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Monitoring the radioecological state of the agroecosystem of the Navbahor area, Bekabad district, Tashkent region (a case study of the Khoji-Ahmad farm)

Toshkent viloyati Bekobod tumani Navbahor hududidagi agroekotizimning radioekologik holatini monitoring qilish («Xoji-Ahmad» fermer xo'jaligi misolida)**Мониторинг радиоэкологического состояния агроэкосистемы территории Навбахор Бекабадского района Ташкентской области (на примере фермерского хозяйства «Ходжи-Ахмад»)****B. N. KHAKIMOV¹, H. N. HOJIQULOV¹, J. R. AYUPOVA¹**¹ Scientific-Research Institute of Veterinary, Uzbekistan**ARTICLE INFO****ARTICLE TYPE**

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AUTHOR, TITLE AND ABSTRACT METADATA (EN / UZ / RU)**ENGLISH****B. N. KHAKIMOV¹, H. N. HOJIQULOV¹, J. R. AYUPOVA¹**¹ Scientific-Research Institute of Veterinary, Uzbekistan

Abstract. This article presents the results of radiometric studies conducted at the Khoji-Ahmad dairy farm located in the Navbahor area of the Bekabad district, Tashkent region. To assess the radiological status of the farm comprehensively, laboratory analysis was performed on samples of soil, water bodies and livestock feed supplies, specifically alfalfa and hay. On the basis of the empirical laboratory data the local radiation background was evaluated, and evidence-based conclusions and practical recommendations were developed to ensure the ecological safety and radiological purity of dairy products in the region.

Keywords: radiometric studies; Bekabad district; dairy farm; radiation-hygienic assessment; radioactive isotopes; ambient gamma background; ionizing radiation; livestock feed; soil and water samples; environmental safety; caesium-137

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Annotatsiya. Ushbu maqolada Toshkent viloyati Bekobod tumanining «Navbahor» hududida joylashgan «Xoji-Ahmad» sut yo'nalishidagi fermer xo'jaligida o'tkazilgan radiometrik tadqiqotlar natijalari yoritilgan. Tadqiqot vaqtidagi radiatsion-gigiyenik holatni har tomonlama baholash maqsadida xo'jalik hududidagi tuproq, suv havzalari, shuningdek chorva ozuqasi hisoblangan beda va pichan namunalarida radiatsiyaviy ko'rsatkichlar va radionuklidlar miqdori laboratoriya sharoitida atroflicha tahlil qilingan. Olingan tahlil natijalari asosida hududning radiatsion foni holatiga baho berilgan hamda sut yo'nalishidagi chorvachilik mahsulotlarining ekologik xavfsizligi va radiatsion tozaligini ta'minlash bo'yicha ilmiy xulosalar va amaliy tavsiyalar ishlab chiqilgan.

Kalit so'zlar: radiometrik tadqiqotlar; Bekobod tumani; sut yo'nalishidagi fermer xo'jaligi; radiatsion-gigiyenik baholash; radioaktiv izotoplar; tashqi gamma-fon; ionlashtiruvchi nurlanish; ozuqa bazasi; tuproq va suv namunalari; ekologik xavfsizlik; seziy-137

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Аннотация. В данной статье представлены результаты радиометрических исследований, проведённых в молочном фермерском хозяйстве «Ходжи-Ахмад», расположенном на территории «Навбахор» Бекабадского района Ташкентской области. Для комплексной оценки радиационно-гигиенической обстановки в лабораторных условиях был проведён детальный анализ образцов почвы, водоёмов, а также кормовых культур (люцерны и сена), отобранных на территории хозяйства. На основе полученных экспериментальных данных дана оценка уровню естественного радиационного фона и разработан научно обоснованный комплекс выводов и рекомендаций, направленных на обеспечение экологической и радиационной безопасности животноводческой продукции.

Ключевые слова: радиометрические исследования; Бекабадский район; молочное фермерское хозяйство; радиационно-гигиеническая оценка; радиоактивные изотопы; внешний гамма-фон; ионизирующее излучение; кормовая база; образцы почвы и воды; экологическая безопасность; цезий-137

1. KIRISH

Introduction

Yer yuzidagi barcha tirik organizmlar hayoti davomida doimiy ravishda ionlashtiruvchi nurlanish ta'sirida bo'ladi. Ionlashtiruvchi nurlanish manbalari kelib chiqishiga ko'ra uch asosiy guruhga ajratiladi.

Birinchi guruhni kosmik nurlanish tashkil etadi. Ushbu nurlanish Quyosh va boshqa kosmik jismlardan kelib chiqadigan yuqori energiyali zarrachalar oqimi bo'lib, atmosfera orqali Yer yuzasiga yetib keladi. Kosmik nurlanishning intensivligi dengiz sathidan balandlik, geografik kenglik hamda atmosferaning fizik holatiga bog'liq holda o'zgarib turadi.

Ikkinchi guruh tabiiy radioaktiv manbalardan iborat bo'lib, ularga Yer qobig'idagi tog' jinslari, tuproq, suv, atmosfera havosi, o'simlik va hayvonot dunyosi, shuningdek inson organizmida tabiiy ravishda uchraydigan radionuklidlar (^{238}U , ^{232}Th , ^{40}K va boshqalar) kiradi. Mazkur radionuklidlarning tabiiy parchalanishi natijasida hosil bo'ladigan ionlashtiruvchi nurlanish kosmik nurlanish bilan birgalikda tabiiy radiatsion fonni shakllantiradi. Tabiiy radiatsion fon biosferaning ajralmas tarkibiy qismi bo'lib, barcha tirik organizmlar evolyutsiyasi davomida ushbu omil ta'siri ostida rivojlangan.

Uchinchi guruh sun'iy radionuklidlardan iborat bo'lib, ular asosan yadroviy qurol sinovlari, atom energetikasi obyektlaridagi avariya va radioaktiv materiallardan foydalanuvchi sanoat korxonalari faoliyati natijasida atrof-muhitga tushadi.

2. MATERIALLAR VA METODLAR

Materials and methods

Kuzatuv punktlarini tanlashda quyidagi mezonlarga alohida e'tibor qaratildi: radiatsion xavf tug'dirishi mumkin bo'lgan sanoat obyektlarining joylashuvi; shamol yo'nalishi va atmosfera massalarining harakatlanish xususiyatlari; mavjud yoki ehtimoliy radioak-

tiv ifloslanishning tarqalish yo'nalishi; yer resurslaridan foydalanish tarkibi va agroekotizimning funksional tuzilishi; tuproq qoplami turlari va ularning fizik-kimyoviy xususiyatlari; chorva mollari yaylovlari hamda yem-xashak ekinlari joylashgan maydonlar; sug'orish tarmoqlari va suv manbalarining hududiy joylashuvi.

Tadqiqot davomida hududning tashqi gamma-fon doza quvvati radiometrik asboblardan yordamida o'lchandi. Olingan natijalar radiatsion monitoring bo'yicha amaldagi me'yoriy hujjatlar talablari asosida baholandi. Kuzatuv natijalari statistik usullar yordamida qayta ishlanib, hududning radioekologik holati kompleks tahlil qilindi. Monitoring ma'lumotlari asosida tadqiqot hududining radiatsion xavfsizlik darajasi baholandi hamda agroekotizimning ekologik barqarorligini ta'minlashga qaratilgan ilmiy-amaliy tavsiyalar ishlab chiqildi.

3. TADQIQOT NATIJALARI VA ULARNING TAHLILI

Results and discussion

Radioekologik monitoring doirasida tadqiqot obyekti sifatida Toshkent viloyati Bekobod tumani Navbahor hududida joylashgan «Xoji-Ahmad» fermer xo'jaligi tanlandi. Monitoring ishlari Veterinariya ilmiy-tadqiqot instituti Biokimyo va radiobiologiya laboratoriyasi mutaxassislari tomonidan fermer xo'jaligi veterinariya shifokori ishtirokida amalga oshirildi.

Monitoring dasturiga muvofiq radiatsion nazorat obyektlari sifatida qishloq xo'jaligi yerlari, yem-xashak ekinlari, chorvachilik binolari, yem omborlari, suv manbalari hamda chorva mollari boqiladigan yaylovlar tanlandi. Tadqiqot davomida tashqi gamma-fon doza quvvati dala sharoitida portativ dozimetr yordamida aniqlandi. O'lchovlar shamolsiz va bulutsiz ob-havo sharoitida, havo harorati 28°C bo'lgan vaqtda, yer yuzasidan 5–8 sm hamda 1 m balandliklarda bajarildi. Kuzatuv punktlari agroekotizimning relyefi, shamol yo'nalishi va yerlardan foydalanish xususiyatlari hisobga olingan holda tanlandi.

1-jadval

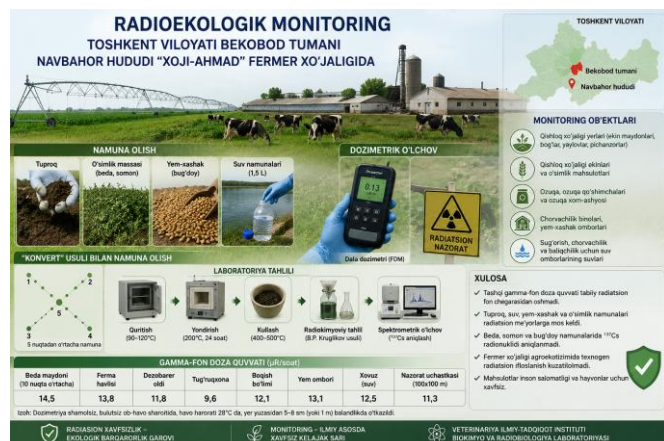
Monitoring natijalari / Table 1. Monitoring results

Kuzatuv obyekti	Gamma-fon doza quvvati ($\mu\text{R}/\text{soat}$)
Beda maydoni (10 nuqta bo'yicha o'rtacha)	14,5
Ferma hovlisi	13,8
Dezobaryer oldi	11,8
Tug'ruqxona	9,6
Boqish bo'limi	12,1
Yem saqlash ombori	13,1
Suv havzasi	12,5
Nazorat uchastkasi (100 × 100 m)	11,3

Barcha o'lchovlar bir xil ob-havo sharoitida, yer yuzasidan 5–8 sm va 1 m balandlikda bajarilgan.

Olingan natijalar tadqiqot hududida tashqi gamma-fonning tabiiy radiatsion fon chegarasida ekanligini ko'rsatdi. Kuzatuv nuqtalari bo'yicha qayd etilgan ko'rsatkichlar o'rtasidagi tafovutlar hudud relyefi, tuproqning fizik xususiyatlari va tabiiy radionuklidlarning notekis taqsimlanishi bilan izohlanadi.

Monitoring davomida laboratoriya tahlillari uchun 1 kg tuproq, 1 kg yem-xashak va 1,5 litr suv namunalari olindi. Suv namunalari oldindan xlorid kislotasining suyultirilgan eritmasi bilan ishlov berilgan plastik idishlarga yig'ildi; ushbu usul radionuklidlarning idish devorlariga adsorbsiyalanishining oldini olish imkonini berdi. Laboratoriyada suv namunalari 100–150 ml hajm ajratilib, 100–105 °C haroratda bug'latildi va hosil bo'lgan qoldiq radiometrik tahlil qilindi.



1-rasm. Radioekologik monitoring natijalari / **Fig. 1.** Results of the radioecological monitoring

O'simlik namunalarini tanlashda «konvert» usuli qo'llanildi: har bir maydondan beshta nuqtada namuna olinib, o'rtacha aralash namuna shakllantirildi. Bundan tashqari, chorva mollari iste'mol qiladigan yaylovlardan yashil massa, yem omboridan bug'doy va somon namunalari olindi.

Laboratoriya tahlili uchun yashil massa namunalari dastlab 90–120 °C haroratda doimiy massagacha quritildi. So'ngra namunalar 200 °C da karbonizatsiya qilinib, keyinchalik 400–500 °C haroratda mufel pechida to'liq kul holatiga keltirildi. Hosil qilingan kul namunalari radioaktiv sezii (^{137}Cs) miqdori B.P. Kruglikov tomonidan tavsiya etilgan radiokimyoviy usul asosida aniqlandi. Ushbu metod seziiy geksaxlortellurit birikmasi ko'rinishida ajratib olish va keyinchalik spektrometrik tahlil qilishga asoslanadi.

Laboratoriya tekshiruvlari natijasida beda, somon va bug'doy namunalari ^{137}Cs radionuklidi aniqlanmadi. Shuningdek, tuproq va suv namunalari ham radiatsion ko'rsatkichlar amaldagi radiatsion xavfsizlik me'yorlaridan oshmaganligi qayd etildi. Olingan natijalar fermer xo'jaligi agroekotizimida radiatsion fonning tabiiy darajada ekanligini hamda texnogen radionuklidlar bilan ifloslanish kuzatilmaganligini ko'rsatdi.

4. XULOSALAR

Conclusions

1. Tadqiqot hududidagi tashqi gamma-fon doza quvvati 9,6–14,5 $\mu\text{R}/\text{soat}$ oralig'ida bo'lib, tabiiy radiatsion fon chegarasidan oshmadi.
2. Tuproq, suv, yem-xashak va o'simlik namunalari radiatsion ko'rsatkichlar amaldagi radiatsion xavfsizlik me'yorlariga mos ekanligi aniqlandi.
3. Beda, somon va bug'doy namunalari radiokimyoviy tahlillar natijasida ^{137}Cs radionuklidi aniqlanmadi; bu qishloq xo'jaligi mahsulotlarining radiatsion jihatdan xavfsizligini tasdiqlaydi.
4. Fermer xo'jaligi hududida texnogen radiatsion ifloslanish belgilari kuzatilmadi va agroekotizimning radioekologik holati barqaror deb baholandi.

5. Olingan natijalar hududda yetishtirilayotgan yem-xashak va chorvachilik mahsulotlari radiatsion xavfsizlik talablariga javob berishini hamda inson salomatligi va hayvonlar uchun radiatsion xavf mavjud emasligini ko'rsatdi.

Shu bilan birga, radiatsion vaziyatni uzoq muddatli nazorat qilish maqsadida qishloq xo'jaligi yerlari, suv manbalari va yem-xashak mahsulotlarida radioekologik monitoringni muntazam ravishda davom ettirish tavsiya etiladi.

DECLARATIONS

Declarations

Author contributions CRediT

Conceptualization; Methodology; Investigation; Data curation; Formal analysis; Writing – original draft; Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

Funding

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Ethics approval

The work consisted of radiometric measurements and laboratory analysis of soil, water and feed samples carried out in accordance with the requirements in force in the Republic of Uzbekistan. It involved no experiments on animals and no human participants.

Informed consent

All authors have read and approved the final version of the manuscript and have given their consent to its submission and publication. The study involved no human participants and no personal data.

Data availability statement

All data supporting the findings of this study are presented in the article and are available from the corresponding author upon reasonable request.

Conflict of interest

The authors declare no conflict of interest.

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Generative AI disclosure

Generative AI was used only partially. The authors used Claude (Anthropic, Opus 5) for language editing, formatting of the reference list and preparation of the English and Russian metadata. No text, data, figures or conclusions were generated by AI. The authors reviewed and verified all output and take full responsibility for the content of the publication.

EXTENDED SUMMARY IN ENGLISH

Kengaytirilgan inglizcha xulosa / Расширенный реферат на английском языке

Purpose and research problem

All living organisms are continuously exposed to ionizing radiation throughout their lives, and the sources of that radiation fall into three main groups: cosmic radiation, whose intensity varies with altitude above sea level, geographical latitude and the physical state of the atmosphere; natural radioactive sources, comprising the rocks of the Earth's crust, soil, water, atmospheric air, plants, animals and the radionuclides occurring naturally in the human body, such as uranium-238, thorium-232 and potassium-40, whose decay together with cosmic radiation forms the natural radiation background; and artificial radionuclides, which enter the environment mainly as a result of nuclear weapon tests, accidents at nuclear power facilities and the activity of industrial enterprises using radioactive materials. The Bekabad district of the Tashkent region is one of the largest industrial areas of the republic, and the presence of ferrous metallurgy there makes it necessary to establish whether livestock production in the surrounding agroecosystems remains radiologically clean. The purpose of this study was to assess the radioecological state of the agroecosystem of the Navbahor

area of the Bekabad district, using the Khoji-Ahmad dairy farm as a case study, to measure the ambient gamma dose rate at the principal points of the farm, to determine the radionuclide content of soil, water and feed, and on that basis to develop practical recommendations for ensuring the ecological safety and radiological purity of dairy products.

Materials and methods

The monitoring was carried out by specialists of the Laboratory of Biochemistry and Radiobiology of the Scientific-Research Institute of Veterinary together with the veterinarian of the farm. Observation points were selected with regard to the location of industrial facilities that might present a radiation hazard, the prevailing wind direction and the movement of air masses, the likely direction of spread of existing or potential radioactive contamination, the pattern of land use and the functional structure of the agroecosystem, the types of soil cover and their physical and chemical properties, the location of pastures and fodder crops, and the layout of irrigation networks and water sources. The objects of radiation control were agricultural land, fodder crops, livestock buildings, feed stores, water sources and grazing pastures. The ambient gamma dose rate was determined in the field with a portable dosimeter; measurements were made in windless, cloudless weather at an air temperature of 28 °C, at heights of 5–8 cm and 1 m above the ground surface. For laboratory analysis 1 kg of soil, 1 kg of feed and 1.5 litres of water were collected. Water samples were collected in plastic containers pre-treated with dilute hydrochloric acid to prevent adsorption of radionuclides onto the container walls; in the laboratory 100–150 ml aliquots were evaporated at 100–105 °C and the residue analysed radiometrically. Plant samples were taken by the envelope method, five points per field being combined into one average sample; green mass was taken from the pastures and wheat and straw from the feed store. For analysis the green mass was first dried at 90–120 °C to constant mass, then carbonized at 200 °C and finally ashed completely in a muffle furnace at 400–500 °C. Caesium-137 in the ash was determined by the radiochemical method recommended by B.P. Kruglikov, based on the separation of caesium as a hexachlorotellurite compound followed by spectrometric analysis. The results were processed statistically and evaluated against the requirements of the normative documents in force for radiation monitoring.

Results and discussion

The ambient gamma dose rate recorded at the eight observation points of the farm ranged from 9.6 to 14.5 µR/h. The highest value, 14.5 µR/h, was obtained as the mean of ten points in the alfalfa field, followed by the farmyard at 13.8 µR/h, the feed store at 13.1 µR/h, the water reservoir at 12.5 µR/h, the feeding section at 12.1 µR/h, the area in front of the disinfection barrier at 11.8 µR/h and the control plot of 100 × 100 m at 11.3 µR/h; the lowest value, 9.6 µR/h, was recorded in the calving house. All these figures lie within the limits of the natural radiation background, and the differences between the observation points are explained by the relief of the area, the physical properties of the soil and the uneven distribution of natural radionuclides. Laboratory examination showed that the radionuclide caesium-137 was not detected in the samples of alfalfa, straw or wheat. The radiation indicators of the soil and water samples likewise did not exceed the radiation safety norms in force. Taken together, the field measurements and the laboratory analyses show that the radiation background in the agroecosystem of the farm is at its natural level and that no contamination with technogenic radionuclides was observed.

Conclusion and contribution

The radioecological monitoring carried out in the agroecosystem of the Khoji-Ahmad farm in the Navbahor area of the Bekabad district permits the following conclusions. The ambient gamma dose rate in the study area lay between 9.6 and 14.5 µR/h and did not exceed the limits of the natural radiation background. The radiation indicators of the soil, water, feed and plant samples were found to comply with the radiation safety norms in force. Radiochemical analysis did not detect caesium-137 in the samples of alfalfa, straw or wheat, which confirms the radiological safety of the agricultural products. No signs of technogenic radioactive contamination were observed on the territory of the farm, and the radioecological state of the agroecosystem was assessed as stable. The results show that the feed and livestock products produced in the area meet radiation safety requirements and that no radiation hazard exists for human health or for the animals. At the same time, in order to maintain long-term control of the radiation situation, it is recommended that radioecological monitoring of agricultural land, water sources and feed

products be continued on a regular basis. The contribution of this work lies in providing documented baseline radiological values for a dairy agroecosystem situated in an industrial district, against which future measurements can be compared.

ADABIYOTLAR RO'YXATI

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