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Radiation safety exploration of New Moscow territory for potential medicinal plant raw materials production

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Relevance of the study

In the pharmaceutical industry, medicinal plant raw materials that contain different types of biologically active substances are widely used to manufacture medicines. The World Health Organization reports that herbal products are used by more than 60% of the world's population, and in developing countries, it reaches 80% [1,2].

The pharmaceutical production of plant raw materials can be assured by procuring wild-growing medicinal plants, but there are currently many limitations. Wild medicinal plant raw materials are difficult to harvest in modern conditions due to the risk of their extinction in nature and environmental pollution. The use of many medicinal plant species is often hindered by their inability to form extensive thickets. The situation is also complicated by a lack of human resources and the insufficiently controlled export of medicinal plant raw materials abroad.

Even though there are limitations, the industry still struggles with insufficient implementation of resource development activities at the national level [1]. The area of the Russian Federation is about 17 million km^2, of which 13.1 million km^2 is the natural habitat of wild-growing medicinal plants [3]. Ensuring radiation safety is a component of the ecological well-being required for the harvesting of raw materials. It is necessary to maintain a healthy growing environment.

Aim and objectives

The aim of the work is to assess the radiation safety of the environment of the territory of New Moscow and the possible use of this area for harvesting medicinal plant raw materials. The following aims have been established for this study:
1) To investigate the occurrence of medicinal plant species in the study area;
2) To create a radiation safety map of the study area;
3) To analyze the radioactive isotopes present in the water and soil of the study area.

Materials and methods

The northern suburbs of Kuzovlevo village, located in Rogovskoye settlement in the Moscow region, were selected for analysis and were the site of heavy fighting in 1941. In the aftermath of World War II, the aforementioned location was utilized for agricultural pursuits. The area remains unused presently. The period of study for this zone spanned three days.

As part of the study, a radiation protection map was prepared using a dosimeter-radiometer "DRBP-03" (State Register of Measuring Instruments of the Russian Federation No. 16370-97). A remote detection unit was used to record the ß-particle flux density [$Sm^{-2}\cdot s^{-1}$] along the route. Plant species found were documented and water and soil samples were collected.

The samples collected were analyzed on the «MKS-01A MULTIRAD» spectrometer (State Register of Measuring Instruments of the Russian Federation No. 32716-06) in the geometry of a Marinelli vessel.

Results and discussions

The expedition identified over 150 plant species, including 38 medicinal plants listed in the current pharmacopoeia. The ASTERACEAE family, with over 15 species, followed by POLYGONACEAE and ROSACEAE, as well as EQUISETACEAE and BETULACEAE comprised the majority of the plant species found in the area. The key medicinal plant species are listed in Table 1.

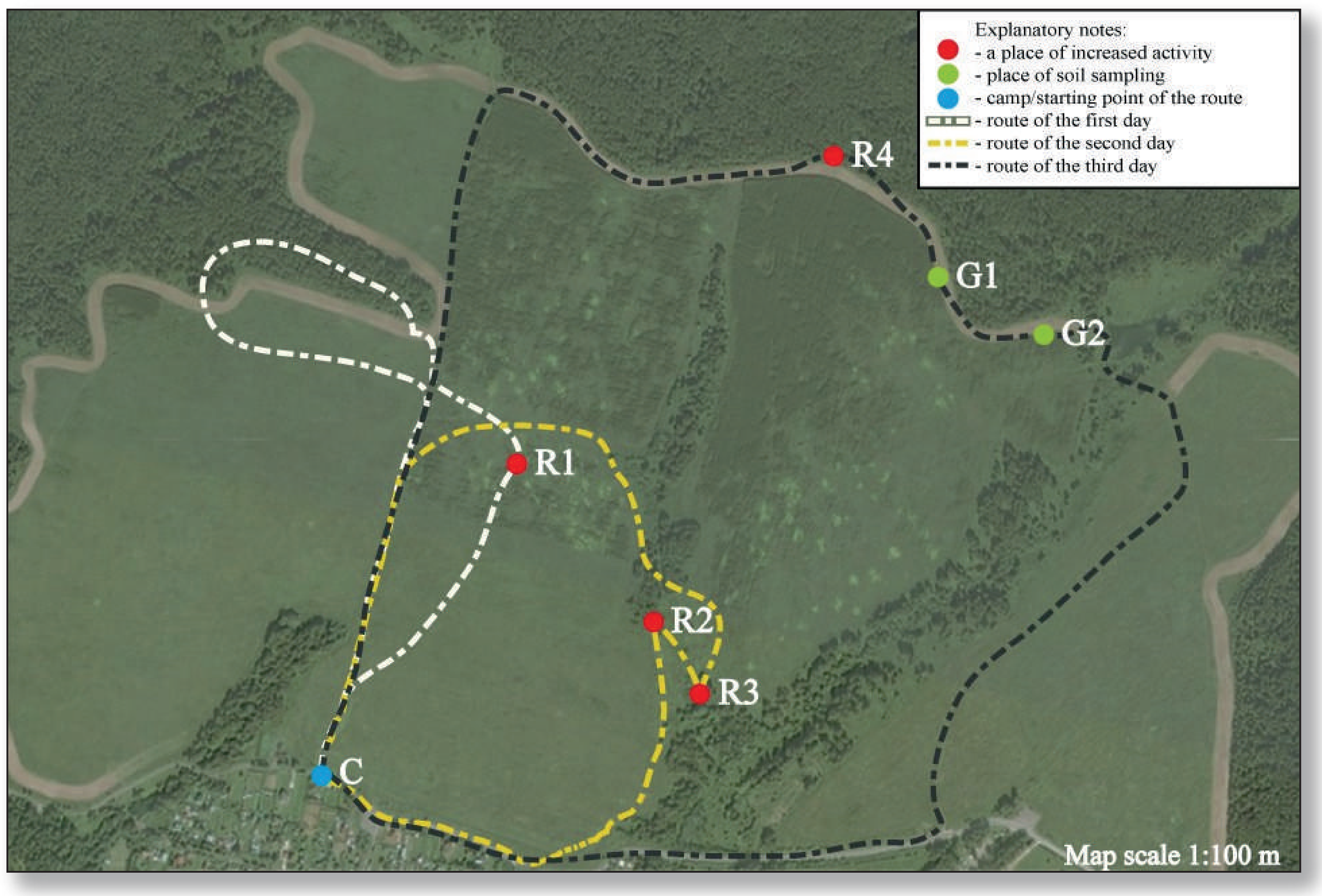
Species of medicinal plants growing in the territory of Rogovskoye settlement in New Moscow

Table 1.

Plant family	Species of medicinal plants	
ASTERACEAE	• Centaurea cyanus L. • Inula helenium L. • Arctium lappa L. • Taraxacim officinale Wigg. • Tanacetum vulgare L.	• Artemisia absinthium L. • Matricaria recutita (Purbs.), Nutt.,Chamomilla recutita (Purbs.) Rydb. • Gnaphalium uliginosum L. s I. • Achillea millefolium L. s I. • Bidens tripartita L.
BETULACEAE	• Betula pendula Roth. • Betula pubescens Ehrh.	• Alnus incana (L.) Moench. • Alnus glutinosa (L.) Gaerth.
FABACEAE	• Melilotus officinalis (L.) Lam.	• Trifolium hybridum L. • Trifolium pratense L.
FAGACEAE	• Quercus robur L.	
VALERIANACEAE	• Valeriana officinalis L.s.I	
GENTIANACEAE	• Centaurium erythea L.	
HYPERICACEAE	• Hypericum perforatum L.	• Hypericum maculatum Crantz.
POLYGONACEAE	• Polygonum persicaria L. • Polygonum hydropiper L. • Polygonum aviculare L.	• Rumex confertus Willd. • Rumex crispus L. • Rumex obtusifolius L.
BRASSICACEAE	• Thlaspi arvense L.	
URTICACEAE	• Urtica dioica L.	
PLANTAGINACEAE	• Plantago major L.	
ROSACEAE	• Aronia melanocarpa L. • Fragaria vesca L. • Potentilla erecta L.	• Rubus idaeus L. • Alchemilla vulgaris L.
PINACEAE	• Picea abies L.	• Pinus sylvestris L.
CRASSULACEAE	• Sedum telephium L.	
EQUISETACEAE	• Equisetum arvense L.	

The diagram displays the paths taken by the expedition (Figure 1). The journey consistently commenced and terminated at point C.

Fig. 1. Map of the explored area.



In the analysis of the terrain, the average level of ß-particle flux density fell within the range of 0.18 – 0.22 ± 0.08 $Sm^{-2}\cdot s^{-1}$ and did not surpass the set limit of 0.25 $Sm^{-2}\cdot s^{-1}$ [4]. The map highlights in red those regions where the acceptable limit of the defined feature was marginally surpassed (Table 2). At locations R1, R2, and R4, this outcome may be due to a significant presence of fungi. Certain species of fungi can accumulate isotopes of Cs^{137}. Location R3 is an area of anthropogenic origin, which may also be the cause of the overestimation of the defined characteristic. Additionally, the existence of a few unusual areas can be attributed to measurement errors as the equipment nears the limit of its measurable range.

The value of the ß-particle flux density at anomalous locations

Table 2.

Locations	ß-particle flux density, $Sm^{-2}\cdot s^{-1}$
R1	0,27 ± 0,10
R2	0,28 ± 0,10
R3	0,35 ± 0,11
R4	0,28 ± 0,10

Soil sampling sites are marked in green color. These sites were selected based on their distance from settlements and areas with increased activity. Following laboratory sample analysis, the results are presented in Table 3. The indicators fall within normal range, indicating the safety of soil in regards to economic activities and radiological hazards.

Specific activity of major isotopes in soil samples

Table 3.

	Isotope	Value, expressed in Becquerels per kilogram (Bq/kg).
G1	^{137}Cs	< 6.1.
	^{226}Ra	19.2 ± 6.7
	^{232}Th	35.4 ± 8.4
	^{40}K	540 ± 130.0
G2	^{137}Cs	5.1 ± 3.7
	^{226}Ra	25.8 ± 7.4
	^{232}Th	35.5 ± 8.5
	^{40}K	580 ± 140

During the study, the intention was to gather water samples from nearby springs. Nevertheless, the local streams have dried up as a result of seasonal changes, thereby making the collection of water samples unfeasible.

Conclusions

After analysing all the data collected in the field and examining the samples in the laboratory, it was possible to determine that despite the proximity of the Obninsk NPP, the territories of New Moscow near the village of Kuzovlevo, Rogovskoye settlement in the Moscow region are favourable places for agricultural activities from the point of view of radiation safety.

The diversity of medicinal plant species growing in the area may serve as a basis for harvesting wild plant raw materials in the future. However, more research is needed to make more accurate predictions.

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