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ALPHA SPECTROMETRY OF ENVIRONMENTAL AND FOOD SAMPLES WITH PHOTON/ELECTRON-REJECTING ALPHA-LIQUID-SCINTILLATION (PERALS)

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In environmental and food monitoring radio-nuclides are normaly analysed with gamma spectrometry. Routine analysis of cesium nuclides can be realised fast and without much sample preparation. Also a few nuclides of the uranium- and thorium-series can be detected with gamma spectrometry at the low Bq/kg level. ^{226}Ra, ^{224}Ra and ^{228}Ra can be determined via their decay products when secular equilibrium of the sample is reached (e.g. ^{226}Ra via its daughters ^{214}Pb and ^{214}Bi).

Alpha spectrometry is the method of choice for the determination of alpha nuclides in the mBq range. The analytes have to be separated from interfering nuclides and quenching parameters prior to the spectrometry. So, the main task in alpha spectrometry consists in an efficient sample preparation and an alpha/beta discrimination for the spectrometric measurement.

Based on the work of Jack McDowell sensitive methods for the analyses of naturally occuring nuclides such as uranium, thorium, polonium and other alpha-nuclides in water, honey and spices were developed and validated [1]. Such techniques enables the tolerance and limit values for radionuclides in food to be controled in accordance with of the Swiss Ordinance on Contaminants and Ingredients (FIV) [2]

The method's principle is based on a selective extraction of the alpha nuclides from water samples rsp. from an aqueous extract of mineralised samples. The extractant has also the function of a cocktail in the alpha liquid spectrometry and therefore the extract can be analysed directly without further clean-up (Photon/Electron-Rejecting Alpha-Liquid-Scintillation, PERALS [1]). Normaly, one liter of water sample is extracted with 5 mL of cocktail to achieve low detection limits. The cocktail phase is separated from the aqueous phase by use of a phase separator for liquid samples. Methods were developed for the analyses of ^{234}U and ^{238}U, the thorium nuclides ^{228}Th, ^{230}Th, ^{232}Th and other alpha nuclides.

The achieved detection limits in water were 2 mBq/L for ^{234}U and ^{238}U and 1 mBq/L for ^{228}Th, ^{230}Th, ^{232}Th. In honey 800 mBq/kg could be determined with a counting time of 24 hours. Recoveries were 87% for ^{232}Th in water at an activity of 44 mBq/L. For ^{234}U and ^{238}U recoveries were 95% (level 125 mBq/L). In honey recoveries were 95.5% for ^{234}U and ^{238}U at an activity of 2.5 Bq/kg Honey.

[1] W. Jack McDowell and Betty L. McDowell: Liquid Scintillation Alpha Spectrometry, CRC Press London/Tokyo (1994).
[2] Eidgenösisches Departement des Innern: Fremd- und Inhaltsstoffverordnung (FIV), Ordinance of Contaminants and Ingredients 26.6.1995 (rev 21. 5. 2002.
[3] Ch. Baltzer: Bestimmung von ^{234}U and ^{238}U in Honig mit α-Spektrometrie. Dipomarbeit an der Fachhochschule Beider Basel (FHBB) (2005).