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Selective separation of no carrier added Sc-47 from reactor irradiated Ca using zirconium vanadate gel for nuclear medical applications

Abstract

Background/Goal/Objective of the study:

In recent decades, great efforts have been paid for the development of radiopharmaceuticals which can be used for combined imaging and therapy or briefly, for radiotheragnostics. This approach of employing one molecular vector to render diagnosis beside targeted radiotherapy claim the parallel expansion in the production and separation of radioisotopes of dual purposes. One of these radioisotopes which received great attention, scandium-47, due to its favorable nuclear and chemical properties [T½ = 3.35 d, Eβ-(max.) = 600 keV, Eɣ = 159 keV]. In this context, it seemed of interest to study the production and separation of Sc-47 and this work spotlights on the rapid and effective separation of no-carrier-added (NCA) Sc-47 from natural Ca targets using inorganic ion exchanger.

Methodology:

A target of 1 gm of natural calcium carbonate was irradiated in the ETRR-2 Research Reactor, Egypt, at a thermal neutron flux of 1.8 x 1014 n cm-2 s-1 for 24 h. zirconium-vanadate gel was prepared following the method published by Roy, et al. and studied as a sorbent material for the separation of 47Sc(III) from 47Ca(II). The Influence of HCl and HNO3 concentrations on the distribution coefficients of 47Sc(III) and 47Ca(II) ions was investigated by batch technique. Chromatographic column separation of 47Sc(III) from 47Ca(II) was carried out using the prepared zirconium vanadate gel. Finally, the radionuclidic and radiochemical purities of the eluted 47Sc(III) were examined.

Results and Discussion:

The results obtained from the batch adsorption studies revealed that the adsorption efficiency of 47Sc(III) ions is strongly dependent on the initial acid concentration and high adsorption can be obtained at 0.001 M HCL and HNO3. Conversely, the change in acid concentration not affect the 47Ca(II) ions adsorption. These results are in concordance with numerous studies in which the ionic radius of one ion is smaller than the other. This finding made us consider the possibility of radiochemical separation of 47Sc(III) from 47Ca(II) using zirconium vanadate gel ion exchanger packed column, where 47Sc(III) is substantially retained at 0.001 M HNO3 without any remarkable adsorption of 47Ca(II) ions. 1 M HNO3 directly eluted the retained 47Sc at a flow rate of 1 ml/min with elution yield of 75%. The eluted 47Sc with high radiochemical and radionuclidic purities.

Conclusion:

In summary, Zirconium vanadate gel is an effective material for separation of 47Sc(III) from irradiated Ca target with high yield and high purity and our results thus hold a great promise for the use of 47Sc(III) in the preparation of radiopharmaceuticals for theranostics applications.

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