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Polonium - 210 and Lead - 210 in urine samples of Warsaw residents

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^{210}Po is natural, short-lived ($T_{1/2} = 138.3$ days) alpha radiation emitter. It occurs in Earth crust in trace amounts as a product of radioactive Uranium–Radium decay series. The isotope is found in small amounts in human environment: air (<0.5 mBq/m³), drinking water (about 0.5 mBq/L), food (20-200 mBq/kg), tobacco (13.3 mBq/cigarette in Poland) and cigarette smoke (9.62 mBq/cigarette in Poland). Polonium introduced into the body is strongly radiotoxic, damages circulatory system and lungs. In the case of ^{210}Po ingested by humans, the content of this radionuclide in the human body can be determined based on the analysis of excreta such as urine samples. ^{210}Po is a daughter of ^{210}Pb which is beta and gamma emitter of half-decay $T_{1/2} = 22.3$ years. In small quantities, it is present in the human environment: air (<0.1 mBq/m³), drinking water (approximately 1.5 mBq/l), food (43-155 mBq/kg). ^{210}Pb in the atmosphere, in addition to natural origin, artificial isotope of nuclear explosions origin is introduced (particularly in the years 1952 to 1962). ^{210}Pb is toxic both as a heavy metal, accumulating in the human body and as a radioactive isotope.

The aim of the study was the determination together ^{210}Po and ^{210}Pb in urine samples of people not occupationally exposed (smokers and non-smokers). Urine samples of adults Warsaw inhabitants were collected. There were analyzed daily samples and two days samples. The average volume of the sample was 1.73 l/24 h (range 0.9-2.3 l/24 h).

The samples, after the addition of the tracer ^{209}Po , were evaporated almost to dryness with the addition of about 50 ml of concentrated HNO_3 . To the thus prepared samples perchloric acid was added in order to drive off the nitric acid. Samples were evaporated and the residue was dissolved in a 0.5 M solution of hydrochloric acid with a small addition of ascorbic acid (complexing metal ions such as Fe^{3+}). This was followed by deposition of ^{210}Po and ^{210}Pb on a nickel disc dimensions $f = 23.8$ mm, thickness 0.5 mm, coated on one side with teflon. Deposition was carried out, stirring the solution, for 6 hours at 85°C, all the while controlling the temperature and liquid level. After the deposition disc was removed, rinsed with water, ethanol and dried. Then the measurement of ^{210}Pb beta radiation was carried (thin film covering the disc to eliminate alpha radiation). Next the measurement of ^{210}Po alpha radiation was performed.

Fluctuations in activity concentration of ^{210}Po in the urine are quite substantial, from 1.01 mBq/l in urine sample of 81 year old woman tobacco smoker to 13.38 mBq/l in urine sample of 62 year old man, also a smoker of tobacco. Average ^{209}Po yield pattern was 42%. Concentrations of radioactive ^{210}Pb in urine are less diverse and range from 0.86 mBq/l in urine sample of 59 year old non-smoker male to 8.97 mBq/l in urine sample of 62 year old female non-smoker. On average, tobacco smokers excreted per day in urine 5.84 ± 6.23 mBq/d (range 1.84 - 21.01 mBq/d) of ^{210}Po isotope and on average 7.37 ± 4.42 mBq/d (range 1.86 - 15.78 mBq/d) of ^{210}Pb isotope. Non-smokers excreted in the urine per day on average 4.23 ± 2.81 mBq/d (range: 2.35 - 10.30 mBq/d) of ^{210}Po and 6.76 ± 2.97 mBq/d (range: 1.86 - 11.14 mBq/d) of ^{210}Pb . Daily excretion of ^{210}Po with urine increases with age insignificantly. The highest values were observed for persons at the age of about 60 years.

Primary authors: Dr STAROŚCIAK, Ewa (Central Laboratory for Radiological Protection); Dr ROSIAK, Lidia (Central Laboratory for Radiological Protection)

Presenter: Dr ROSIAK, Lidia (Central Laboratory for Radiological Protection)

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