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CONTENT OF CESIUM -137 IN FOOD PRODUCTS AND DRINKING WATER OF THE KASHKADARYA REGION OF THE REPUBLIC OF UZBEKISTAN

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Abstract

Radioactive substances can enter the body through the respiratory system, the gastrointestinal tract, contaminated water and food, as well as through damaged skin and even through intact skin. Cesium-137 is one of the most common artificial radionuclides, widely used in industry, medicine, and scientific research, which increases the likelihood of its release into the environment if radioactive sources are handled improperly. The relevance of this topic for the Kashkadarya region is due to the region's developed agricultural sector, extensive irrigated land, and the fact that a significant portion of the population obtains drinking water from underground and surface sources that undergo insufficient radiological monitoring. Despite this, data on the Cs-137 content in water and local agricultural products is limited, increasing the importance of assessing the radiation safety of food products.

The purpose of the study is to investigate the content of cesium-137 in agricultural products and drinking water produced in the Kashkadarya region of the Republic of Uzbekistan for the purpose of hygienic assessment of radiation safety.

One of the key tasks of radiation safety is the creation of an effective system for monitoring food products and drinking water. The primary route of cesium-137 entry into the human body is through the food chain. Cesium-137 accumulates primarily in muscle tissue and is the primary contributor to internal radiation doses.

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Introduction

Cesium-137 is a product of the nuclear fission of ^235U and ^239Pu and is one of the most dangerous radionuclides of man-made origin. Due to its high solubility and ability to form ions similar to potassium ions, Cs-137 is easily incorporated into biochemical processes. It is actively absorbed by plants from the soil and can penetrate the bodies of animals and humans. Unlike strontium-90, which accumulates in bone tissue, Cs-137 is predominantly distributed in soft tissues, especially muscle. Its biological half-life is 70–140 days, which, with constant intake, provides a stable background of internal irradiation.

The effect of Cs-137 on the body is associated with beta and gamma radiation, which damages cellular structures, which in the long term can cause:

- DNA mutations;
- weakening of the immune system;
- increased risk of cancer;
- endocrine regulation disorders;
- deterioration of cardiovascular function.

Therefore, the assessment of its content in food and water is an important element of sanitary and hygienic supervision.

The Kashkadarya region is one of the rapidly developing regions of the Republic of Uzbekistan. Large industrial enterprises, agricultural complexes, and water supplies are concentrated here, making the issue of ensuring the radiation safety of food and drinking water particularly pressing. Cesium-137 (Cs-137) is one of the most common man-made radionuclides formed during the fission of uranium and plutonium in reactors and nuclear explosions. With a half-life of approximately 30 years, it remains radioactive in the environment for decades, participates in biogeochemical cycles, and can enter the human body through food and drinking water. Cs-137 is a radionuclide that produces an internal dose and poses a potential health hazard when systematically consumed. Cs-137 is highly soluble, mobile, and bioaccumulative. In soil, it can remain attached to clay and organic matter for long periods of time, gradually migrating into plants and then into the food chain.

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The main routes of entry of Cs-137 into food include:

- absorption by plants from the soil;
- transition into milk and meat through animal feed;
- filtration into groundwater and surface water;
- contamination of vegetables and greens when irrigated with contaminated water.

The Kashkadarya region is characterized by a sharply continental climate, significant temperature fluctuations, low precipitation, and highly mineralized soils. Under these conditions, Cs-137 migration follows the following patterns:

1. Low humidity promotes the fixation of Cs-137 in the upper soil layers

In arid climates, radionuclides are less intensively washed out into the lower horizons and remain in the plant root zone .

2. A high proportion of clay fractions increases the sorption of Cs-137

The soils of the southern regions of the region contain silt, clays and carbonates, which are capable of binding radiocesium , which reduces its mobility, but increases the likelihood of its entry into plants.

3. Irrigated agriculture promotes the redistribution of Cs-137

Irrigation flow moves soil particles and can transport radionuclides over long distances, especially in poorly filtered and stagnant waters.

4. Organic matter enhances bioaccumulation

Plants grown in fertile and irrigated soils can absorb Cs-137 ions more quickly, increasing the likelihood of its presence in food products.

The most sensitive crops to the accumulation of Cs-137

Numerous studies show that different agricultural crops have different abilities to absorb cesium.

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Increased accumulation of Cs-137:

- wheat and other grains;
- cabbage and green leafy crops;
- potatoes, carrots, beets;
- melons and gourds;
- corn;
- rice (on irrigated lands);
- legumes.

Moderately accumulate:

- apples, grapes, pomegranate;
- onion, garlic;
- nuts.

Minimally accumulate:

- tomatoes, cucumbers;
- oil crops (sunflower, cotton).

However, at elevated concentrations of Cs-137 in the soil, even plants with low accumulating capacity may contain significant amounts of radiocesium .

Animal products as a source of Cs-137

Dairy products are a sensitive indicator of radiological contamination.

Reasons:

- rapid entry of Cs-137 into the animal body;
- transfer of radionuclide into milk within 12–24 hours;
- high bioavailability .

Milk and meat from animals grazing on irrigated pastures or fed feed containing elevated levels of Cs-137 may contain radionuclides at concentrations of interest for monitoring.

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Particularly sensitive:

- cattle;
- sheep and goats;
- bird - to a lesser extent.

This makes animal products an important subject of radiological monitoring in the Kashkadarya region.

Although Cs-137 usually migrates inactively into water horizons, a number of factors in Kashkadarya increase the likelihood of its presence in water:

1. Irrigation and reverse drainage , which promote the penetration of radionuclides into groundwater.

2. Use of shallow wells that are vulnerable to contamination.

3. Geochemical structure of the region , including mineralized and salt-containing layers.

4. Seasonal fluctuations in water levels that affect the concentration of dissolved substances.

Even with low Cs-137 soil levels, some agricultural crops can accumulate radionuclides due to the physiological properties of their root systems. International standards allow Cs-137 levels in various food products to range from 50 to 600 Bq/kg. For most regions of Uzbekistan, recorded values are typically well below these limits; however, the lack of comprehensive monitoring for Kashkadarya requires caution in these estimates.

To form an objective picture of radiation safety it is necessary:

1. Creation of a system of continuous radiological monitoring of soil, water and food products.
2. Conducting gamma spectrometric analysis of samples from various areas of the region.
3. Comparison of the obtained data with international and national standards.
4. Regularly informing the population about the radiation status of food and water products.

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Materials and methods of the study. Measurements of the specific activity of cesium-137 were conducted using gamma spectrometry on an MKGB-01 " Radek " spectrometer-radiometer in the research and testing radiology laboratory of the Center for the Development of Professional Qualifications of Medical Workers of the Ministry of Health of the Republic of Uzbekistan.

To determine cesium-137 levels in food products and drinking water, the following key procedures were performed: sampling, sample preparation , and preparation of counting samples, measurement of cesium-137 specific activity, calculation of measurement results and uncertainties, and assessment of compliance with radiation safety criteria. The summer-fall period was chosen for sampling, when most agricultural crops ripen in the Kashkadarya region.

Sample preparation and measurements were carried out in accordance with the "Methodology for measuring the specific activity of natural radionuclides, cesium-137, strontium-90 in samples of environmental objects and enterprise products using the MKGB-01 "RADEK" gamma and beta radiation spectrometer-radiometer and the MKSP-01 "RADEK" gamma spectrometer."

Results

To determine cesium-137, 17 samples of crop and livestock products and 4 water samples were collected from settlements in the Kashkadarya region. The results are presented in the table.

Table Content of Cs -137 in locally produced food products

No.	Types of samples examined	Quantity studied samples	The average specific activity of cesium-137	Sanitary Rules and Regulations (SanPiN) standard
1	Agricultural plants (fresh vegetables, fruits, herbs, melons, etc.)	12	1.7 ± 0.4 Bq/kg	120
2	Farm animals (beef, chicken, turkey, lamb)	5	7.1+ 4.2 Bq/kg	160 Bq/kg
3	Drinking water	4	0.08 ± 0.05 Bq/kg	11 Bq/kg

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Discussion

The study results show that there are currently no preconditions for contamination of food and drinking water with man-made radionuclides in the Kashkadarya region. Cesium-137 is detected in trace amounts in water and in minimal quantities in annual plants. Higher levels are observed in the meat of animals from local farms, which is due to the radionuclide's long-term accumulation.

In general, the content of cesium-137 in agricultural and livestock products, as well as in drinking water, does not exceed the requirements of SanPiN 0193-06 “Radiation Safety Standards (NRB-2006)” and SanPiN 0366-19 “Hygienic Standards for Food Safety”.

Conclusion

Despite low levels of cesium-137 in food and drinking water in the Kashkadarya region, systematic environmental radiation monitoring is necessary to ensure public health and safety. According to the modern concept of the biological effects of ionizing radiation, even small doses of radiation increase the likelihood of stochastic effects (genetic, carcinogenic, etc.), which may manifest themselves years later.

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