Biogeochemistry of honey chemical elements

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Abstract. The quality of honey is reduced due to the fact that various insecticides and residues of acaricides fall into it. This is due, on the one hand, to frequent violation of instructions on the use of drugs - time of use, dose, frequency of processing and intervals between them, on the other hand, it is necessary to take into account the state of bee colonies and their nests. Violation of these requirements may lead to the ingress of toxic substances into food honey, as well as changes in the normal functioning of the metabolism in the body of insects.

1. Introduction
Studies to determine the level of chemicals in honeycomb were conducted in apiaries of the Ural Federal District (Tyumen, Chelyabinsk, and Kurgan regions) and Siberian Federal District (Omsk region and Altai Krai). It was noted that the honey samples of the Chelyabinsk region had a high propensity for the accumulation of pollutants, which is associated with a high anthropogenic load. The level of pollutants in the honey samples of these areas in descending order can be represented as follows: Chelyabinsk region > Kurgan region > Altai region > Tyumen region > Omsk region.

On the threshold of the third millennium, mankind entered a special period of its development, when anthropogenic activity becomes a geological force capable of changing the picture of the world, transforming the territory, and bringing out new varieties of plants and animal breeds. Improving the environment, preserving and multiplying the components of their biocenoses, leaving the untouched part of the landscape becomes more difficult. On the contrary, the economic activity of people that does not take into account environmental protection measures can put the world on the brink of a global ecological catastrophe [1]. Analysing today's environmental problems, it should be remembered that each generation of people leaves to descendants not only the remarkable fruits of their work, the results of science and practice, but also the depletion of the natural environment, air pollution and natural waters, soil and landscape degradation.

Most of the pollutants are deposited at a distance of 10–50 km from the source of pollution, spreading in accordance with the wind pattern, part of them enters the upper atmosphere and can be transported for many hundreds and even thousands of kilometres [2].

Increasing anthropogenic pollution of the environment in different zones and regions requires the study of this effect on bees and beekeeping.

The problem of producing high quality and safe bee products is currently being discussed all over the world. It has been established that the quality of bee products depends on many conditions. Sources of their pollution can be pollutants trapped in water, air, soil, honey-bearing vegetation, adversely affecting both the direct route and the indirect route. It is extremely important to place the apiary...
correctly, depending on the state of the environment, taking into account its pollution with pesticides, to monitor the condition of bee colonies and the health of bees [3-5].

2. Materials and research methods

The work was performed at the Department of Anatomy and Physiology of Northern Trans-Ural state agricultural university, from 2004 to 2014.

To study the ecological condition in the Northern Trans-Ural region, honey samples were taken at apiaries in the Tyumen, Kurgan and Chelyabinsk regions, as well as honey samples from apiaries of the Altai Territory and Omsk Region.

Samples were previously subjected to autoclave mineralization using ANKON - AT-2 device. Mobile TM forms in soil samples were extracted with an acetate-buffer solution with a pH of 4.8, after which the TM content in the extract and mineralizate was determined by an atomic absorption method on an AAS-3 and Kvant-Z ETA spectrophotometer (GOST 30692-2000). The Hg content was determined by flameless atomic absorption by the cold vapour method on a Julia-5K instrument. The level of Na and K was determined on the "PAGE-2U" device.

The content of residual quantities of pesticides was investigated by the method of gas-liquid chromatography on "Crystal - 2000" device.

The determination of the presence of radionuclides in samples of soil, plants and bee products was carried out in accordance with the methodological guidelines “Radiation monitoring. Strontium-90 and cesium-137. Food products. Sampling, analysis and hygienic evaluation”. Determination of cesium-137 radionuclides was performed by scintillation gamma spectrometry, and strontium-90 by scintillation beta spectrometry in native material on the Progress spectrometric complex on beta and gamma spectrometers using the native method according to the “Methodological guidelines for determining strontium-90 and cesium-137 in soils and plants” (MUK 2.6.717-98) [5].

Evaluation of the conformity of the quality of the studied samples was performed according to GOST 10 070-95; VP-13.5.13 / 09-00; SanPin 2.3.2.1078-01 in Bq/kg.

3. Research results

The results of the work performed indicate that the level of lead in the honey of different areas ranged from 0.26 to 1.17 mg/kg at maximum permissible concentration (MPC) of 1.0 mg/kg. The smallest value is registered in the honey of the Tyumen region (0.46 ± 0.02 mg/kg), the largest - in the Chelyabinsk region (0.96 ± 0.08 mg/kg), which is obviously related to the state of the environment (table 1).

| Regions          | Pb         | Cd         | As         | Cu         | Zn         |
|------------------|------------|------------|------------|------------|------------|
| Tyumen region    | 0.46±0.02  | 0.02±0,001 | 0.02±0.002 | 2.93±0.09  | 9.95±0.33  |
| Altai region     | 0.58±0.01  | 0.04±0,002 | 0.02±0.001 | 5.60±0.12  | 5.56±0.24  |
| Omsk region      | 0.91±0.01  | 0.03±0,001 | 0.05±0.003 | 5.63±0.12  | 5.89±0.12  |
| Kurgan region    | 0.82±0.02  | 0.01±0,001 | 0.02±0.001 | 5.89±0.21  | 4.41±0.11  |
| Chelyabinsk region| 0.96±0.08  | 0.05±0,003 | 0.05±0.003 | 6.97±0.27  | 9.40±0.32  |
| MPC              | 1.0        | 0.05       | 0.05       | -          | -          |

The content of cadmium in honey ranged from 0.006 to 0.09 mg/kg, its smallest value (0.01 ± 0.001 mg/kg) was observed in samples of honey from the Kurgan region, and the highest registered in the Chelyabinsk region (0.05 ± 0.003 mg/kg) (table 1).

Table 1 shows that in the honey samples the maximum level of copper (6.97 ± 0.27 mg/kg) was in the honey samples of the Chelyabinsk region, the minimum - in the samples of the Tyumen region (2.93 ± 0.09 mg / kg). In the honey of the Altai Territory, the amount of copper was 5.60 ± 0.12 mg/kg, the Omsk region - 5.63 ± 0.12 mg/kg, and Kurgan - 5.89 ± 0.21 mg/kg. The highest value of arsenic was
recorded in samples of honey in the Omsk and Chelyabinsk regions (0.05 ± 0.003 mg/kg), the smallest reading was observed in samples of the Tyumen, Kurgan regions and Altai region (0.02 ± 0.002 mg/kg). The highest zinc content was observed in the Tyumen samples (9.95 ± 0.33 mg/kg), a smaller amount in the samples of the Kurgan region (4.41 ± 0.11 mg/kg).

As for the amount of potassium, calcium and phosphorus in honeycomb, they are presented in Table 2.

| Regions          | K, mg %     | Ca, g/kg | P, g/kg |
|------------------|-------------|----------|---------|
| Tyumen region    | 78.9±8.16   | 2.5±0.08 | 1.3 ±0.06 |
| Altai region     | 125.0±12.36 | 1.9±0.04 | 2.6 ±0.07 |
| Omsk region      | 50.4±4.44   | 1.6±0.05 | 3.9±0.09  |
| Kurgan region    | 78.8±6.37   | 2.6±0.07 | 2.6±0.08  |
| Chelyabinsk region| 86.4±8.54   | 2.5±0.06 | 3.8±0.13  |

As a result of the research, it turned out that the level of radionuclides in honey samples collected directly from the nests of bee colonies at apiaries in the Ural Federal District and Siberian Federal District was within different limits. Thus, in samples of the Tyumen region, the amount of these substances was on average: cesium-137 - 15.6 ± 3.11 Bq/kg (for MPC 100 Bq/kg), strontium-90 - 2.4 ± 0.43. In the samples of honey in the Altai region, the level of these radionuclides was significantly higher and accordingly amounted to: cesium-137 - 35.4 ± 5.63 Bq/kg, strontium-90 - 28.30 ± 4.53 Bq/kg. In the Omsk region, cesium-137 was -13.2 ± 2.57 Bq/kg, strontium-90 - 1.30 ± 0.23 Bq/kg. In samples of honey of the Kurgan region, the level of these elements was: cesium-137 - 16.8 ± 3.63 Bq/kg and strontium-90 - 3.7 ± 0.53 Bq/kg, which is lower than in honey of the Altai region and higher than the Omsk region. In the samples of the Chelyabinsk region, the level of radionuclides was: cesium-137 - 18.3 ± 3.45 Bq/kg, strontium-90 - 6.3 ± 0.63 Bq/kg (figure 1).

![Figure 1. The amount of radionuclides in honey samples of Western Siberia and the Southern Urals, Bq/kg.](image)

The residual amount of pesticides in the samples was within the MPC (MPC for HCH and DDT in honey corresponds to 0.005 mg/kg) (figure 2).
4. Conclusion
Thus, the content of heavy metals, radionuclides and organochlorine pesticides in the samples of honey of the Ural Federal District and Siberian Federal District was within the limits of the permissible amount. It was noted that the honey samples of the Chelyabinsk region had a high propensity for the accumulation of pollutants, which is associated with a high anthropogenic load. The level of pollutants in the honey samples of these areas in descending order can be represented as follows: Chelyabinsk region> Kurgan region> Altai region> Tyumen region> Omsk region.

References
[1] Bannikov A G and Rustamov A K 1977 Protection of Nature (Moscow) pp 3-55
[2] Ilyin F E 2005 Regional features of environmental quality transformation and their reflection on the health status of the population of the Tyumen region Nature protection (Tyumen) pp 4-13
[3] Pomazkina L V and Lubnina E V 2002 Monitoring of contamination of arable soil and field crops in the emission zone of the Irkutsk Aluminum Smelter Agrochemistry 259-65
[4] Ishkildin A T and Ishemgulova N Z 2002 The ecological state of the natural environment of the South of the Pre-Ural steppe and mountain-forest zones of Bashkortostan New in science and practice of beekeeping 193-8
[5] Pashayan S A 2006 Migration properties of heavy metals Beekeeping 9 9-11