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MONITORING OF RADIATION BACKGROUND LEVELS IN ODESA'S MARKETS

Abstract

Monitoring of the dose rate of gamma radiation in the air (radiation background) was carried out in the pavilions and on the territory of the markets "Pryvoz", "Pivnichnyi", "Cheryomushky", "Novyi", "Pivdennyi" and "Kyivskyi" in Odessa for the period of 2024 (winter, spring, summer, autumn). The GreenTest device was used to determine the level of background radiation. It was established that the level of gamma radiation dose rate in the air of the pavilions

and the open area had some variability, but did not exceed sanitary and hygienic standards. According to the results of the research, it was found that the absorbed dose of gamma radiation in the air in the closed pavilions of the markets of Odessa ranged from 0.03±0.01 to 0.17±0.01 μSv/h. The absorbed dose rate of gamma radiation in the air in the open area of markets is set in the range from 0.08±0.01 to 0.18±0.01 μSv/h. It was found that the highest level of gamma background was recorded in the territory of the pavilions of the "Novyi" and "Pivnichnyi" markets, which is 10% higher than the corresponding research indicators in the "Pivdennyi" and "Kyivskyi" markets, 22.2% higher than the indicators in the "Cheryomushky" market, and 37.5% higher than the indicators in the "Pryvoz" market. The same indicator in the open area was maximum at the «Kyivskyi» market, which is 15.4% higher than the corresponding indicator at the «Novyi» market, 25% higher than at the «Privoz» market, and 50% higher than the indicators at the «Cheryomushky», «Pivdennyi», and «Pivnichnyi» markets. It was found that the radiation background had the highest values in the spring and summer period compared to the winter and autumn months.

Keywords: *natural background radiation, technogenically enhanced radiation background, gamma radiation dose, monitoring, radiation safety.*

Introduction. Throughout history, humanity has been exposed to radioactive radiation coming from space and from Earth's radioisotopes. This radiation forms the natural radiation background. Since the middle of the 20th century, after people began to intensively master atomic energy, the natural radiation background on the planet and in its individual regions has been constantly increasing, and is called technogenically enhanced [1-4]. In nature, the radiation background is almost always at a level that does not lead to a violation of human health, therefore, the radiation background that has a harmful effect is always the result of human activity [5, 6].

Analysis of recent research and publications. Human protection from ionizing radiation is a pressing issue for many industries, including agriculture and the food industry. As the intensity of ionizing radiation increases, its dangerous impact on public health also increases [7].

The problem of radiation safety is becoming particularly relevant in modern conditions, when the issue of protecting public health from the negative effects of radioactive factors is a priority for environmental, social, and state policy. After the Chernobyl accident, the problem of radioactive contamination became one of the key aspects of environmental safety in Ukraine [8].

The presence of residual amounts of radionuclides in soil, water, and air in various regions of Ukraine requires constant monitoring and control, especially in large urban agglomerations. Ensuring radiation safety for consumers is an important aspect of the overall health strategy [9, 10].

Odesa, as a city with intensive economic activity and significant flows of goods, may be exposed to radiation risks, which requires special attention from government agencies and the scientific community. In addition, Odesa is a large industrial and port center, actively involved in trade activities, including markets where a wide range of food and household goods are traded. Therefore, it is important to ensure control of the radiation background in markets, as food and other goods can be a source of potential danger due to the accumulation of radionuclides.

Monitoring of radiation background in markets is relevant due to possible sources of radioactive contamination. In addition, the factor of global trade and

international economic cooperation creates additional risks due to the possibility of goods from environmentally unfavorable regions entering local markets [3, 8-10].

In addition to the above, military actions have made certain adjustments to the ecological state of the environment of southern Ukraine.

Thus, according to Pacev I.G. and co-authors, the ecological system suffered significant damage from the invasion of the aggressor country to the Chernobyl NPP, which led to an increase in the radiation background in this area by 7.6 times due to the movement of armored vehicles, which raised radioactive dust into the air [11]. As is known, radioactive dust can rise into the air and travel considerable distances, contaminating vast areas.

Reporting and monitoring of emissions from nuclear power plants, spent nuclear fuel reprocessing facilities, and atmospheric air pollution with radioactive substances is regulated by a number of European directives implemented into Ukrainian legislation, as well as a number of state documents, in particular the Radiation Safety Standards of Ukraine (NRBU-97) [12, 13].

Therefore, monitoring the radiation background will give us an understanding of the level of radiation safety and allow us to respond promptly to any threats, thus providing additional protection for the population. Therefore, monitoring the radiation background of the city of Odessa, in particular the locations of markets, is a very relevant issue today.

Goal. Determination of the dose rate level of gamma radiation in the air (radiation background) in the markets of Odessa, which has a tendenc y to change due to military actions in Ukraine. Dosimetric monitoring of gamma radiation was carried out in the territory of closed pavilions and in the open territory of the markets.

Presentation of the main research material. Dosimetric studies of the dose rate of gamma radiation in the air (radiation background) were conducted in the territory of the markets of Odessa for the period of 2024 (winter, spring, summer, autumn). The study was conducted in large markets, namely: «Pryvoz», «Pivnichnyi», «Cheryomushky», «Novyi», «Pivdennyi», «Kyivskyi». Measurements were carried out both in the premises of the markets and in the open area where livestock and crop products were sold. The research was conducted at the Department of Infectious Pathology, Biosafety and Veterinary-Sanitary Inspection named after Professor V. Ya. Atamas. The GreenTest device was used to determine the level of background radiation. Measurements were performed according to the instructions for this device.

GreenTest is designed for rapid analysis of nitrate content in fresh vegetables, fruits, and meat, and is also used to determine the level of background radiation and detect objects, food products, building materials, etc. contaminated with radioactive elements. The device measures the radiation background by the magnitude of the power of ionizing radiation (gamma radiation). This device works using a detector (Geiger-Muller counter). The device does not require calibration before operation and periodic verification, as it has undergone this procedure during production, using reference sources. GreenTest measures the background radiation level immediately after switching on. It operates in continuous measurement mode and displays the

measurement result on the display in «Radiation» mode. Also in this mode, text and color prompts regarding the value of the radiation background are displayed for the operator [14].

The absorbed dose rate of gamma radiation in air was measured in the geometric center of the room at a height of 1m from the floor. Five measurements were taken, from which the arithmetic mean value was calculated. The corresponding algorithm was used to measure the radiation background in the open area of markets, selecting places where products of animal and plant origin were sold. Measurements were taken at a height of 1 m from the floor and at a distance of 1 m from the product.

Statistical processing of the obtained results was carried out using variational statistics methods, the average statistical value (M) and deviation from the average statistical value (m) were determined, data processing was carried out using the Microsoft Excel computer program.

According to the results of the research, it was found that the absorbed dose of gamma radiation in the air of closed pavilions of Odessa markets ranged from 0.03±0.01 to 0.17±0.01 μSv/h, which corresponds to the established standards. The average level of background radiation in closed pavilions varied from 0.04±0.02 to 0.16±0.03 μSv/h. The results of the studies are presented in Table 1.

Thus, according to our research, the average level of background radiation per year in closed pavilions at the «Pryvoz» market was 0.08±0.01 μSv/h, at the «Novyi» market it was 0.11±0.01 μSv/h, at the «Cheryomushky» market the experimental indicator was 0.09±0.01 μSv/h, at the «Pivdennyi» and «Kyivskyi» markets the indicated indicator was 0.10±0.01 μSv/h, at the «Pivnichnyi» market - 0.11±0.01 μSv/h, respectively.

Table 1

Results of determining the dose rate of gamma radiation in the air of closed pavilions of Odessa markets,
M ± m, n = 6

No. in order	Market name	Time of year	Dose rate, μSv/h
1	"Pryvoz"	Winter	0.09±0,03
		Spring	0.10±0,04
		Summer	0.06±0,06
		Autumn	0.08±0,02
	On average		*0,08±0,01*
2	"Novyi"	Winter	0.09±0,04
		Spring	0.11±0,05
		Summer	0.13±0,03
		Autumn	0.12±0,04
	On average		*0,11±0,01*

3	"Cheryomushky"	Winter	0.04±0,02
		Spring	0.10±0,05
		Summer	0.12±0,03
		Autumn	0.09±0,03
	On average		*0,09±0,01*
4	«Pivdennyi»	Winter	0.15±0,02
		Spring	0.11±0,05
		Summer	0.09±0,06
		Autumn	0.06±0,03
	On average		*0,10±0,01*
5	«Kyivskyi»	Winter	0.11±0,07
		Spring	0.14±0,03
		Summer	0.07±0,02
		Autumn	0.08±0,02
	On average		*0,10±0,01*
6	«Pivnichnyi»	Winter	0.14±0,03
		Spring	0.07±0,04
		Summer	0.16±0,03
		Autumn	0.08±0,03
	On average		*0,11±0,01*

The absorbed dose rate of gamma radiation in the air in the open area of markets (Table 2) is set within the range from 0.08±0.01 to 0.18±0.01 μSv/h, which complies with sanitary and hygienic standards. The average level of background radiation per year in the territory of the markets of Odessa had a certain variability and ranged from 0.10±0.01 to 0.15±0.01 μSv/h.

Table 2

Results of determining the dose rate of gamma radiation in the air in the open area of the markets of Odessa,
M ± m, n = 6

No. in order	**Market name**	**Time of year**	**Dose rate, μSv/h**
1	"Pryvoz"	Winter	0.11±0,01
		Spring	0.12±0,01
		Summer	0.14±0,02
		Autumn	0,12±0,03
	On average		*0.12±0,01*
2	"Novyi "	Winter	0.12±0,01
		Spring	0.16±0,01
		Summer	0,15±0,03
		Autumn	0.09±0,03

	On average		*0.13±0,01*
3	"Cheryomushky"	Winter	0.12±0,01
		Spring	0,09±0,02
		Summer	0.10±0,01
		Autumn	0.10±0,02
	On average		*0.10±0,01*
4	«Pivdennyi»	Winter	0,13±0,04
		Spring	0.09±0,01
		Summer	0.12±0,01
		Autumn	0.16±0,02
	On average		*0,10±0,01*
5	«Kyivskyi»	Winter	0.13±0,02
		Spring	0.14±0,01
		Summer	0.18±0,01
		Autumn	0,15±0,03
	On average		*0.15±0,01*
6	«Pivnichnyi»	Winter	0.08±0,01
		Spring	0.11±0,01
		Summer	0,12±0,02
		Autumn	0.09±0,01
	On average		*0.10±0,01*

According the Table 2, the average level of background radiation for the year in the open area of the «Pryvoz» market was 0.12±0.01 μSv/h, in the «Novyi» market it was 0.13±0.01 μSv/h, in the «Cheryomushky», «Pivdennyi» and «Pivnichnyi» markets the experimental indicator was 0.10±0.01 μSv/h, in the «Kyivsky» market the indicated indicator was 0.15±0.01 μSv/h. Studies have shown some variability in the absorbed dose of gamma radiation in the air both in closed market pavilions and in their open area. Fluctuations in average values for 2024 are graphically displayed in Fig. 1 and Fig. 2.

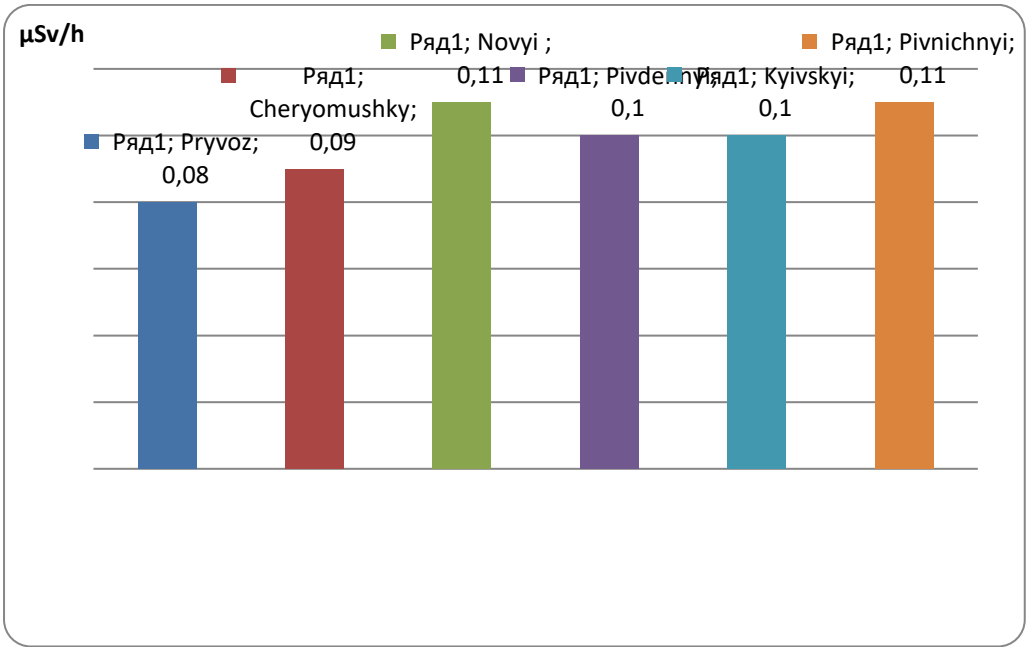

Figure 1. Comparison of gamma radiation dose rates in the air of indoor market pavilions in Odessa for 2024

Thus, Fig. 1 shows that the highest average background radiation levels in closed pavilions were registered at the «Novyi» and «Pivnichnyi» markets, which are 10% higher than the corresponding experimental indicators at the «Pivdennyi» and «Kyivskyi» markets, 22.2% higher than the indicators at the «Cheryomushky» market, and 37.5% higher than the indicators at the «Pryvoz» market.

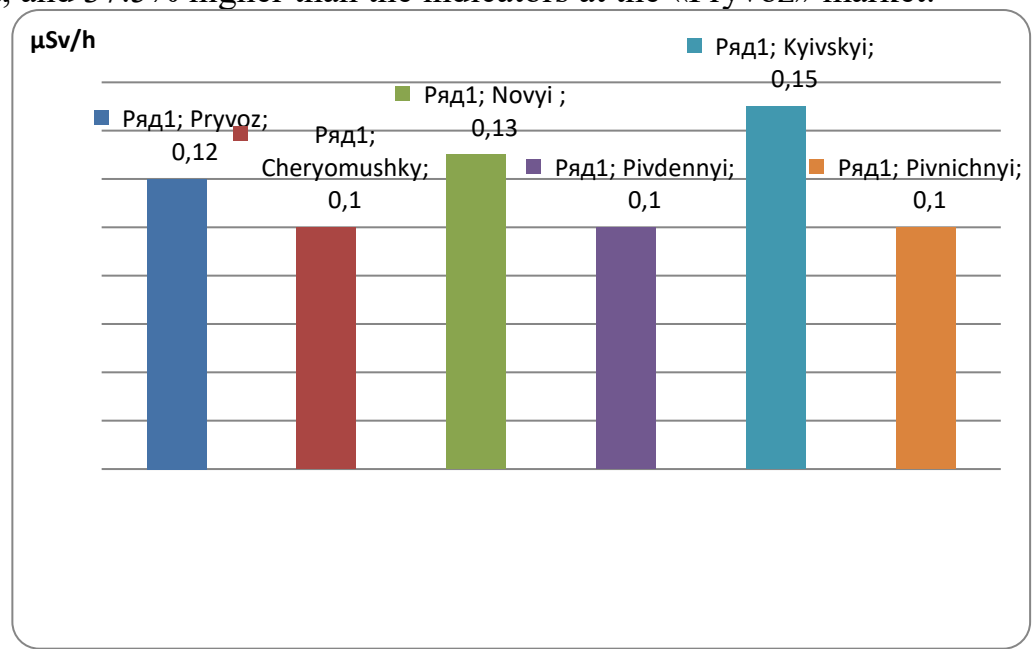

Figure 2. Comparison of gamma radiation dose rates in the air in the open area of Odessa markets for 2024

From Fig. 2, we can conclude that the highest average background radiation levels in the open area were registered at the «Kyivskyi» market. In percentage terms, this is 15.4% higher than the corresponding indicator on the «Novyi» market, 25%

higher than on the «Pryvoz» market, and 50% higher than on the «Cheryomushky», «Pivdennyi», and «Pivnichnyi» markets.

Comparison of the average annual values of gamma radiation dose rates in the air in closed market pavilions and in their open areas showed that the level of background radiation in the second case is 18.6% higher than in the first, which may indicate the shielding ability of buildings.

As for fluctuations in the average values of the radiation background over the period of the year, this is reflected in Fig. 3 and Fig. 4.

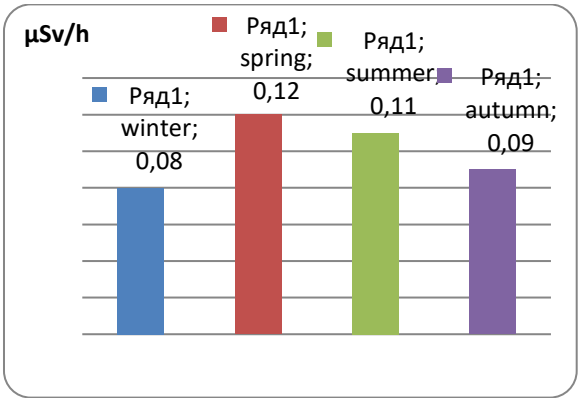

Figure 3. Comparison of gamma radiation dose rates in the air of indoor market pavilions in Odessa by periods of the year

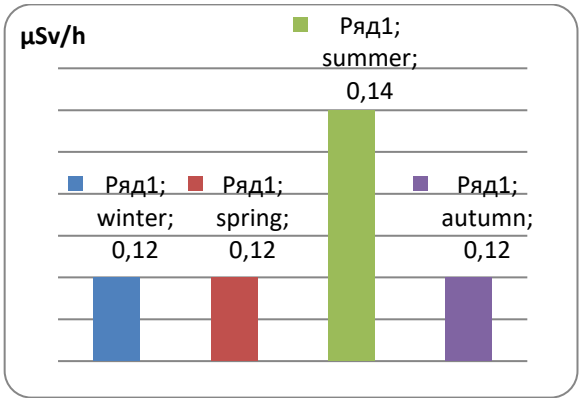

Figure 4. Comparison of gamma radiation dose rates in the air in the open area of Odessa markets by period of the year

As can be seen from Fig. 3 and 4, the radiation background had a certain variability over the periods of the year, its highest values were observed in the spring and summer period. The dose rate of gamma radiation in the air of indoor pavilions of Odessa markets in the spring is 50% higher than the average for the winter period, 9.1% for the summer and 33.3% for the autumn period, respectively. Regarding the dose rate of gamma radiation in the air in the open area of the markets of Odessa by periods of the year, in this case the summer period is the leader, during which this indicator is 16.7% higher than the corresponding indicator for other periods of the year.

Conclusions and prospects for further research. Studies have shown some variability in the power of the gamma radiation dose absorbed in the air both in the closed pavilions of the markets and in their open areas.

According to the results of measuring the absorbed dose rate of gamma radiation in the air in the indoor pavilions of the markets of Odessa, it was found that the highest average radiation background values in the indoor pavilions were registered in the «Novyi» and «Pivnichny» markets, which are 10% higher than the corresponding research values in the «Pivdennyi» and «Kyivskyi» markets, 22.2% higher than the values in the «Cheryomushky» market, and 37.5% higher than the values in the «Pryvoz» market.

It was established that the highest values of the absorbed dose of gamma radiation in the open area of markets were registered at the «Kyivskyi» market. In percentage terms, this is 15.4% higher than the corresponding indicator on the «Novyi» market, 25% higher than on the «Privoz» market, and 50% higher than on the «Cheryomushky», «Pivdennyi», and «Pivnichnyi» markets.

The average annual radiation background in the open area of the markets is 18.6% higher than the radiation background in the closed pavilions of the markets. The radiation background on the territory and pavilions of Odessa markets has the highest indicators in the spring and summer period.

Based on the monitoring conducted, it was established that the absorbed dose rate of gamma radiation in the air (radiation background) does not exceed the permissible levels established by the NRBU-97. The results of our research have further prospects for monitoring the radiation status of the city of Odessa, which is a relevant issue in the context of military operations in Ukraine.

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МОНІТОРИНГ РІВНЮ РАДІАЦІЙНОГО ФОНУ НА РИНКАХ м. ОДЕСИ

Анотація

Проведено моніторинг потужності дози гамма-випромінювання в повітрі (радіаційного фону) у павільйонах і на території ринків «Привоз», «Північний», «Черьомушки», «Новий», «Південний» та «Київський» м. Одеси за період 2024 року (зима, весна, літо, осінь). Для визначення рівня радіаційного фону використовували прилад GreenTest. Встановлено, що рівень потужності дози гамма-випромінювання в повітрі павільйонів та відкритій території мав деяку варіабельність, але не перевищував санітарно-гігієнічних нормативів. За результатами досліджень встановлено, що потужність поглиненої дози гамма-випромінювання в повітрі у закритих павільйонах ринків м. Одеси знаходилася в межах від 0,03±0,01 до 0,17±0,01 мкЗв/год. Потужність поглиненої дози гамма-випромінювання в повітрі на відкритій території ринків встановлена в межах від 0,08±0,01 до 0,18±0,01 мкЗв/год. Виявлено, що найвищий рівень гамма-фону фіксувався на території павільйонів ринків «Новий» та «Північний», що на 10% вище за відповідні дослідні показники на ринках «Південний» та «Київський», на 22,2% вищі за показники на ринку «Черьомушки» та на 37,5% вищі за показники на ринку «Привоз». Той же показник на відкритій території був максимальним на ринку «Київський», що на 15,4% вище за відповідний показник на ринку «Новий», на 25% вищі, ніж на ринку «Привоз», та на 50% вищі за показники на ринках «Черьомушки», «Південний» та «Північний». Встановлено, що радіаційний фон мав найвищі показники у весняно-літній період у порівнянні з зимовими та осінніми місяцями.

Ключові слова: *природній радіаційний фон, техногенно-підсилений радіаційний фон, доза гамма-випромінювання, моніторинг, радіаційна безпека*

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