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 distillation[1] and wet extraction[2,3]) 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 (Bi_2O_3) 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 Bi_2O_3 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 Bi_2O_3 target and the conditions of column chromatography were investigated. The radioactivity was measured with a high-purity germanium detector. The quantitation of ^{211}At was carried out with γ-ray at 687 keV ($I_\gamma = 0.261\%$).

We produced ^{211}At at the RIKEN Nishina Center using the ^{209}Bi$(\alpha, 2n)^{211}$At reaction (29 MeV, 250 particle nA, 30 min). A Bi_2O_3 pellet was used as the target. The irradiated target was added to 12 mL of 0.25 M EDTA $\cdot$ 2Na solution and 0.01 M L-ascorbic acid solution in a 50 mL tube. By shaking this mixture for 60 min, the Bi_2O_3 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 mm$\phi \times$ 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 H_2O, and 10 mL of 1 M L-Ascorbic acid in this order (conditioning).

On dissolving the Bi_2O_3 target, 71% of ^{211}At was adsorbed to the 50 mL tube. Column chromatography was carried out using the ^{211}At remaining in the solution. The operations and results are shown in Fig. 1. We found that ^{211}At could be separated with a 50% yield at a more mild condition (0.3–1 M NaOH). However, 7–25% and 1–7% of ^{211}At were lost at the charge and washing processes, respectively. The column residue of ^{211}At was 15–22%. The separation method of At in our study is still unstable and has to be improved.

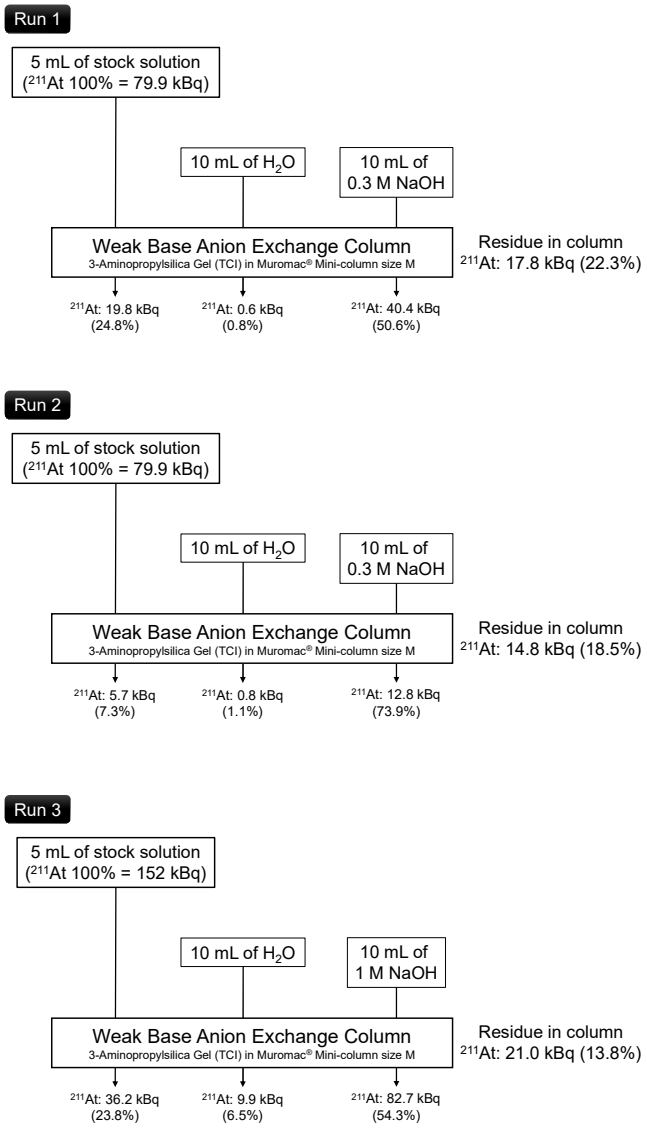

Fig. 1. Methods and results of column chromatography. Run 1 and Run2 had the same conditions; however, the results did not show the same behavior.

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