acceptable limits in our country and abroad for foodstuffs of animal origin.

2. The bee families and the honey yielded by them are suitable biological indicators for the pureness of the environment and can be included in the monitoring systems for optimizing or removal of the ecological damages in particular regions.

3. The bee families are adapted well in ecologically affected regions, 10-15 km away from the industrial polluting enterprises, and help in the recovery of wildgrowing plants and the regulation of the biological equilibrium.

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