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Determination of magnesium in biological materials by neutron activation and anti-coincidence & gamma;-ray spectrometry

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Magnesium is considered as an essential element at moderate levels. Both deficiency and toxic effects of Mg in humans have been reported in the literature. Titrimetry, spectrophotometry, and atomic absorption spectrometry are generally used for the measurement of Mg levels. Instrumental NAA (INAA) is also an attractive tool for the rapid, simple and reliable determination of Mg. However, due to high background activity in biological samples, the measurement of gamma-rays emitted by ^{27}Mg is generally difficult. The main objective of the present work has been to study the advantages of anti-coincidence gamma-ray spectrometry for the determination of low levels of Mg in biological materials using INAA. The ^{27}Mg nuclide has a half-life of 9.46 min and it emits two major gamma-rays, namely 843.8 and 1014.4 keV, which are not coincident. Therefore, the use of anti-coincidence counting should not cause any reduction in peak efficiency of either of the photopeaks. The peak efficiency reduction factors of the two peaks have been measured as 0.98 and 1.00, respectively. It has been observed in many biological materials that the background around the 1014.4-keV peak of ^{27}Mg is mainly due to the 1778.9-keV peak of ^{28}Al , 1368.6-keV peak of ^{24}Na , 1642.7-keV peak of ^{38}Cl , and 1810.7-keV peak of ^{56}Mn . Anti-coincidence counting technique can be beneficially used under such situations. Several biological reference materials (RM) and standard reference materials (SRM) were analyzed for Mg by INAA. Between 200 and 700 mg of these materials were irradiated in the Dalhousie University SLOWPOKE-2 Reactor facility at a neutron flux of $5 \times 10^{11} \text{ cm}^{-2} \text{ s}^{-1}$ for 1 min, allowed to decay for 1 min, and counted for 10 min. The anti-coincidence gamma-ray spectrometer used in this work consisted of a HPGe detector and a $10^{\circ} \times 10^{\circ}$ NaI(Tl) guard detector with a $3^{\circ} \times 3^{\circ}$ NaI(Tl) plug. The peak-to-Compton plateau ratio of this system is about 590:1. The 843.8-keV peak suffers from interference by the 846.8-keV peak of ^{56}Mn which has a longer half-life of 2.58 h. In the anti-coincidence counting mode, the percentage overlap of the 843.8-keV peak is less because of the suppression of the 846.8-keV peak. We have developed a simple correction method which has been used for the determination of Mg in 15 NIST RM and SRM using the 843.8-keV gamma-ray of ^{27}Mg . The measured values have been found to agree well with the certified values.

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