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Honey Contamination in the Republic of Kazakhstan

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***Abstract*—**This study involves detailed information about contaminants of honey in the Republic of Kazakhstan. The requirements of the technical regulation 'Requirements to safety of honey and bee products' and GOST 19792-2001 were taken into account in this research. Contamination of honey by antibiotics wqs determined by the IEA (immune-enzyme analysis), Ridder analyzer and Tecna produced test systems. Voltammetry (TaLab device) was used to define contamination by salts of heavy metals and gamma-beta spectrometry, 'Progress BG' system, with preliminary ashing of the sample of honey was used to define radioactive contamination. This article pointed out that residues of chloramphenicol were detected in 24% of investigated products, in 22% of them – streptomycin, in 7.3% - sulfanilamide, in 2.4% - tylosin, and in 12% - combined contamination was noted. Geographically, the greatest degree of contamination of honey with antibiotics occurs in the Northern Kazakhstan – 54.4%, and Southern Kazakhstan - 50%, and the lowest in Central and Eastern Kazakhstan with 30% and 25%, respectively. Generally, pollution by heavy metals is within acceptable limits, but the contamination from lead is highest in the Akmola region. The level of radioactive cesium and strontium is also within acceptable concentrations. The highest radioactivity in terms of cesium was observed in the East Kazakhstan region - 49.00±10 Bq/kg, in Akmola, North Kazakhstan and Almaty - 12.00±5, 11.05±3 and 19.0±8 Bq/kg, respectively, while the norm is 100 Bq/kg. In terms of strontium, the radioactivity in the East Kazakhstan region is 25.03±15 Bq/kg, while in Akmola, North Kazakhstan and Almaty regions it is 12.00±3, 10.2±4 and 1.0±2 Bq/kg, respectively, with the norm of 80 Bq/kg. This accumulation is mainly associated with the environmental degradation, feeding and treating of bees. Moreover, in the process of collecting nectar, external substances can penetrate honey. Overall, this research determines factors and reasons of honey contamination.

***Keywords*—**Antibiotics, contamination of honey, honey, radionuclides.

I. Introduction

IN recent years, there has been growing concern about honey contamination with medicines, especially antibiotics. These drugs can penetrate honey at all stages of its production: when bees are treated with antibiotics for such diseases as an American and European foulbrood, nosemosis, and when added to barrels with poor quality (old, immature) honey to prevent fermentation processes. The prevalence of the type of contamination, which includes the uncontrolled use of antimicrobial agents, is one of the topical problems of veterinary sanitation. In this case, we have analyzed the level of honey contamination with four kinds of antibiotics and provided its veterinary-sanitary assessment. Among the technogenic radionuclides, radioactive isotopes of cesium-137 and strontium-90 are revealed to be especially dangerous. The sources of the environmental contamination are nuclear weapon testing, nuclear power plants and reprocessing plants for nuclear waste. Radionuclides migrate in the following chain: atmosphere - soil - plants (nectar) - bees – products, including honey – human. These substances are able to accumulate and remain in the bee tissues and honey for a long time [1].

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II. Material and Methods

To determine the degree of honey contamination with antibiotics and radionuclides, 32 samples of honey were selected and divided according to the geographical range: East Kazakhstan - 12 samples, Central Kazakhstan - 10 samples, North Kazakhstan - 10 samples.

Determination of residual antibiotic amounts was implemented by ELISA (enzyme-linked immunosorbent assay). The study of honey samples for residual antibiotic amounts was carried out according to the methodology attached to the test systems. Test systems used were manufactured by Tesna (Italy). To measure the absorption coefficient, the Ridder 680 analyzer was used (Bio-Rad, USA).

The test basis is the antigen-antibody reaction. The determination of honey contamination with salts of heavy metals was carried out with a voltammetric analyzer TA-Lab using the method of inversion voltammetry after preliminary preparation of samples by a combination of "wet" and "dry" mineralization. Toxic elements, which are accumulated on the working electrode from the analyzed solution, are electrochemically dissolved at a reached potential of each element. The recorded maximum anode current of the element is linearly dependent on the concentration of the element being determined. The electrical dissolution of elements from the electrode surface and recording of analytical peaks on the voltammogram are carried out at a varying potential. Mass concentrations of elements in the sample are determined by the addition method of certified mixtures of elements [2]. Radioactive contamination was determined on the Progress-BG apparatus, with preliminary ashing of the honey sample. The gamma-beta-spectrometry "Progress-BG" complex is intended to determine the radionuclides of strontium-90 and cesium-137 in honey by radiochemical method [3]. Studies of honey contamination with pesticides were carried out on a liquid chromatograph SHIMADZU LC-20 Prominence. A 30 g honey sample is mixed with 3 g of anhydrous sodium sulfate and the pesticides are extracted three times with hexane in portions of 30 ml each time for 15 min, carefully rubbing the honey with a glass rod in a narrow beaker. The extracts are combined and the hexane is distilled off on a rotary evaporator to a volume of 30 ml or less, but then the extract is made up to 30 ml with hexane. A 30 ml volume of the extract is recorded in the chromatographic column with ASA silica gel, and the

extract is purified and the solvent is evaporated to a volume of 0.2-0.3 ml, then 1 ml of hexan is added. The resulting eluate is then analyzed with chromatography. The number of pesticides was calculated by:

$$X = \frac{A1S2}{PS1} \quad (1)$$

where **A1** is the sample content in a standard solution, μg; **S1** is the peak area of the standard solution, mm2; **S2** is the area of the sample peak, mm2; **P** is the mass or volume of the test sample, g or ml [4].

III. Results and Discussion

When studying honey for antibiotics, we found that 24% of samples had residual chloramphenicol, 22% - streptomycin, 7.3% - sulfanilamide, and 2.4% - tylosin (according to Fig. 1).

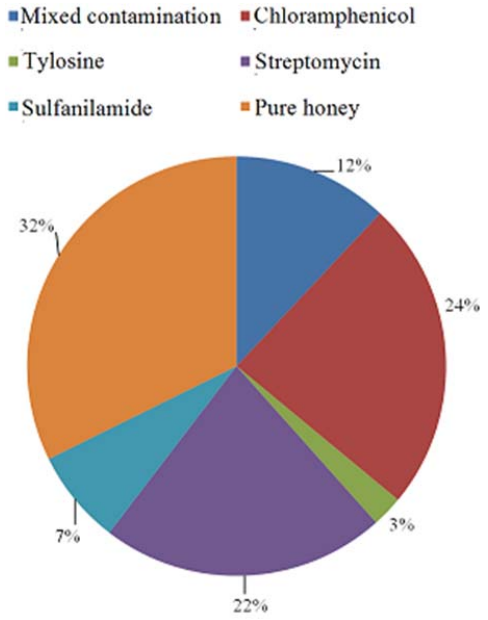

Fig. 1 Contamination of honey with antibiotics

As it can be seen from the results, the most abundant are chloramphenicol and streptomycin. 12% of samples contained 2 types of antibiotics, 2.4% - 3 types of antibiotics (According to Fig. 2).

According to geographical origin, the greatest degree of honey contamination with antibiotics is observed in the North Kazakhstan - 54.4%, and Almaty region - 50%, the smallest is in the Central and Eastern Kazakhstan, 30% and 25%, respectively (according to Fig. 3).

After analyzing our results, we can state that some types of honey in the Republic of Kazakhstan are contaminated with antibiotics. This indicates the possible uncontrolled consumption of them as a nutritional supplements and medicines. The veterinary-sanitary assessment of honey shows that the level of honey falsification with sugar is quite high, which leads honey to the category of a non-benign product.

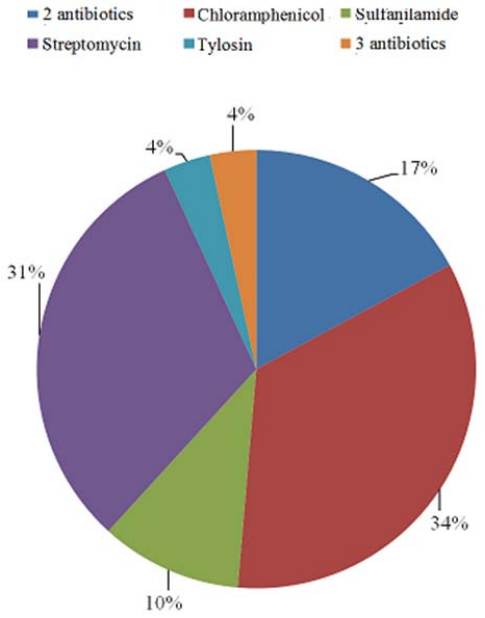

Fig. 2 Abundance of antibiotic groups

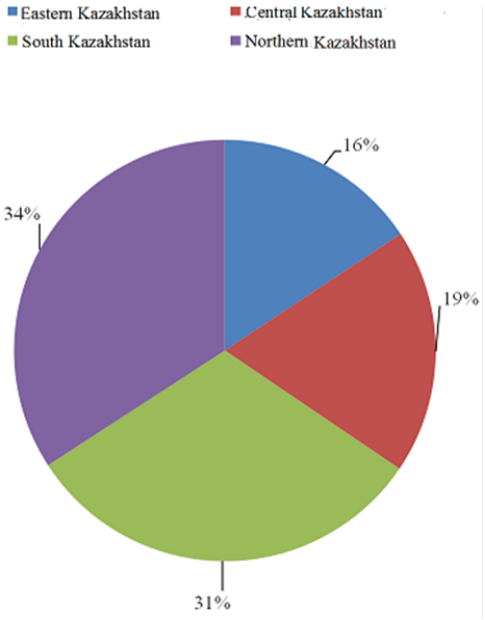

Fig. 3 Contamination of honey with salts of heavy metals

The results of contamination of honey with salts of heavy metals by region are shown in Table I. As it can be seen from Table I, contamination of honey samples by regions was within the permitted norm; however, the level of honey contamination with zinc in the North Kazakhstan and Almaty regions is 5-6 times higher than in other regions. Lead contamination is the highest in the Akmola region. Honey in the North Kazakhstan and Almaty regions is contaminated with copper.

We established the specific radioactivity of honey samples for two radionuclides, cesium-137 and strontium-90, in East Kazakhstan, Akmola, North Kazakhstan and Almaty regions. The results are shown in Table II.

TABLE I
CONCENTRATION OF SALTS OF HEAVY METALS BY REGION

The name of the indicator (mg / kg)	Standard	Region			
		East Kazakhstan	Akmola	North-Kazakhstan	Almaty
Zink	-	0.12±0.05	0.008±0.001	0.073±0.02	0.075±0.02
Cadmium	0.05	0.03±0.002	0.04±0.006	0.03±0.004	0.02±0.003
Plumbum:	1.0	0.43±0.08	0.94±0.23	0.8±0.2	0.059±0.02
Cuprum	-	-	-	0.8±0.05	0.7±0.03

TABLE II
LEVEL OF RADIOACTIVE CONTAMINATION OF HONEY (BQ/KG)

The name of the indicator, Bq / kg	Standard	East Kazakhstan region	Akmola region	North-Kazakhstan region	Almaty region
Activity 137Cs	100.0	49.00±10	12.00±5	11.05±3	19.0±8
Activity 90Sr	80.0	25.03±15	12.00±3	10.2±4	1.0±2

Table II shows that the level of cesium and strontium radionuclides is within the permitted concentrations. The highest radioactivity is observed in the East Kazakhstan region, where radioactivity in cesium was 49.00±10; in Akmola, North Kazakhstan and Almaty regions - 12.00±5, 11.05±3 and 19.0±8 Bq/kg, respectively, at a rate of 100 Bq/kg. According to strontium results, the radioactivity was 25.03±15 in the East Kazakhstan region, in Akmola, North Kazakhstan and Almaty regions - 12.00±3, 10.2±4 and 1.0±2, respectively, at a rate of 80 Bq/kg. This indicates a low level of radioactive contamination of honey in Kazakhstan

IV. CONCLUSION

To feed bee colonies, prevent and control bee diseases, antibiotics are widely used. Their residual concentrations, according to available information, are transferred by bees to honey and remain there for a long time [5].

The duration of antibiotic preservation in honey depends on its nature, origin, nature of interaction with its components, particularly with mono- and disaccharides. Individual antibiotics are preserved in commercial honey for more than three years. Such product can cause allergic reactions, disrupt the balance of the intestinal microflora. There are stable forms of microorganisms, and further use of antibiotics for therapeutic purposes becomes ineffective [6]-[8].

Markets of our country sell honey that was not tested for the presence of antibiotics. Lack of the necessary control often contributes to the unreasonable use of various antibiotics in beekeeping and significant excess of prescribed medicine doses. It was found that residual amounts of chloramphenicol were in 24% of samples, streptomycin - in 22%, sulfonamide - in 7.3%, and tylosin - in 2.4%. This indicates the possible uncontrolled consumption of these substances as nutritional supplements and medicaments.

Human industrial activity affects the environmental pollution. Migration of the toxic microelements in the environment leads to their accumulation in the body of bees, honey, beebread and in humans through beekeeping products [9].

The issue of honey contamination with pesticides is also actual. Many pesticides can accumulate in various environmental objects used by bees and enter the human body due to their resistive and cumulative properties. All these factors negatively affect the bees themselves [10]-[12].

Based on the results obtained in this study, it can be seen that the radioactive contamination of honey samples by regions was within the permitted norm, but the level of honey contamination in the East Kazakhstan region was two to three times higher than in other regions.

HCCH pesticides and their isomers, DDT and its metabolites were not detected. Thus, we can conclude the following: the investigated honey in the Republic of Kazakhstan was contaminated with antibiotics, HCH pesticides and their isomers; DDT and its metabolites were not contaminated; the level of honey contamination with salts of heavy metals was within the permitted norm. However, it should be noted that the data vary by regions, so the highest level of cesium in the East Kazakhstan region, of cadmium and lead - in the Akmola region, and of copper - in the North-Kazakhstan region. Radioactive contamination is also within the permitted limit, even though there is a difference between regional concentrations.

To obtain environmentally friendly honey, it is necessary to monitor the environment and restrict the use of chemical substances, and to control honey production at all stages, from apiary to sales.

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