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Determination of magnesium in biological materials by neutron activation and anti-coincidence γ-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 27Mg 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 27Mg 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 27Mg is mainly due to the 1778.9-keV peak of 28Al, 1368.6-keV peak of 24Na, 1642.7-keV peak of 38Cl, and 1810.7-keV peak of 56Mn. 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 × 1011 cm-2 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”x10” NaI(Tl) guard detector with a 3”x3” 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 56Mn 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 27Mg. The measured values have been found to agree well with the certified values.

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