

## QUANTIFICATION OF RADIONUCLIDE LEVELS IN HORSE CHESTNUT SEEDS

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### Abstract

Radionuclides are unstable forms of elements that emit radiation, and they are hazardous pollutants that can have a significant impact on the environment, the food chain, and human health. These substances persist in the environment for a long time, potentially causing soil, water, and air contamination, which poses risks to ecosystems and human populations. When present in soil and groundwater, radionuclides can be absorbed by plants, leading to potential radiation exposure for people who consume contaminated plant parts. Therefore, it is important to analyze the radionuclide content in the seeds of horse chestnuts grown in different regions. In a recent study, we analyzed the concentration of radioactive isotopes, including Strontium-90 and Caesium-137, in horse chestnut seeds using Atomic Absorption Spectroscopy (AAS) in accordance with Sanitary Rules and Regulations. The findings from this study revealed that the levels of radioactive isotopes detected in horse chestnut seeds obtained from both Tashkent City and Qibray district met the requirements outlined in Sanitary Rules and Regulations (SanPiN № 0193-06).

**Key words:** horse chestnut, radionuclides, radioactive isotopes, Sanitary Rules and Regulations.

### 1. Introduction.

Radionuclides, which are unstable forms of elements that emit radiation [1], pose a significant threat to the environment, the food chain, and human health. Naturally occurring radionuclides can be found in the air, water, and soil [2]. These hazardous pollutants can have far-reaching implications and require careful consideration in environmental and public health management. Indeed, interest in researching the uptake of radionuclides from soil into vegetation has heightened due to concerns regarding the potential for deposited radioactivity to permeate food chains, thus posing a risk to human health through ingestion. This concern has prompted the establishment of the field of radioecology, dedicated to investigating the movement of radionuclides along environmental pathways and accurately quantifying their transfer rates between various components of ecosystems. This multidisciplinary field encompasses the study



of the behavior and fate of radioactive substances in the environment, including their uptake by plants and potential impact on human populations [3]. The principal sources of radioactive waste and contamination include the generation of electrical power and nuclear weapons from nuclear fuels, nuclear weapons testing, fuel reprocessing, and nuclear incidents. Although significant quantities of contaminated soil and water arise from low- and intermediate-level wastes, these account for only a minor proportion of the overall radioactivity. Most of the radioactivity comes from high-level waste (HLW) and spent nuclear fuel (SNF) [4]. The isotope Strontium-90 carries a greater environmental impact compared to other isotopes due to its notably extended half-life of 28.1 years [5]. Similarly, Cesium-137 fallout has served as a widely accepted environmental indicator, effectively detailing historical contamination of the environment by fission products [6]. Thus, we analyzed the amount of radioactive isotopes, including Strontium-90 and Caesium-137, in horse chestnut seeds using Atomic Absorption Spectroscopy (AAS) in accordance with Sanitary Rules and Regulations. The results of the research indicated that the amounts of radioactive isotopes identified in horse chestnut seeds collected from Tashkent City and Qibray district were in compliance with the standards specified in Sanitary Rules and Regulations (SanPiN № 0193-06).

## 2. Materials and methods.

**Preparation of a solution of lanthanum chloride.** To prepare a solution of lanthanum chloride, 26.7 grams of lanthanum chloride heptahydrate are placed into a 100 ml volumetric flask, dissolved in 0.125M hydrochloric acid, and then diluted to volume with the same solvent.

**Preparation of the primary standard solution of strontium.** The primary standard solution of strontium is prepared by placing 0.715 grams of previously dried at 300 °C for 3 hours, cooled in a desiccator for 2 hours, strontium chloride into a 1000 ml volumetric flask, dissolving it in 50 ml of water, and then diluting it to volume with water. The resulting solution contains 400 mkg of strontium in 1 ml.

**Preparation of the standard solution of strontium.** A standard solution of strontium is prepared by taking 5 ml of the primary standard solution, placing it into a 20 ml volumetric flask, and diluting it to volume with 0.125 M hydrochloric acid. The resulting solution contains 100 mkg of strontium in 1 ml.

**Preparation of the primary standard solution of caesium.** Approximately 500 mg (accurately weighed) of caesium powder is dissolved in 50 ml of 6M hydrochloric acid in a 1000 ml volumetric flask, diluted to volume



with water, and mixed. The resulting solution contains about 500 mkg of caesium in 1 ml.

**Preparation of the standard solution of caesium.** 2 ml of the primary standard solution of caesium is placed into a 100 ml volumetric flask and diluted to volume with a solution of 0.125M hydrochloric acid. The resulting solution contains about 10 mkg of caesium in 1 ml.

**Preparation of a test solution.** For the test solution, 1 gram of seeds is added to 60 ml of concentrated hydrochloric acid (36,5 -38%) and heated in a water bath, periodically rinsing the inner surface of the crucible with a solution of 6M hydrochloric acid, for 30 minutes. The solution is then cooled and placed into a 100 ml volumetric flask. The walls of the crucible are washed with a small amount of a solution of 6M hydrochloric acid and placed into the same flask. Then the resulting solution is diluted to volume with water, mixed, and filtered through a membrane filter with a hole diameter of 0.45  $\mu\text{m}$ . The first 5 ml of filtrate is thrown away.

1.5 ml of the resulting solution is placed into a 50 ml volumetric flask and diluted to volume with 0.125M hydrochloric acid. Then 2 ml of the resulting solution is placed into a 200 ml volumetric flask and 2 ml lanthanum chloride solution is added. This solution is diluted to volume with 0.125M hydrochloric acid and mixed (the concentration of the solution is about 0.4 mkg/ml).

Absorption of standard and test solutions is sequentially detected at wavelengths of 460.7 nm (strontium) and 852.1 nm (caesium) using an atom-absorption spectrophotometer equipped with a hollow strontium and caesium cathode lamp and an air-acetylene burner.

A 0.125 M solution of 0.1% lanthanum chloride-containing hydrochloric acid is used as a standard solution. Based on the obtained results, a calibration curve is compiled, and the concentration of the test solution is determined in mg/kg using the resulting graph.

### 3. Results and discussion.

The levels of radionuclides, including Strontium-90 and Caesium-137 in horse chestnut seeds collected from Tashkent City and Qibray district were meticulously analyzed using AAS (**Fig.1**).

| No | Name of radionuclides | Sanitary Rules and Regulations (SanPiN № 0193-06). | Amount of radionuclides in seeds collected from Tashkent, | Amount of radionuclides in seeds collected from Qibray, |
|----|-----------------------|----------------------------------------------------|-----------------------------------------------------------|---------------------------------------------------------|
|----|-----------------------|----------------------------------------------------|-----------------------------------------------------------|---------------------------------------------------------|

|   |                     |                          | mg/kg                 | mg/kg                 |
|---|---------------------|--------------------------|-----------------------|-----------------------|
| 1 | <b>Strontium-90</b> | Less than 7,96<br>mg/kg  | $1,301 \cdot 10^{-5}$ | $1,095 \cdot 10^{-5}$ |
| 2 | <b>Caesium-137</b>  | Less than 79,64<br>mg/kg | $1,293 \cdot 10^{-5}$ | $1,186 \cdot 10^{-5}$ |

**Figure 1: Results of the analysis of the radionuclides strontium-90 and caesium-137 in horse chestnut seeds collected from Tashkent city and Qibray district.**

The results revealed that the horse chestnut seeds from Tashkent contained  $1,301 \cdot 10^{-5}$  mkg/kg of Strontium-90 and  $1,293 \cdot 10^{-5}$  mkg/kg of Caesium-137, while the seeds from Qibray contained  $1,095 \cdot 10^{-5}$  mkg/kg of Strontium-90 and  $0,186 \cdot 10^{-5}$  mkg/kg of Caesium-137. In accordance with Sanitary Rules and Regulations (SanPiN № 0193-06), it is stipulated that the quantity of Strontium-90 must not exceed 7.96 mg/kg, and that of Caesium-137 should not surpass 79.64 mg/kg. The findings indicate that the levels of radionuclides present in horse chestnut seeds are fully compliant with the established standards.

#### 4. Conclusion.

The horse chestnut seeds collected from Tashkent City and Qibray district underwent a thorough analysis using Atomic Absorption Spectroscopy (AAS) to detect and measure the presence of radionuclides, specifically Strontium-90 and Caesium-137. The comprehensive studies conclusively demonstrate that the levels of radionuclides in the seeds from both Tashkent City and Qibray district meet the strict requirements outlined in the Sanitary Rules and Regulations (SanPiN № 0193-06). This detailed analysis confirms that the horse chestnut seeds comply with established health and safety standards and are safe to use

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