Trial of astatine separation using column chromatography

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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, but mainly two methods (dry distillation[1)] and wet extraction[2,3)]) are used. Dry distillation can obtain yield a pure solution of At, however complicated apparatus must be constructed.[1)] On the other hand, although wet extraction is a simple method, the aqueous solution is contaminated with an organic solvent after back extraction. In order to apply At for TAT, the separation method has be improved further. In this work, column chromatography was attempted as one of the improved methods.

We produced ^{211}At at RIKEN Nishina Center using the ^{209}Bi$(\alpha, 2n)^{211}$At reaction (29 MeV, 250 particle nA, 30 min) and ^{210}At at Cyclotron and Radioisotope Center (CYRIC), Tohoku University using the ^{209}Bi$(\alpha, 3n)^{210}$At reaction (50 MeV, 100 particle nA, 30 seconds). A bismuth oxide (Bi_2O_3) pellet was used as the target. The irradiated target was dissolved in 2 mL of 4 M HCl containing 1 M $NaHSO_3$, and 6 mL of 0.84 M EDTA·2Na solution was added (stock solution).

Batch experiments of 5 fillers (anion-exchange resin, cation exchange resin, activated carbon, alumina, and cellulose) were conducted, in which 0.1 mL of fillers were added to 1 mL of stock solution. These mixtures were shaken for 5 min and centrifuged for 10 min. The fillers and supernatant was separated and their radioactivity were measured (Table 1). A significant amount of At was adsorbed on anion exchange resin and activated carbon, however little At was adsorbed on the other fillers.

We attempted column chromatography using anion-exchange resin and activated carbon. 1 mL of stock solution was charged into a filler (5 mmϕ × 4 mm), and the column was eluted. In both cases, almost all At was trapped in the column. Trapped At was not eluted by concentrated HCl. However, At on the activated carbon column was eluted by 10 M NaOH solution. Thus we optimized the separation method (Fig. 1) and drew the elution curve (Fig. 2). In the experiment, 85% of charged At was eluted by 10 column volumes of 10 M NaOH solution. It is suggested that At is oxidized to AtO(OH) at pH 14 which is the condition of the eluent.[4)] This result suggested that AtO(OH) do not adsorbed on activated carbon. We could harvest high yield At easily.

However, the At solution was strongly alkaline. Therefore, it is not possible to use this solution for biological research (pre-clinical and clinical research). In the future, we plan to test the removal method of concentrated cations, consider another target dissolution method, and apply other fillers.

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Table 1. Results of batch experiment (ratio of At%).

	Absorbed	Supernatant
Anion-Exchange Resin	73.4 ± 1.4	0.95 ± 0.14
Cation-Exchange Resin	8.4 ± 0.3	78.8 ± 0.5
Activated Carbon	85.1 ± 1.3	1.3 ± 0.2
Alumina	15.5 ± 0.5	66.4 ± 1.3
Cellulose	11.8 ± 0.4	68.3 ± 2.5

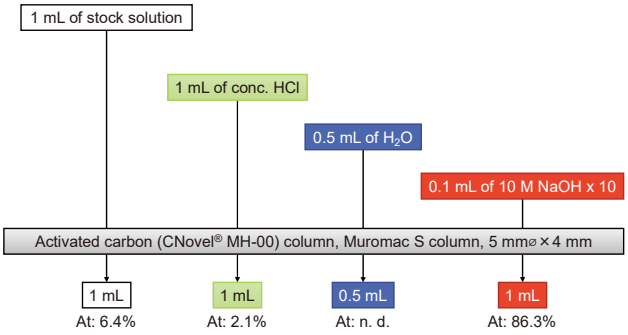

Fig. 1. Separation method of At using column chromatography (filler: activated carbon).

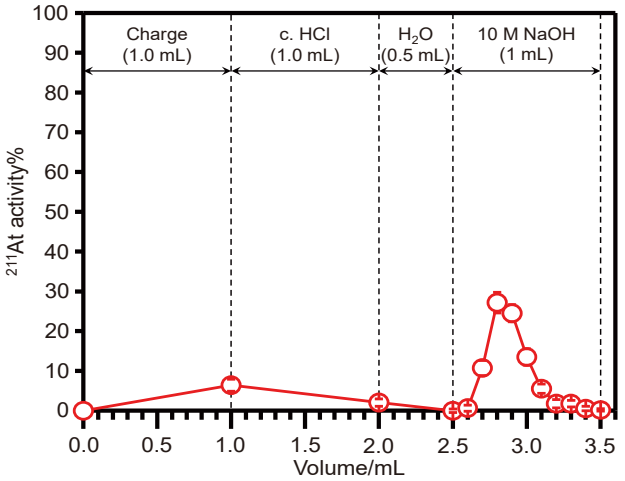

Fig. 2. Elution curve of At from activated carbon column.

References
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