Column chromatography of astatine using weak base anion exchange resin

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Astatine (At) is one of the nuclides expected to be applied for targeted α-particle therapy (TAT). Several methods for At separation are known. Two methods (dry distillation1) and wet extraction2,3) are used mainly. Dry distillation can obtain a pure solution of At without impurities; however, it requires the construction of a complicated apparatus.1) On the other hand, although wet extraction is a simple method, the aqueous solution is contaminated with the organic solvent after back extraction. To solve these problems, we tried At separation using column chromatography.4) However, the eluent was too alkaline for biological studies. Therefore, we need to find a solution with mild conditions. In the general wet separation of At, it is necessary to dissolve bismuth metal or bismuth oxide (Bi₂O₃) into nitric acid. We examined the dissolution method using hydrochloric acid (4 M HCl).4) However, large amounts of anions other than astatide anion (At⁻) existed in the solution, which was used to dissolve the Bi₂O₃ target in our study. This influenced the behavior of At in column chromatography, and we could not achieve a high yield of At tracer. In this work, we reconsidered the chemical operation. Improvement of the dissolution method of the Bi₂O₃ target and the conditions of column chromatography were investigated. The radioactivity was measured with a high-purity germanium detector. The quantitation of 211At was carried out with γ-ray at 687 keV (Iγ = 0.261%).

We produced 211At at the RIKEN Nishina Center using the 209Bi(α, 2n)211At reaction (29 MeV, 250 particle nA, 30 min). A Bi₂O₃ pellet was used as the target. The irradiated target was added to 12 mL of 0.25 M EDTA-2Na solution and 0.01 M L-ascorbic acid solution in a 50 mL tube. By shaking this mixture for 60 min, the Bi₂O₃ target was completely dissolved.

This solution was used for column chromatography studies. 3-Aminopropyl Silica Gel (Tokyo Chemical Industry Co., Ltd.) was used as the weak anion exchange resin, and 1 mL (7 mmϕ × 26 mm) of the resin was filled into the Muromac® Mini-column (M size). This was flushed with 25 mL of EtOH, 10 mL of H₂O, and 10 mL of 1 M L-Ascorbic acid in this order (conditioning).

On dissolving the Bi₂O₃ target, 71% of 211At was adsorbed to the 50 mL column. Column chromatography was carried out using the 211At remaining in the solution. The operations and results are shown in Fig. 1. We found that 211At could be separated with a 50% yield at a more mild condition (0.3–1 M NaOH). However, 7–25% and 1–7% of 211At were lost at the charge and washing processes, respectively. The column residue of 211At was 15–22%. The separation method of At in our study is still unstable and has to be improved.

Fig. 1. Methods and results of column chromatography. Run 1 and Run2 had the same conditions; however, the results did not show the same behavior.

References

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