UNIVERSITY "UNION - NIKOLA TESLA"

Nikola Tesla

THE THIRD INTERNATIONAL CONFERENCE ON SUSTAINABLE ENVIRONMENT AND TECHNOLOGIES

PROCEEDINGS

"Creating sustainable commUNITy"

INTERNATIONAL CONFERENCE ON SUSTAINABLE ENVIRONMENT AND TECHNOLOGIES

22-23 SEPTEMBER 2023

CARA DUŠANA 62-64, BELGRADE, SERBIA

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CONTENT:

Plenary lectures:

Lectures:

GROSS ALPHA AND GROSS BETA ACTIVITY IN LEAVES (FIG, APRICOT AND VINE)

Marija Janković[1], Nataša Sarap[1], Hadi Waisi[2,3], Jelena Krneta Nikolić[1], Milica Rajačić[1], Ivana Vukanac[1], Filip Veljković[4], Bojan Janković[4]

[1] University of Belgrade, „Vinča" Institute of Nuclear Sciences, National Institute of the Republic of Serbia, Radiation and Environmental Protection Department, Belgrade, Serbia

[2]University UNION-Nikola Tesla, Faculty of Ecology and Environmental Protection, Belgrade, Serbia

[3]University of Belgrade, Institute of General and Physical Chemistry, Belgrade, Serbia

[4] University of Belgrade, „Vinča" Institute of Nuclear Sciences, National Institute of the Republic of Serbia, Department of Physical Chemistry, Belgrade, Serbia

marijam@vin.bg.ac.rs

ABSTRACT

This paper presents the results for gross alpha and gross beta activity in leaves samples: Fig (*Ficus carica),* Vine (*Vitis vinifera* L.), and Apricot (*Prunus armeniaca*). Samples were collected in Iraq (Sulaymaniyah, Kurdistan region), and in the Serbia (Belgrade), in the summer 2018. The analysis was done in dried and milled samples as well as in the annealed samples, using gas flow proportional counter. Determination of gross alpha and gross beta activity presents rapid method, essential for the analysis of radioactivity in environmental samples. The gross alpha activity is defines as the total activity of alpha emitters, and originates from the decay chains of ^{238}U and ^{232}Th, which quantity depends on the geological and geographical formation of natural radionuclides. The main contributor to the gross beta activity is natural long-lived isotope ^{40}K, as well as ^{210}Pb, ^{228}Ra. The gross beta measurements also include a contribution from anthropogenic radionuclides ^{137}Cs and ^{90}Sr. Radionuclides that emitting low-energy beta radiation (^{3}H and gaseous or volatile radionuclide such as iodine) cannot be detected by gross beta activity measurements.

Keywords: radioactivity, gross alpha and gross beta activity, fruit leaves

INTRODUCTION

Natural radioactivity in environment originates mainly from the primordial radionuclides, such as ^{40}K, and the radionuclides from the ^{238}U and ^{232}Th and their decay products. Radionuclides from the ^{232}Th and ^{238}U series are responsible for the largest contribution to the gross alpha activity while activity of ^{40}K comprises about 89 % of the gross beta activity, while the remainder arises from ^{90}Sr, ^{137}Cs ^{210}Pb, and ^{228}Ra [1-3]. During the nuclear weapons testing in the 1960s and after nuclear accidents in Chernobyl and Fukushima, artificial radionuclides ^{137}Cs and ^{90}Sr were released in the atmosphere from where they were deposited on the soil surface by fallout. Based on their long half-life these radionuclides can still be found in the environment [3,4]. From that reason monitoring of radioactivity in environment is of great importance. In order to assess concentration of radionuclides in plants it is necessary to know that the accumulation of radionuclides by plants may occur by two ways: absorption by the leaves and shoot of the plant from the air and precipitation (direct method), or by root uptake from the soil (indirect method). The first way is dominant at the moment and immediately after nuclear and other accidents that lead to an increase of concentration of anthropogenic radionuclides in the atmosphere, while the second way is dominant when the concentration of radionuclides decreases [5].

Soil-root uptake is conditioned primarily by soil chemical and physical factors which may selectively retain a radionuclide, such as ^{137}Cs. The uptake of radionuclides by plants is a process based on five main factors: the amount of organic matter or clays; the pH of the soil; the chemical composition of the soil; the chemical species of the radionuclides; the presence of fungi and bacteria. UO_2^{2+} is a chemical form that is taken up by plants in the pH range 5.0–5.5. In the case that U forms hydroxide, phosphate, or carbonate complexes, its bioavailability is reduced. Ra and Pb are mainly associated with organic matter, and their transfer to plants is therefore via this pathway. The presence of organic matter, inorganic colloids (clay), and competing elements will strongly affect the uptake of ^{90}Sr and ^{137}Cs by plants from the soil. [5,6]

The transport of radionuclides across the epidermis of plant leaves is determined in part by the anatomy of the leaf, and by physiological factors. Artifiical radionuclides ^{90}Sr and ^{137}Cs, which enter to the gross beta activity, are readily taken up by the leaf. ^{137}Cs undergoes more translocation into fruit and seeds than ^{90}Sr which tends to remain in the plant part in which it was initially absorbed [5].

The plants (vegetables and fruits) may cause accumulation of radionuclides in their organs, and that may be multiplied risk to human population via food chain.

The aim of this work was to measure gross alpha and gross beta activity in leaves samples: Fig (*Ficus carica),* Vine (*Vitis vinifera* L.), and Apricot (*Prunus armeniaca*) collected in Iraq (Sulaymaniyah, Kurdistan region), and in the Serbia (Belgrade).

MATERIAL AND METHODS

Fruit plants are divided into three classes: woody trees, bushes and herbaceous plants, according to their gross morphology and physiology [7]. Leaves samples investigated in this work belong to woody trees. Sampling of leaves: Fig (*Ficus carica),* Vine (*Vitis vinifera* L.), and Apricot (*Prunus armeniaca*) were carried out in Iraq (Sulaymaniyah, Kurdistan region), and in the Serbia (Belgrade), in the summer 2018. Samples were dried at room temperature and in the oven at the temperature of 105°C. After drying samples were ashed at 450 °C [8]. Analysis was done in ashed samples using the gas low-level proportional counter Thermo-Eberline FHT 770T. The counting gas is a mixture of 90 % Ar and 10 % methane. Efficiencies of detectors were determined using the certified radioactive calibration standards ^{241}Am and ^{90}Sr (9031−OL−334/11 and 9031−OL−335/11, respectively, Czech Metrology Institute), traceable to the Bureau International des Poids et Mesures (BIPM). The counting efficiency was 26 % for alpha and 35% for beta radiation. Measurement time was 14400 s, by 4 independent detectors simultaneously. Measurement uncertainty was expressed as an expanded measurement uncertainty at the confidence level of 95% (k=2).

RESULTS AND DISCUSSION

The obtained results for gross alpha and gross beta activity in investigated leaves samples are presented in Table 1. It can be observed that for all investigated samples activity is higher for samples collected in Iraq. In Apricot leaves and Vine leaves samples the difference between the values, for both gross alpha/beta activities, for samples from Iraq are almost twice as large. For Fig leaves samples the obtained results are similar.

Table 1 Gross alpha and gross beta activity (Bq/kg) in investigated samples

Sample	**Gross alpha activity**	**Gross beta activity**
Apricot leaves (*Prunus armeniaca*) Serbia	61 ± 11	518 ± 29
Apricot leaves (*Prunus armeniaca*) Iraq	108 ± 12	949 ± 39
Vine leaves (*Vitis vinifera* L.) Serbia	33 ± 7	220 ± 16
Vine leaves (*Vitis vinifera* L.) Iraq	56 ± 8	448 ± 23
Fig leaves (*Ficus carica)* Serbia	56 ± 12	400 ± 27
Fig leaves (*Ficus carica)* Iraq	69 ± 11	413 ± 27

In the literature there are no data about gross alpha and gross beta activity in similar samples. In order to determine specific activity of individual radionuclide, gamma spectrometric analysis and ^{90}Sr determination, by radiochemical procedure, must be performed.

The study [9] shows a comprehensive analysis of radionuclide concentration in soil, water and plants in Iraq using gamma spectrometry. Analyzes of radionuclide content are mostly done in the fruit sample (apricot) [10,11].

In Serbia, the monitoring of radioactivity is carried out in accordance with the Rulebook on the establishment of programs for systematic testing of radioactivity in the environment [12]. According to the environmental monitoring program continuous testing and measurements of radioactivity in different types of samples are performed, among other things it is also done in plants. The obtained concentrations of radionuclides in fruit samples (apricot, fig) can be seen in [13,14,15], but these results were obtained using gamma spectrometry.

The existence of the difference in the obtained values in this paper for Apricot leaves and Vine leaves can be explained by the fact that concentrations of naturally occurring radionuclides in fruit vary widely because of the differing background levels, climate, and agricultural conditions that prevail.

CONCLUSION

Gross alpha and gross beta activity in fruit leaves samples (Apricot, Vine and Fig) were analyzed. Investigation was performed for samples taken in Iraq and Serbia. The obtained results show higher values for gross alpha and gross beta activity in Apricot leaves and Vine leaves for samples from Iraq. For Fig leaves the results are similar. In the absence of recent atmospheric releases of radionuclides, the use of plants as monitors of soil deposits or reservoirs of radionuclides should be used primarily when some information on the characteristics of the soil reservoir is known. In order to estimate which way is dominant for radionuclide absorption by the plant, further analysis is necessary, including gamma spectrometry analysis of radionuclides as well as ^{90}Sr determination. It is also necessary to performed analysis of soil samples and estimate transfer factor of radionuclides.

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