Development of 90Sr-90Y generators using the cation exchange technique at IPEN/CNEN-SP

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Introduction. There is a widespread interest in the use of ^{90}Y for various therapeutic applications, including radiolabeled tumor-specific antibodies for tumor therapy, radiolabeled particles for irradiation of malignant tumors in the liver, irradiation of solid tumors and treatment of rheumatoid arthritis of the knee joint.[1-3] Yttrium-90 is generated through the decay of reactor-produced ^{90}Sr ($t_{1/2}$=28 years) and isolated by methods like precipitation, extraction, electrochemical separation and ion exchange chromatography[1]. Because of its simplicity, the ion exchange methods are most commonly used in the generator systems for the separation of ^{90}Y from ^{90}Sr in very pure form. Most of these generators have been prepared using the Dowex-50 cation exchange resins, that can retain ^{90}Sr while the ^{90}Y daughter is eluted in various solvents such as citrate, oxalate, acetate, and ethylenediaminetetraacetic acid (EDTA). One must note that ^{90}Sr is a bone-seeker and produces bone marrow depression, so the permissible ^{90}Sr has a lifetime tolerance of 74kBq (2μCi) when fixed in bone[4]. The objective of this work is to develop a methodology for the preparation of ^{90}Sr-^{90}Y generators using a cation exchange resin method. ^{90}Sr is strongly adsorbed in the resin and ^{90}Y is eluted in 0.03mol.L^{-1} EDTA. **Materials and methods.** All experiments were performed at the Radiopharmacy Center at

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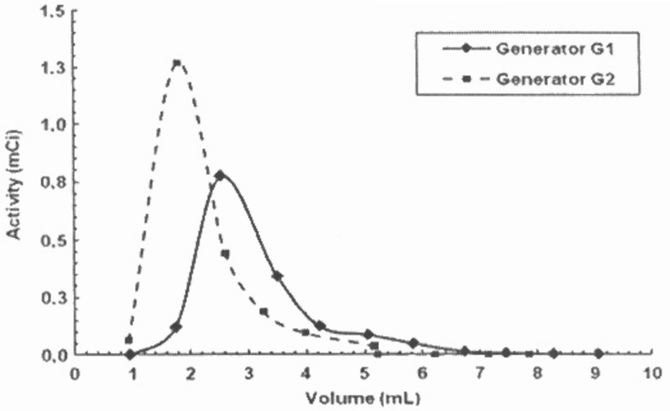

Figure 1.—Elution profile for (G_1) and (G_2) ^{90}Sr-^{90}Y generators with 0.03 mol·L^{-1} EDTA.

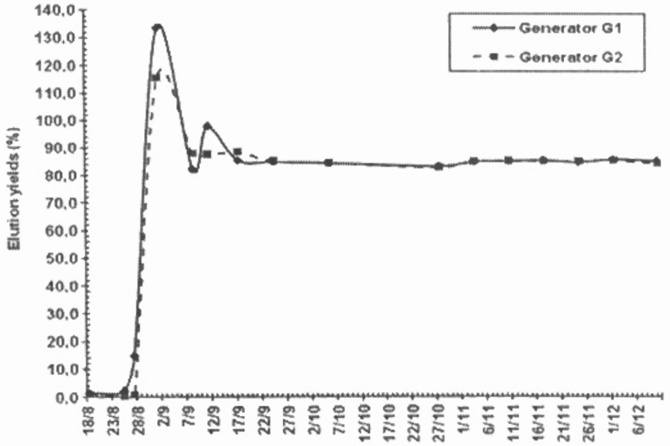

Figure 2.—Elution yields for (G1) and (G2) ^{90}Sr-^{90}Y generators.

IPEN/CNEN-SP. Two generators (G_1 and G_2) were developed, both loaded with 3 mCi (111 MBq) of ^{90}Sr. The solution containing the pair $^{90}Sr/^{90}Y$ was prepared in 1mol.L^{-1} HCl. The cation exchange resin used in both generators was Dowex 50W-X8 (100-200 mesh, H^+ form) that was converted to Na^+ form with 1mol.L^{-1} NaOH and distilled water. After the activation, the resin was conditioned with 100 mL of 0.003 mol.L^{-1} EDTA at pH= 4.55. The generator (G_1) consisted of a glass chromatographic column with a 1cm diameter and 10cm high fitted with a glass frit at the bottom. The column was assembled vertically. The flow rate was 11 drops/min. The generator (G_2) differed only in the diameter, 0.8 cm with a flow rate of 6 drops/min. The elutions for both generators for separation process were performed with 0.003 mol.L^{-1} and 0.03 mol·L^{-1} EDTA. The radioactivity measurements were performed using a Capintec CRC®-15 beta dose calibrator. A liquid scintillation counting analyzer (LSC) was also available for determination of the beta emitters (^{90}Sr and ^{90}Y) and an HPGe detector for the determination of the gamma emitter (^{85}Sr tracer). Pure samples of ^{90}Y and ^{90}Sr-^{90}Y were used as standards in the LSC. The quality control performed for the two generators system consisted of following the decay of ^{90}Y in each elution and also by measuring the activities of ^{85}Sr (HPGe) and ^{90}Sr (beta counting). **Results.** Figure 1 shows the elution profile for the (G_1) and (G_2) generators eluted with 0.03 mol.L^{-1} EDTA. Generator G_2 could be eluted with lower volumes (5 mL) than the generator G_1 (8 mL). Figure 2 shows the elution yields for both generators. Initially (up to 28/8), the generators were eluted with 0.003mol.L^{-1} EDTA with larger elution volumes and low yields. The concentration of EDTA was changed to 0.03mol.L^{-1}, decreasing the elution volumes and increasing the elution yields. Both generators had the same behavior along the 4 months of use with average elution yields of 85%. The activity of each eluted sample was measured during 1 month for the ^{90}Y $t_{1/2}$ determination. The results showed low deviation errors of the $t_{1/2}$ obtained in relation to the theoretical one (2.6 to 6.5%) indicating a small presence of ^{90}Sr during the elutions. It was noticed that for generator G_1 the half-life started to lower in the last elutions, indicating a possible contamination with ^{90}Sr. The same samples were analyzed for ^{85}Sr (HPGe) and ^{90}Sr (LSC) and it was not detected the presence of both radioisotopes, indicating a high radionuclidic purity of ^{90}Y. **Conclusion.** A very promising methodology for the preparation of ^{90}Sr-^{90}Y generators was developed using the cation exchange technique. In this technique, ^{90}Sr is strongly adsorbed in both generators, and ^{90}Y eluted using 0.03 mol.L^{-1} EDTA. The results showed that chromatographic columns with smaller diameters presented a better performance during the elutions, with smaller elution volumes and larger radioactive concentrations. Next steps include the development of a methodology to destroy EDTA, the determination of ^{90}Sr breakthrough using an ICP-OES technique and the gradual increase of the ^{90}Sr-^{90}Y activity.

References

1. Xiques A C, Olivé K I, González E C, Beckford D, Montanã R I. [2009] Radiochim. Acta. 97:739-746.
2. Chinol M, Hnatowich D J [1987] J. Nucl. Med. 28:9:1465-1470.
2. Wike J S, Guyer C E, Ramey D W, Philips B P [1990] Appl. Radiat. Isot. 41:861-865. Suzuki Y [1964] Int. J. Appl. Isot. 15:599-602.