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Sequential determination of 90Sr, 239Pu and 241Am in urine

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Urine analyses can be used to assess the performance of the radiation protection control practices. The separation methods used for estimation of radionuclides in urine are often time consuming and of lower sensitivity. The determination of low levels of actinides and strontium in biological samples require lengthy and tedious chemical processes, which include pre-concentration of samples, radiochemical separation, and source preparation. The determination of radionuclides in samples of urine thus requires fast approach due to radiotoxicological nature of Am, Pu and Sr to human body. In recent years, many studies have applied extraction chromatography to radionuclide isolation from urine samples. In our work, molecular recognition sorbents AnaLig®Sr-01 and AnaLig®Pu-02 from IBC Advanced Technologies, and Eichrom´s DGA® resin were used to effectively and selectively pre-concentrate, separate and determine strontium, plutonium and americium in urine samples. Method employs four-columns separation consisting of four different commercial products. First is Eichrom's Pre-filter Material, that removes organic compounds present in urine, which interfere with separation and decrease specific radionuclide sorbtion efficiency. This step improves reduction of carry over between columns in tandem and simplyfies whole separation method that is absent of difficult sample pretreatment steps for coloured material elimination used in other works. After passing through the Pre-filter Material column, urine samples are sequentialy loaded onto second and third column, containing one of the AnaLig® series sorbent, that contain specific crown-ethers, and on fourth, stacked with DGA® resin (branched) in which the extractant system is N,N,N',N'-tetrakis-2-ethylhexyldiglycolamide. Before analysis, samples of urine are acidified with concentrated nitric acid to acquire final concentration of 2 M. Volumes of urine samples varied from 50 ml to 200 ml. Depending on volume, various amounts of NaNO2 were added to secure oxidation of Pu3+ to Pu4+ form, obtaining three different oxidation states for each used radionuclide, in our case Sr2+, Am3+ and Pu4+. These are selectively captured on specific column, providing easy way for separative determination of harmful radionuclides in one sample at once. Radionuclides in columns were eluted with certain volumes of 0.05 M Na4EDTA for AnaLig®Sr-01, 9M HCl with TiCl3 for AnaLig®Pu-02 and with 0,1M HCl for DGA® resin. Strontium samples were counted repeatedly by Cerenkov counting over a 2 week period to monitor the ingrowth of 90Y on TRI CARB 2900 TR (PerkinElmer), while americium and plutonium samples were measured with ORTEC α-spectrometer 576A. Required time of procedure for 100 ml of urine is approximately 2 hours from collection of urine to beginning of measurement. This sequential method does not use phosphate co-precipitation of strontium or plutonium and ashing steps to remove organic compouds, which rapidly quickens and simplifies analysis process. Method separates Sr, Am and Pu from urine with high chemical recoveries and is suitable for use after accidents or emergency situations.

Key words: urine analysis, AnaLig Sr01, extraction chromatography, strontium, plutonium, americium

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