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Effect of heavy metals on food mobilization of honeybees

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Abstract
Bees and their products selectively accumulate some metals. Tissues of bees and perg accumulate cadmium and copper, propolis - zinc, honey and wax - cobalt. The task of our research was to identify the behavioral responses of bees to high concentrations of heavy metals. The article presents the results of the mobilization activity of feeding bees with the addition of heavy metals to sugar syrup, as well as the effect of heavy metals on food mobilization of bees. In model experiments using a feeder, with an increase in the concentration of heavy metals in the sugar syrup, the duration of feeding decreases. According to the results of the research, it was clarified that the aversive reaction of bees to heavy metals in the killing order is the following series: cadmium > lead > strontium > cobalt > zinc.

Keywords: Duration of feed intake, heavy metals, aversive reaction, sugar syrup, behavioral reactions.

Introduction
The amount of contaminants in beekeeping products is primarily due to the state of the environment at the apiary locations and the peculiarities of the applied technological processes [2]. Beekeeping products are contaminated with toxic substances not only from the atmosphere, but also through trophic bonds from the soil through plants to bees [1, 3]. Interest in researching this process is due to the fact that polluted beekeeping products not only harm hive residents, but also pose a threat to human health [11, 10]. Honey and beekeeping products have the ability to accumulate dangerous substances in order to human health in the soil, plants, water and air. This is one of the main factors causing beekeeping problems [4, 7].
Currently, researchers pay great attention to the issue of the migration of heavy metals along the chain of soil - plant - bee bodies - bee melt - beekeeping products [8]. Heavy metals with high toxicity accumulate in soil, plants, spread along trophic chains and pose a significant threat to not only humans, but also honey bees [6]. In the results of the scientific researches, it can be said that the content of heavy metals in inflorescences of honeybees is several times lower than in the soil on which they grow, and in the body of bees - slightly less than in plants [9]. Most of them accumulate in products that do not pass through the body of bees (propolis, pollen), and less - in products processed by bees (honey, perga), and the accumulation of toxic elements in wax occurs already outside the body of bees [12, 13].
However, these researches do not take into account the behavioral responses of bees to high concentrations of heavy metals in plants. The number of bees present on the sugar syrup feeder decreases dramatically with the addition of high concentrations of heavy metals [11].

The purpose of the research: Evaluate behavioral reactions and duration of feeding by bees depending on the concentration of heavy metals in it.

Research methodology: The research was carried out in experimental conditions on the apiary of Tashkent State Agrarian University. There were 100 bee families on the apiary. For the experiment, we selected 20 bee families. The duration of fodder intake was recorded by means of a device, which is a chamber of transparent organic glass, inside which a petri dish with a solution of sugar syrup is placed. The top of the camera is removable. A hole is made in the side wall through which one bee can pass. When the bees came up, it was kept open until 10 individuals appeared in the chamber.

Closing the entrance, the countdown of the time during which the bees consumed syrup began. After the last bee left the feeder, the end time of the feed was detected and the upper part of the chamber was opened, from where the bees flew freely. As ecotoxicants added to the syrup, heavy metals were used: zinc, lead, cadmium, cobalt, strontium. With each of these substances, syrup was prepared in several concentrations: 0.0001; 0,001; 0,01; 0,05; 0,1; 0,5; 1,0; 5,0; 10% (picture 3). The control was 50% sugar syrup without additives (picture 1,2). The duration of consumption of sugar syrup 219.8 ± 4.3 seconds. All variants were tested in 3-4 repetitions. Obtained data are statistically processed by method of paired comparisons according to Stuadent's criterion [5].

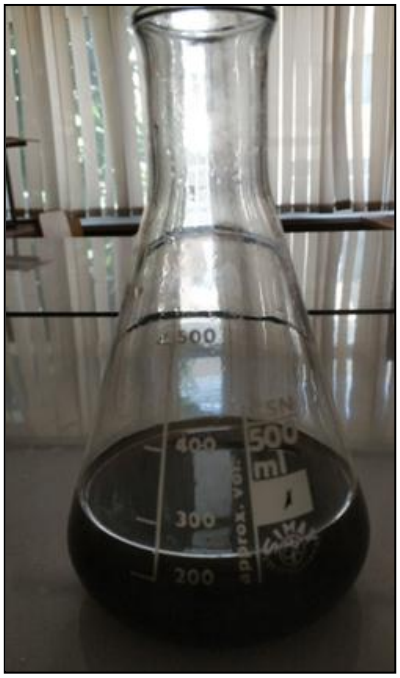
Results: With an increase in the concentration of all researching heavy metals, a natural decrease in the duration of feed consumption by bees is seen. However, different elements cause different reactions. Behavioral responses of bees to high concentrations of heavy metals are shown in Table 1.

Table 1: The average duration of intake of fodder by bees depending on the concentration of heavy metals in it, s

Concentration, %	Lead Pb	Zinc Zn	Cadmium Cd	Cobalt Co	Strontium St
0,0001	188±2,5	187±2,1	175±3,2	193±2,9	192±2,4
0,001	175±3,0	173±1,2	120±2,5	160±3,4	175±2,5
0,01	144±1,1	141±3,7	100±1,6	130±2,8	153±3,1
0,05	110±1,0	135±1,1	5,5±4,3	80±3,5	120±2,3
0,1	94±5,2	115±3,4	3,1±1,1	70±2,2	95±2,6
0,5	77±1,8	100±2,2	3,8±0,6	50±3,8	70±3,2
1,0	65±1,5	85±2,8	0,00	30±4,2	20±2,6
5,0	40±2,9	60±2,2	0,00	20±5,0	10±4,6
10	0,00	42±4,0	0,00	10±2,0	8±3,0

The results of research indicate that the consumption of sugar syrup with the addition of cadmium by bees stops at 1.0% - nom, and the duration of ingestion of food is on average 175 s. with 0.0001% - syrup, lead - stops at 10% - content, the duration of ingestion of lead is 10 times more than cadmium. This suggests that the behavioral response of bees and the reduction in feed intake from cadmium concentrations is higher than lead, strontium, cobalt and zinc. Average duration of feed intake with addition of 0.0001% strontium concentration is 4% more than lead, 5% more than zinc, 17% more than cadmium and 1% less than cobalt. At the same time, when strontium is added, the intake of feed lasts 8 ± 3.0 s even at a 10% concentration, and the intake of lead and cadmium at the same concentration absolutely ceases to eat. But by adding zinc, the feed intake lasts 42 ± 4.0 s even at 10% concentration, and cobalt additions at the same concentration reduce the food intake process to 10 ± 2.0 s, and strontium to 8 ± 3.0 s. Feed intake from zinc concentrations is 32% more than cobalt, and 34% more than strontium.

Picture 1, 2: Measurement of dry weight of sugar syrup



Picture 3: 10% cadmium concentration in 50% sugar syrup

Conclusions

Thus, in model experiments using a feeder, it was shown that with an increase in the concentration of heavy metals in the sugar syrup, the duration of feeding bees decreases. The correlation between the concentration of heavy metals added to the sugar syrup and the duration of ingestion of fodder by the bees suggests that significant concentrations of these substances in the plants cause an aversive reaction of the bees, which allows only partial ingress of heavy metals into beekeeping products and bee bodies. The aversive reaction of bees to heavy metals in the killing order is the following series: cadmium > lead > strontium > cobalt > zinc.

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