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Article

Radiomonitoring in the Dairy Farm "Sotarboev Muzaffar" Located in the Citizens' Assembly Territory of Amudarya District, Republic of Karakalpakstan

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Abstract: This article presents data on radiometric research conducted at the dairy farm "Sotarboev Muzaffar" located in the citizens' assembly territory of Amudarya district, Republic of Karakalpakstan. Soil, alfalfa, water reservoirs, and hay samples collected from the farm area were analyzed under laboratory conditions. Detailed results of radiometric measurements and laboratory investigations are provided.

Keywords: ionizing radiation, radioactive element, external gamma background, radioactive fallout, neutron, proton, dosimetry, muffle furnace, feed, nuclear reactions, radioactive isotopes.

Introduction

All living organisms on Earth are constantly exposed to ionizing radiation. According to their origin, ionizing radiation sources can be divided into three groups:

- Cosmic radiation;
- Natural radioactive substances present in geological formations, soil, water, air, plants, animals, and even in the human body;
- Artificial radionuclides formed as a result of nuclear weapons testing or nuclear power plant accidents (e.g., Chernobyl, Fukushima), as well as emissions from radioactive industrial facilities [1].

The first two groups form the natural background radiation. Artificial radionuclides may settle on the Earth's surface in the form of local, tropospheric, or global fallout. Under certain conditions, these sources can significantly affect animals and humans through internal and external exposure. The total radiation background is determined by the sum of external and internal radiation sources [2].

In addition to naturally occurring radioactive isotopes, numerous artificial isotopes are produced through nuclear reactions (e.g., neutron irradiation in reactors or bombardment with heavy particles). After nuclear tests or accidents, radionuclides such as I-131, Ba-140, Sr-90, and Cs-137 are released. Sr-90 and Cs-137 are the primary contributors to long-term global radioactive contamination. These radionuclides enter abiotic (water, soil) and biotic (plants, animals) components of the biosphere and participate in biological cycles. They may enter the human body via plant products or through animals consuming contaminated feed [3-4].

Objectives of Radioecological Monitoring

The main purpose of radiometric monitoring is to obtain objective data on radiation effects on crop production, livestock farming, and fisheries, especially near radiation-hazardous facilities such as nuclear power plants and industrial enterprises [5].

The main tasks include:

- Determining radioactive contamination pathways of soil, air, and water bodies;
- Assessing the radiation contamination level of the territory;
- Evaluating the current state and forecasting consequences of radioactive contamination;
- Developing recommendations to prevent and reduce radioactive contamination in populated areas;
- Implementing measures to limit radionuclide entry into animal feed and human diets [6].

Materials and Methods

Radiation monitoring included a network of control plots considering contamination sources, wind direction, land structure, soil characteristics, and pasture conditions.

Monitoring Objects:

- Agricultural soils (fields, gardens, pastures, hayfields);
- Agricultural crops and plant products;
- Feed, feed additives, and raw materials;
- Livestock facilities and feed storage units;
- Water reservoirs used for irrigation, livestock watering, and fisheries.

Water samples were collected 5 meters from the shoreline (or directly from livestock drinking systems). Samples were stored in 1.5-liter plastic containers pre-treated with dilute hydrochloric acid to prevent radionuclide adsorption. In the laboratory, 100–150 ml of water was evaporated at 100–105°C and the residue analyzed.

Plant and soil samples were collected annually during harvest using the envelope method from five points to obtain composite samples. Grain and flour samples were collected using the quartering method. Initial measurements were conducted using a field dosimeter (FDM), followed by laboratory analyses.

Research was conducted by specialists of the Biochemistry and Radiobiology Laboratory of the Veterinary Research Institute in cooperation with Amudarya district veterinary services. Samples of alfalfa, straw, wheat, and feed from storage facilities were collected.

Dosimetry Results

Dosimetric measurements were conducted at a dairy farm housing 85 cattle heads.

Measured dose rates (μR/hour):

- Alfalfa field (11 points, envelope method): 14.6 μR/h
- Behind farm gate and disinfection barrier: 13.7 μR/h
- Before disinfection barrier: 11.7 μR/h
- Maternity section: 10.7 μR/h
- Feeding section: 12.4 μR/h
- Feed storage: 13.3 μR/h
- Collector: 15.9 μR/h

- Water reservoir: 12.1 μR/h
- Staff rest area: 10.1 μR/h
- Milk containers: 9.2 μR/h
- Inside building: 11.4 μR/h
- Livestock shelter (shade): 9.3 μR/h

Measurements were conducted under calm, cloudless weather conditions at an ambient temperature of 37–38°C, at a distance of 1 m (6–9 cm above surface) [7-8].

In a 100×100 m pasture area:

- Highest point: 15.9 μR/h
- Center: 12.3 μR/h
- Lowest point: 8.1 μR/h [9].

Laboratory Analysis

- Green mass samples (~250 g each) were:
- Dried at 90–120°C to constant weight (45–50 g);
- Carbonized at 100°C for 24 hours;
- Ash-treated in a muffle furnace at 400–500°C [10].

Ashing coefficient:

$Koz = M / -m$

Where:

M – mass of raw sample

m – mass of ash

Ash samples were analyzed for Cs-137 using the radiochemical method of B.P. Kruglikov (1967), based on cesium hexachlorotellurite precipitation from hydrochloric acid solution. Spectrometric measurements were then performed [11-12].

Conclusion

The measured external radiation doses did not exceed natural background levels. Laboratory analyses showed no detectable Cs-137 in soil, hay, or water samples. The results confirm that the farm territory is radiologically safe and poses no radiation hazard to livestock or human health.

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