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Improvement of Detection Limits for Gamma-Ray Emitting Naturally Occurring Radionuclides in Drinking Water and Biological Materials by Instrumental Analysis using Compton Suppression Spectrometry

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The instrumental measurement of very low activities from naturally occurring radioactive materials (NORM) by gamma-ray spectrometry requires the use of detection systems with the lowest possible external activity. Generally, lead shielding and special detector construction materials are used for this purpose. In our laboratory, we have combined a lead shield and a Compton suppression system (CSS) to lower the external background activity. The external background was evaluated by first counting the empty detector for 24 h without the lead shielding in conventional mode (A). Then the same procedure was repeated with the lead shield (B). A third counting was done using the CSS and the Pb shield (C). A background reduction factor of approximately 3 was obtained by comparing the spectra collected using systems (A) and (B). When the conventional and the CSS with Pb shielding (i.e. B and C) were compared, the average background reduction factor was about 16. It was then possible to identify many radionuclides in tap water, well water, spring water, mussel tissues and oyster tissues. For example, the following radionuclides were detected in a canned tuna sample: (i) 234U, 234Th, 230Th, 214Pb, and 214Bi belonging to the 238U decay series; (ii) 235U, 231Th, 231Pa, and 227Th of 235U decay series; and (iii) 228Ac, 228Th, 212Pb, and 214Bi of the 232Th decay series. A comparison of the minimum detectable activity (MDA) values showed that the CSS gave the lowest value for 228Ac, 212Pb, 212Bi and 208Tl while comparable values were obtained for other radionuclides.

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