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IDENTIFYING THE IMPACT OF MILITARY ACTIONS ON THE SAFETY OF AGRICULTURAL PRODUCTS

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Abstract. *The object of this study is the process of assessing the safety of agricultural products in the area near military operations. It is known that military operations lead to contamination of the ecosystem with heavy metals. However, it has not been studied whether contamination of agricultural products with toxic elements and radionuclides occurs in areas where active military operations are not underway, but there is constant movement of military aircraft. The studies were conducted in 2025 in the village of Tovsta (Ukraine), which is located within the 50-kilometer combat zone. The content of heavy metals and radionuclides in milk was analyzed. The results showed that there is contamination of cow's milk with heavy metals. Increased Pb levels were found in May (0.17±0.08 ppm) and July (0.18±0.09 ppm), compared to the concentrations recommended by the World Health Organization. An increase in Cd levels in milk was found in May (0.014±0.01 ppm). A particular increase in the mass fraction of heavy metals in milk was observed in May and July, when the intensity of air threats in the Sumy region was particularly high. It should be noted that in April the mass fraction of Pb in milk was within the permissible limits and did not exceed 0.02 ppm. At the same time, radiological studies of milk did not reveal contamination with radionuclides. The specific activity of Cs-137 was within 2.54±2.54–4.25±2.69 Bq/kg, and the specific activity of Sr-90 was 0.56±0.56–1.13±0.7 Bq/kg. Thus, milk obtained in areas near the zone of active military operations cannot be considered safe for consumption.*

Key words: *food safety, heavy metals, radionuclides, milk, military action, toxicity,..*

Introduction.

The war has created a number of important socio-economic and environmental issues that affect life safety, health, food and energy security. According to the United Nations, the Russia-Ukraine war has disrupted critical food exports for low-income countries, affecting an estimated 1.7 billion people [1]. Since this has led to acute hunger for 276 million, it can be argued that the food system in conflict-affected regions is vulnerable. Current research on the war in Ukraine has focused primarily on the human and economic impacts of the war, with less attention paid to environmental threats. However, it is the disruption of the ecological stability of the territories in the war zone that will have dire consequences in the context of food security. This is because it threatens not only the quantity of agricultural produce, but also its safety. Despite the fact that military actions in the country have been going on for more than

10 years, there are no studies related to establishing the impact of military aggression on the safety of agricultural products produced in the territories of regions where military actions are taking place. The issue of a comprehensive approach to studying the impact of war on the safety of raw materials for the production of food products remains unresolved. This problem is especially relevant given the role of Ukraine in the global agricultural resource sectors. This gap in research highlights the need for a more thorough study of how war affects the safety of agricultural products.

Usually, studies of the impact of the Russian-Ukrainian war on food security are associated with a quantitative assessment of crop losses caused by the war [2] and soil pollution in areas affected by military equipment, shells or other technical means [3,4]. Despite a large number of studies of the impact of the Russian-Ukrainian war on the environment, no direct threat to the safety of agricultural products in areas located near the combat zone has been established.

Thus, the issue of the impact of military aircraft on the toxic pollution of agricultural products grown in the areas through which they transit remains unresolved. A study of the toxic content of agricultural products grown within a 50-kilometer zone of military operations will allow us to establish their safety level. All this gives grounds to assert that it is advisable to conduct a study devoted to the analysis of the content of heavy metals in milk. The aim of the study is to identify milk contamination with toxic elements and radionuclides caused by military actions. The results obtained will allow us to establish the level of its safety within the 50-kilometer zone of military actions. Field research was conducted in April, May and July 2025 in the village of Tovsta, Sumy region (Ukraine), which is located 39 km from the border with Russia (Fig. 1). The distance to the combat zone is 20 km.

Samples of cow's milk (M1, M2, M3 in April, May and July, respectively) were collected from private households. Whole milk obtained during midday milking was analyzed. The content of toxic elements in milk was determined by atomic absorption spectrometry using a PinAAcle900T spectrometer (USA). The specific activity of the Sr-90 radionuclide in milk was determined by beta spectrometry using a SEB-01-150 spectrometer (Ukraine), and the activity of Cs-137 was determined using a SEG-001-

63 gamma radiation energy spectrometer (Ukraine).

The results of the study of some heavy metals in milk are presented in Table 1.

Table 1 - Content of heavy metals in milk

Indicator	WHO Recommended Exposure Limit	Results		
		M1	M2	M3
Mass fraction of Pb, ppm	<0,02	<0,02	<0,17±0,08	<0,18±0,09
Mass fraction of Cd, ppm	<0,0026	<0,01	<0,014±0,01	<0,012±0,01
Mass fraction of As, ppm	–	<0,00025	<0,0001	<0,0001
Mass fraction of Hg, ppm	–	<0,002	<0,002	<0,002
Mass fraction of Cu, ppm	<1,5	0,1±0,05	0,07±0,04	0,04
Mass fraction of Zn, ppm	<5,0	1,57±0,80	2,84±1,35	3,2±1,52

Author's development

It was found that the mass fraction of Pb in milk exceeded the standard values by 9 times. Especially in May (0.17±0.08 ppm) and in July (0.18±0.09 ppm). At the same time, in April, the mass fraction of Pb in milk was within the recommended norm. An increase and excess of the permissible concentration of Cd was also recorded. Its highest content, 5 times higher than the norm, was recorded in sample M2 (0.014±0.01 ppm). The accumulation of Cd in milk can pose a health risk, especially with long-term exposure. Although the level of cadmium in milk samples can be immediately dangerous, chronic exposure can lead to various health problems. Cadmium is a known carcinogen and can damage many organ systems, including the kidneys and reproductive system. A fairly high concentration of zinc was recorded in sample M3 (3.2±1.52 ppm). The negative effects of high levels of Zn in the body can cause side effects such as nausea, vomiting, loss of appetite, abdominal cramps and diarrhea.

According to the results of the study, it was established that the specific activity of radionuclides in milk does not exceed the maximum permissible limits. The highest level of Cs-137 (4.25 Bq/kg) was recorded in milk in April. The activity of Sr-90 was highest in July (1.13 Bq/kg).

Conclusions.

The proportion of Pb in whole cow's milk is 9 times higher than the permissible

level, especially in May (0.17±0.08 ppm) and July (0.18±0.09 ppm). It was found that raw milk in the area near the combat zone is contaminated with Cd, the highest content (0.014±0.01 ppm), which was 5 times higher than the norm, was recorded in May. As a result of radiological studies, it was established that milk produced within the 50-kilometer combat zone is not contaminated with radionuclides (Cs-137, Sr-90).

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