Theranostic Potential of Lutetium-177: Characteristics and Applications

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Lu-177

INTRODUCTION

Lutetium-177, a radioisotope produced in reactors, has a longer half-life of 6.65 days and a maximum particle range of 2 mm in tissue, making it better suited for targeting smaller tumors (demonstrated precise tumor localization, excellent tolerability, and reversible tumor suppression).
Lutetium-177 emits three β-particles (12% at 0.176 MeV, 9% at 0.384 MeV, and 79% at 0.497 MeV) and two γ-particles (6.4% at 0.113 MeV and 11% at 0.0208 MeV).
The presence of gamma emissions provides an additional advantage to Lutetium-177 as it can be used for diagnostic purposes alongside its therapeutic applications.
The clinical application of Lutetium benefits from its physical half-life, making it compatible with a diverse range of targeting agents, spanning from peptides to large biomolecules such as monoclonal antibodies.
Its chemical attributes, including a small ionic radius (0.86–1.03 Å), facilitate chelation with clinically endorsed bifunctional chelators like DOTA and DTPA.

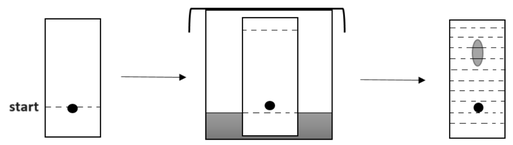
PURPOSE

Using Lutetium-177 to obtain stable radioimmunoconjugates of trastuzumab-DOTA.

METHODS AND MATERIALS

Radioactive labeling of ICs with Lutetium-177

The radioactive labeling of ICs with Lu-177, was achieved by reconstituting the lyophilized cakes using 0.5 mL of 0.9% NaCl solution, with pH adjusted to 6.
Specific activity of 8.15 mCi (Lutetium-177), was prepared by dissolving in 150 μL of 0.04 mol L^{-1} HCl.
Subsequently, 5 μL of the Lutetium-177 solution was added to each vial.
The resulting solution of p-SCN-Bn-DOTA-Tr was incubated for 1 hour at 40 °C.



Instant thin layer chromatography-silica gel (ITLC-SG)

The sample was applied onto a strip at 0 positions, positioned 2 cm from the bottom, and subjected to development using three distinct mobile phases:
A mixture of sodium acetate / 0.4 mol L^{-1} methanol in a 1:1 ratio,
0.9% saline solution,
0.1 mol L^{-1} acetate buffer.
Following the development, the strips were divided into 14 equal segments of 1 cm each, and the radioactivity in each segment was measured.
The mobile phases that yielded the most optimal results were selected to evaluate the stability of the samples at 24, 48, and 72 hours.

RESULTS AND DISCUSSION

Table 1. *The radiochemical purity of Lutetium-177 labeled Tr in different mobile phases*

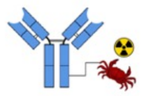
Samples	Mobile phase	Radiochemical Yield [%]
^{177}Lu -DOTA-Tr	0.9% saline solution	100
^{177}Lu -DOTA-Tr	0.4 mol L^{-1} methanol/sodium acetate (1:1)	99.27
^{177}Lu -DOTA-Tr	0.1 mol L^{-1} acetic buffer	98.03

STABILITY

Table 2. *Released Lutetium-177 from ^{177}Lu-DOTA-Tr in 0.9% saline solution at RT*

^{177}Lu-DOTA-Tr		
Incubation time [h]	Radiochemical Yield [%] at time	Release of Lutetium-177 [%]
1	100	0
24	99.14	0.86
48	98.97	1.03
72	98.52	1.48

RADIOCHEMICAL PURITY



177Lu-DOTA-Tr
100 % ⟶ 0.9 % saline solution

CONCLUSIONS

As ongoing research describes new applications for Lutetium-177-based theranostics, its potential is continually evolving. The comprehensive utilization of theranostic potential is in progress, holding significant implications for advancing medical science and enhancing patient outcomes.

REFERENCES

1. W. Wojdowska, U. Karczmarczyk, M. Maurin., P. Garnuszek and R. Mikolajczak, Standardization of procedures for the preparation of ^{177}Lu- and ^{90}Y-labeled DOTA-rituximab based on the freeze-dried kit formulation, *Curr. Radiopharm.* **8**(1) (2015) 62–68;
2. A. Dash, M. R. A. Pillai and F. F. Knapp, Production of ^{177}Lu for targeted radionuclide therapy: available option, *Nucl. Med. Mol. Imaging* **49**(2) (2015) 85–107;

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