AMERICAN Journal of Pediatric Medicine and Health Sciences
Volume 4, Issue 04, 2026 ISSN (E): 2993-2149

Radiomonitoring at the Meat-Oriented Farm "Soatov Otabek" in the Amudarya District of the Republic of Karakalpakstan

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Abstract: This article presents the results of radiometric monitoring conducted at the meat-oriented agro-farm "Soatov Otabek," located in the Amudarya district of the Republic of Karakalpakstan. Samples of soil, alfalfa, water bodies, and hay collected from the farm territory were analyzed under laboratory conditions. The levels of ionizing radiation and the presence of radioactive substances were determined. Based on the obtained results, the radiation status of the farm environment was evaluated and compared with established regulatory standards. The findings confirm the importance of radiomonitoring in ensuring environmental safety and the quality of livestock products.

Keywords: Radioactive elements, ionizing radiation, 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, sources of ionizing radiation can be divided into three main groups. The first group includes cosmic radiation. The second group consists of natural radiation from radioactive substances found in the Earth's crust, soil, water, air, plants, animals, and even the human body. These two groups together form the natural background radiation [1].

The third group includes artificial radionuclides formed as a result of nuclear weapons testing or accidents at nuclear power plants (such as Chernobyl and Fukushima), which are deposited on the Earth's surface in the form of local, tropospheric, or global fallout. Additionally, radioactive substances may be released into the environment during the operation or decommissioning of nuclear and industrial facilities. Under certain conditions, all these sources can significantly affect animals and humans through both external and internal radiation exposure. The total contribution of internal and external sources determines the overall radiation background [2].

In addition to naturally occurring radioactive isotopes present in natural mixtures of elements, many artificial isotopes are produced through nuclear reactions, such as neutron irradiation of stable elements in nuclear reactors or bombardment with heavy particles. In the first months following nuclear tests or accidents, the mixture of fission products typically includes isotopes such as I-131, Ba-140, and Sr-90, and later Sr-90 and Cs-137, which constitute the majority of global radioactive contamination [3].

Radioactive products of nuclear fission, deposited either through dry fallout or more commonly through precipitation (wet deposition), enter both abiotic components (water, soil) and biotic components (plants and animals) of the biosphere, becoming part of biological cycles. In this process, radioactive substances can enter the human body through plant-based foods or through animals that have consumed contaminated feed [4].

Objectives and Tasks of Radioecological Monitoring

The main objective of radiometric monitoring is to obtain objective information on the impact of radiation on crop production, livestock farming, and fisheries, especially in areas near radiation-hazardous facilities such as nuclear power plants and industrial enterprises emitting harmful substances into the atmosphere [5-6].

The main tasks of radiometric monitoring include:

1. Identifying pathways of radioactive contamination of soil, air, and water bodies by radionuclides [7].
2. Determining the level of radiation contamination in the area [8].
3. Assessing the current state and forecasting the consequences of radioactive contamination [9].
4. Developing recommendations to prevent and reduce radioactive contamination in populated areas.
5. Implementing measures to limit the intake of radionuclides into animal feed and the human diet [10].

Materials and Methods

The monitoring system for assessing contamination levels and the condition of agroecosystems is based on a network of control sites and monitoring points. These are established considering factors such as the location of contamination sources, prevailing wind directions, the spread of radioactive pollution, land use patterns, and the characteristics of soil cover and pastures used for agricultural animals.

Radiation Monitoring Objects

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

Water samples were collected at a distance of 5 meters from the shoreline. If the water source was used for livestock watering or automatic drinking systems, samples were collected in 1.5-liter plastic containers pre-treated with a weak hydrochloric acid solution to prevent radionuclide adsorption onto container walls. In the laboratory, part of the water sample (100–150 ml) was evaporated at a temperature of 100–105°C in a drying oven, and the residue was analyzed.

Samples of agricultural crops and soil were collected once a year during the harvest period. To ensure reliable results, plant samples were collected using the “envelope method” from five points to form a composite sample. The sample size varied depending on the type of agricultural product.

During the study, grass samples were collected from typical pastures where cattle were grazed. Since radioactive fallout depends on terrain, sampling points were selected both in lowland areas and in remote desert pastures far from roads.

Grain, bran, and flour samples were collected from different parts of the bulk using the quartering method. Samples weighing at least 1–2 kg were taken for analysis. Preliminary measurements were carried out using a field dosimeter (FDM), followed by detailed laboratory analysis using standard methods.

Based on the above objectives and tasks, researchers from the Biochemistry and Radiobiology Laboratory of the Veterinary Research Institute conducted scientific investigations at the "Soatov Otabek" agro-farm in the Amudarya district of the Republic of Karakalpakstan. Samples of alfalfa, straw, stored feed, compound feed, and wheat from the farm and its surrounding areas were collected and analyzed. The research was carried out in collaboration with veterinary specialists of the Amudarya district.

Results and Discussion

Radiometric monitoring was conducted at the meat-oriented agro-farm "Soatov Otabek," which includes a dairy unit with a capacity of 202 cattle. The study aimed to assess the external gamma radiation levels across different functional zones of the farm and surrounding pasture areas [11].

Dosimetric measurements were carried out using a field dosimeter under stable meteorological conditions (calm, cloudless weather, ambient temperature 37–38°C). Measurements were taken at a height ranging from 6–9 cm up to 1 m above the surface. The terrain was flat, minimizing geomorphological influence on radiation distribution [12].

***Table 1*. External Gamma Radiation Levels at Different Farm Locations**

No.	Measurement Location	Dose Rate (μR/h)
1	Alfalfa field (10-point average, envelope method)	15.6
2	Entrance (behind gate and disinfection barrier)	14.7
3	In front of disinfection barrier	13.7
4	Maternity unit	12.7
5	Feeding section	11.4
6	Feed storage facility	14.3
7	Collector area	14.9
8	Water reservoir	11.1
9	Staff rest area	10.1
10	Milk containers	9.3
11	Inside building	10.4
12	Livestock shelter (shade)	8.3

The obtained results indicate that the highest radiation level was recorded in the alfalfa field (15.6 μR/h), which can be explained by open exposure to environmental radiation sources. Slightly elevated values were also observed near the collector and farm entrance, possibly due to localized accumulation of radionuclides [13].

The lowest radiation levels were recorded in shaded livestock areas (8.3 μR/h) and milk container zones (9.3 μR/h), which are relatively protected from direct environmental exposure.

Field Radiation Assessment

Additional measurements were conducted in a 100×100 m grassland area with a flat landscape. Using the envelope method (5 measurement points), the following results were obtained:

Maximum dose rate: 15.6 μR/h

Central area: 12.4 μR/h

Minimum (lowland) area: 8.1 μR/h

This variation demonstrates that radiation distribution is influenced by microrelief and environmental factors. However, all values remained within the natural background radiation range [14].

Laboratory Analysis

Green biomass samples (alfalfa, hay, feed materials) were analyzed using standard radiochemical methods.

The analytical procedure included:

Drying samples at 90–120°C to constant weight

Carbonization at 200°C for 24 hours

Ashing in a muffle furnace at 400–500°C

The ash coefficient was calculated using:

$$K_{ash} = \frac{M}{m}$$

Radiochemical analysis of cesium-137 (Cs-137) was conducted using the Kruglikov method (1967), followed by spectrometric measurement.

***Table 2.* Laboratory Analysis Results**

Sample Type	Cs-137 Detection	Safety Assessment
Soil	Not detected	Safe
Hay	Not detected	Safe
Water	Not detected	Safe
Feed	Not detected	Safe

The results confirmed the absence of radioactive cesium (Cs-137) in all analyzed samples [15].

Conclusion

The radiometric monitoring conducted at the "Soatov Otabek" agro-farm showed that:

1. External gamma radiation levels across all measured locations remain within natural background limits.
2. No radioactive contamination (Cs-137) was detected in soil, feed, water, or plant samples.
3. The farm environment is radiologically safe for livestock production and does not pose a risk to human health.
4. These findings highlight the effectiveness of regular radiomonitoring in ensuring environmental safety and maintaining the quality of agricultural products.

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