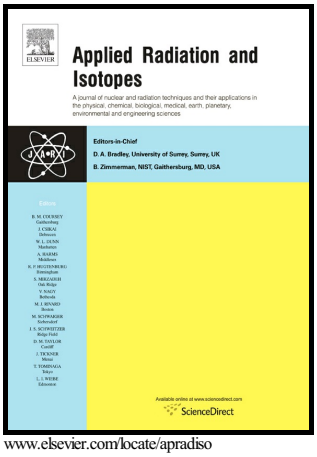

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Evaluation of the separation and purification of ^{227}Th from its decay progeny by anion exchange and extraction chromatography

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Abstract

Thorium-227 is currently undergoing evaluation as a potential radionuclide for targeted cancer therapy, and as such a high chemical purity of the material is required. To establish a reliable procedure for radiochemical isolation of ^{227}Th from the parent ^{227}Ac and decay progeny, which includes the radiotherapeutic ^{223}Ra, the performance of three different separation schemes based on ion-exchange and extraction chromatography have been evaluated. The results suggest that both ion exchange and extraction chromatographic techniques can be successfully used for the separation of ^{227}Th from its decay progeny, however extraction chromatographic resins demonstrate favourable performance in terms of Th recovery and purification from radionuclide impurities.

Keywords: ^{227}Th; radiopharmaceuticals; radiochemical separation; ion-exchange; extraction chromatography

1. Introduction

Thorium-227 is a short-lived α-emitting radionuclide ($T_{1/2}$ = 18.697 (7) d (Collins *et al.*, 2015)), decaying by α-particle emission to ^{223}Ra, with an average α-particle energy of 5.9 MeV. Thorium-227 is part of the ^{227}Ac decay chain (Fig. 1) and can be obtained in clinically relevant quantities from β-decay of the long-term generator ^{227}Ac ($T_{1/2}$ = 21.772 (3) a (Bé *et al.*, 2008)) (Abbas *et al.*, 2011; Larsen et al., 2007). Although ^{227}Ac occurs naturally as part of the ^{235}U decay series in relatively small quantities, it can be produced in significant amounts by thermal neutron irradiation of ^{226}Ra (Dahle *et al.*, 2008a), or retrieved from legacy actinium-beryllium neutron generators (Soderquist *et al.*, 2012). In recent years, ^{227}Th has attracted significant attention as an α-particle emitting radiotherapeutic nuclide with a high potential for application in conjunction with specific tumour seeking monoclonal antibodies as delivery agents (Dahle *et al.*, 2007). The anti-CD20 monoclonal antibody rituximab labelled with ^{227}Th has been examined as a radiotherapeutic agent for treatment of lymphoma. Complete regression of human lym-