



# Environmental Monitoring of Atmospheric Air Pollution with Radionuclides Using Moss Bioindicators

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## Abstract

The purpose of our research was to identify the degree of air pollution with radionuclides using moss bioindicators. We studied samples of moss and soil (near Mingechaur, Baku) to identify the bio-indicator properties of moss and for bioindication of air and soil. We studied samples of moss, soil and water near Mingechaur city and Baku city regions. The activity of radionuclides were determined on Gamma spectrometer. Determination of content and activity of the radionuclides in the tests of soil, plant and water, was carried out at "Canberra" (USA)  $\gamma$ -spectrometer with high a purity germanium detector (HP Ge). It was determined the activity of radionuclides ( $^7\text{Be}$ ,  $^{40}\text{K}$ ,  $^{60}\text{Co}$ ,  $^{208}\text{Tl}$ ,  $^{134}\text{Cs}$ ,  $^{137}\text{Cs}$ ,  $^{210}\text{Bi}$ ,  $^{212}\text{Bi}$ ,  $^{212}\text{Pb}$ ) in the samples of of moss, soil and water samples taken from the Mingechaur region and in Baku region of the Azerbaijan Republic. As a result of the research it was revealede the activity of  $^{40}\text{K}$  was more than other isotopes (648,1 Bq/kg). It was found out  $^7\text{Be}$  of activity 79.08 Bq/kg,  $^{214}\text{Pb}$  of activity 62.62Bq/kg,  $^{214}\text{Bi}$  of activity 28.74 Bq/kg,  $^{137}\text{Cs}$  of activity 14.01 Bq/kg,  $^{134}\text{Cs}$  of activity 12.15 Bq/kg,  $^{60}\text{Co}$  of activity 11.34 Bq/kg and others, which were more in Mingechaur region than in Baku.

**Keywords:** Pollution; Radionuclides; Moss; Bioindicators; Environmental; Biomonitoring.

## 1. Introduction

Rapid industrialization in cities and the contributory relationships with the original pollution sources can cause serious environmental problems within cities [1-4].

Currently, methods based on the use of natural plates, which include mosses, are actively developing to assess the degree of air pollution by radionuclides and other toxic elements.

Mosses are effective accumulators of pollutants contained in the atmosphere. Biomonitoring of atmospheric pollution with radionuclides and other chemical elements using moss is one of the simplest, most promising and effective methods for monitoring, detecting and evaluating changes in air quality.

One of the most important ecological features of mosses as a tool for biomonitoring is that mosses have a high accumulation capacity and a large surface, are widely distributed, have a long life cycle (from 1 year to 15 years) and survive in a highly polluted environment.

The moss biomonitor method is based on a comparative analysis of the concentrations of chemical elements in mosses, selected at different points of the study or background area. The method allows to determine the most polluted zones, monitor the dynamics of air pollution, and with known background concentrations, it makes it possible to quantify the average pollution levels without determining the LPC.

Mosses are living organisms of the plantae kingdom and classified in the phylum bryophyta. They grow in forests, on rocks, on trees, bare soil, cracks of concrete side walls, on burnt bricks on abandoned automobiles, and uncompleted buildings [5].

Previous research works have shown that mosses have proven to be better bioindicators of pollution because they are more sensitive to atmospheric pollution [6].

Meanwhile, atmospheric metals pollution in Nigerian cities has been reported Ojiodu, *et al.* [7] reported that the atmosphere of Owode - onirin in Lagos - state, Southwestern, Nigeria is highly polluted with the heavy metals: Zinc Zn (66.01%), Lead Pb (15.99%), Copper Cu (12.79%), Chromium Cr (2.89%), Nickel and Ni (2.25%) [7].

Autors analyses the level of antioxidants (water-soluble antioxidants, carotenoids, and anthocyanins) in plants under the conditions of environmental cadmium pollution. The authors emphasise excessive background concentration of cadmium in plant samples collected in Kaliningrad and note a positive correlation between cadmium concentration and traffic intensity. A negative correlation between the Cd content and the antioxidatic status of plants and a positive one with the anthocyanin content were established in the course of research [8].

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Mosses are comparatively more effective at accumulating elements and heavy metals than other plant species. Therefore, moss biomonitoring was used as a complementary technique alongside classic instrumental methods in air pollution detection and control. Also, mosses have been used as bioindicators for terrestrial long-lived radionuclides ( $^{40}\text{K}$ ,  $^{238}\text{U}$ , and  $^{232}\text{Th}$ ) and artificial radionuclides ( $^{137}\text{Cs}$ ,  $^{90}\text{Sr}$ , and  $^{239+240}\text{Pu}$ ) in the environment [9-12].

Authors study was undertaken as of radiological and chemical air pollution on both the European and Asian sides of Istanbul, Turkey. In this framework, radionuclide activity concentrations and selected metal amounts in moss samples collected from urban, suburban, industrial, and green zone areas in Istanbul were determined following the moss biomonitoring technique. The activity concentrations in the moss samples vary from 2 to 20 Bq/kg for  $^{226}\text{Ra}$ , from 4 to 23 Bq/kg for  $^{232}\text{Th}$ , and 359 to 2,809 Bq/kg for  $^{40}\text{K}$  for both sides of the city. Concentrations of Al, As, Cd, Cr, Cu, Fe, Hg, Ni, Pb, Sb, V, and Zn were determined by ICP-ES. Additionally, potential ecological impacts of atmospheric deposition for selected metals based on moss analysis around Istanbul were assessed. Results show that the enrichment factor for the European side was greater than 10 for Pb [13].

Based on the above, the purpose of this work was a qualitative and quantitative assessment of atmospheric air pollution with radionuclides to study regional and local pollution of both atmospheric air and the soils of the studied area by environmental pollutants during biomonitoring of biospheric pollution.

In experimental studies as a bioindicator for air bioindication and determining the degree of contamination of the biosphere with environmental pollutants, we used moss collected in the vicinity of Mingechauri and Baku.

## 2. Material and Research Method

We studied samples of moss, soil and water near Mingechaur city and Baku city regions.

The activity of radionuclides were determined on Gamma spectrometer. Determination of content and activity of the radionuclides in the tests of soil, plant and water, was carried out at "Canberra" (USA) $\gamma$ -spectrometer with high a purity germanium detector (HP Ge).

It was determined the activity of radionuclides ( $^7\text{Be}$ ,  $^{40}\text{K}$ ,  $^{60}\text{Co}$ ,  $^{208}\text{Tl}$ ,  $^{134}\text{Cs}$ ,  $^{137}\text{Cs}$ ,  $^{210}\text{Bi}$ ,  $^{212}\text{Bi}$ ,  $^{212}\text{Pb}$ ) in the samples of moss, soil and water samples taken from the Mingechaur region and in Baku region of the Azerbaijan Republic.

In table is given the results of analysis of natural radionuclides in samples of moss soil and water samples, taken from the investigated regions. The weight of the of moss, soil and water samples were measured at an electron microscope. For measurement of sample activities they fulfilled following operations: 1) weighed Petri dishes; 2) weighed Petri dishes with samples; 3) found out the weights of the enumerable sample on a difference of weights; 4) placed chemical dishes with samples in the device gamma – spectrometer “Canberra”, closed the cover with lead protection and measured the radiation activities of sample.

## 3. The Results of the Study and Discussion

The activity of radionuclides in samples of moss, soil and water samples are given in table 1.

**Table-1.** Activity of radionuclides in samples of moss, soil and water samples

Radionuclides	Bq/kg	Bq/kg	Bq/L
	moss	soil	water
$^7\text{Be}$	<79.08	<34.00	<2.99
$^{40}\text{K}$	648,1	570,5	<7.64
$^{60}\text{Co}$	<11.34	<4.68	<0.39
$^{134}\text{Cs}$	<12.15	<5.41	<0.39
$^{137}\text{Cs}$	<14.01	<4.92	<0.41
$^{208}\text{Tl}$	<12.01	<5.56	<0.42
$^{210}\text{Bi}$	<12.93	<5.64	<0.50
$^{212}\text{Bi}$	ND	ND	ND
$^{212}\text{Pb}$	ND	9,37	ND
$^{214}\text{Bi}$	<28.74	19,44	<0.88
$^{214}\text{Pb}$	<62.62	31,88	<0.85
$^{226}\text{Ra}$	ND	ND	ND
$^{228}\text{Ac}$	ND	ND	ND
$^{234}\text{Pa}$	ND	ND	ND
$^{234\text{m}}\text{Pa}$	ND	298,5	ND

Only natural radioactive elements were revealed in the investigated samples. These radionuclides are -  $^7\text{Be}$ ,  $^{40}\text{K}$ ,  $^{60}\text{Co}$ ,  $^{208}\text{Tl}$ ,  $^{134}\text{Cs}$ ,  $^{137}\text{Cs}$ ,  $^{210}\text{Bi}$ ,  $^{212}\text{Bi}$  and  $^{212}\text{Pb}$  isotopes.

Local contamination areas were revealed. The topsoil (0- 5cm) is more contaminated by natural radionuclides. A considerable K40 isotope activity was revealed in the soil samples, on the base of which it can be assumed that the presence of radioactive elements in the moss is connected with their presence in soil and water. The activity of  $^{40}\text{K}$  was more than other isotopes (648,1 Bq/kg). It was found out  $^7\text{Be}$  of activity 79.08 Bq/kg,  $^{214}\text{Pb}$  of activity 62.62Bq/kg,  $^{214}\text{Bi}$  of activity 28.74 Bq/kg,  $^{137}\text{Cs}$  of activity 14.01 Bq/kg,  $^{134}\text{Cs}$  of activity 12.15 Bq/kg,  $^{60}\text{Co}$  of activity 11.34 Bq/kg and others, which were more in Mingechaur region than in Baku.

Thus, the analysis of the obtained data showed that mosses are informative plant species indicating the state of the environment.

## 4. Conclusions

- As a result of experimental studies the magnitude of the activity of radionuclides in moss samples was revealed. Soils and water.
- It was revealed that the activity of  $^{40}\text{K}$  was more than other isotopes (648,1 Bq/kg).
- It was found out  $^7\text{Be}$  of activity 79.08 Bq/kg,  $^{214}\text{Pb}$  of activity 62.62Bq/kg,  $^{214}\text{Bi}$  of activity 28.74 Bq/kg,  $^{137}\text{Cs}$  of activity 14.01 Bq/kg,  $^{134}\text{Cs}$  of activity 12.15 Bq/kg,  $^{60}\text{Co}$  of activity 11.34 Bq/kg and others, which were more in Mingechaur region than in Baku.
- As a result of experimental It was revealed that the activity values of the detection limits of radionuclides in moss, soil and water samples provide valuable information for the biomonitoring of the ecobiosystem.

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