"^{210}Po in Inhalable Products: Comparison of Committed Doses Using the Human Respiratory Tract Model (HRTM)"

Jarosław Wieczorek,[1,*] Bin Feng,[1] and Alicja Boryło[2]

[1]Fudan University, Institute of Radiation Medicine, 2094 Xietu Road, Shanghai 200032, China
[2]Katedra Chemii i Radiochemii, Uniwersytet Gdański, Wita Stwosza 63, 80-308 Gdańsk, Poland

* *e-mail: jwieczorek@fudan.edu.cn /presenting author*

Naturally occurring radionuclides, particularly the alpha-emitting isotope polonium-210 (^{210}Po), are known to accumulate in various types of dried plant matter exposed to environmental deposition. When such materials are subjected to thermal processes for inhalation, ^{210}Po can be released into the air as part of an aerosol. The extent to which this radionuclide is transferred into the respiratory system is influenced by several variables, including temperature, the presence or absence of filtration systems, and the physical properties of the aerosol particles themselves.

This study aims to evaluate and compare the committed effective doses of ^{210}Po that result from different modes of thermal aerosol generation. A respiratory tract deposition model developed by the International Commission on Radiological Protection (ICRP), known as the Human Respiratory Tract Model (HRTM), was used to estimate the distribution and retention of inhaled activity in various compartments of the respiratory tract following exposure.

To carry out the assessment, dried plant-based samples were processed using a set of commonly applied inhalation-related techniques, which included open combustion (analogous to burning) and controlled-temperature thermal release (without direct combustion). In each case, desorption of ^{210}Po was experimentally measured through radiochemical methods involving alpha spectrometry. Sample residues and aerosol fractions were separately analyzed to determine the distribution of radioactive material. Dose calculations were performed using deposition coefficients from the HRTM, incorporating assumptions regarding particle size distribution and respiratory tract airflow.

Results showed that techniques involving direct combustion without any form of particulate filtration yielded the highest transfer rates of ^{210}Po into the aerosol phase, resulting in the greatest modeled dose values. In contrast, methods relying on thermal volatilization at moderate temperatures released smaller fractions of ^{210}Po into the aerosol, suggesting significantly lower radiological impact. The differences in calculated committed doses between the most and least intensive methods exceeded a factor of three.

These findings highlight the strong dependency of internal radiation dose on the chosen thermal technique for aerosol production. The combination of elevated temperatures and the lack of filtration significantly increases the availability of radionuclides for inhalation. Conversely, controlled heating and appropriate filtration mechanisms can effectively mitigate this risk. The results emphasize the importance of accounting for both technological and physical parameters when evaluating potential radiological exposures associated with the use of aerosol-generating plant-based materials.