Radiolabeling Comparison of Accelerator Versus Generator Produced $^{225}$Ac

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Tri-Lab Effort

Leveraging Unique Isotope Program Facilities, Capabilities, and Expertise to Address $^{225}\text{Ac}$ Supply

ORNL - Approximately 25 years of experience in the isolation of $^{225}\text{Ac}$ from fissile $^{233}\text{U}$ via $^{229}\text{Th}$

LANL Isotope Production Facility (IPF) at LANSCE; 100 MeV incident energy up to 275 µA for routine production

BNL Linac at the Brookhaven Linac Isotope Producer (BLIP) 165 µA intensity to targets at incident energies ranging from 66-202 MeV
Routine Accelerator Production of $^{225}$Ac

- Stage 2: Routine production of 50-100 mCi $^{225}$Ac
  - Continued optimization/evaluation of targets
  - Continued optimization of processing for direct $^{225}$Ac and $^{225}$Ac/$^{213}$Bi generator
  - Implementation of chemistry
  - Targetry scale up

- Stage 3: Routine production of 100-1000 mCi $^{225}$Ac
Accelerator Production of $^{225}$Ac

- 0.2% coproduction of $^{227}$Ac
- $t_{1/2}=21.78$ y
- Complicated decay scheme
  - Th
  - Rn
  - Pb
- Will these daughter products have an impact on radiolabeling?
Motivation/Protocol

• To evaluate generator produced $^{225}$Ac radiolabeling yields and compare them to accelerator produced $^{225}$Ac radiolabeling yields

• Evaluate impact of presence of Ac-227

• Determine if differences are observed with time

• Used literature methods of clinical studies

• 50 μCi per reaction
• 100 °C for 30 minutes
• Timepoints
  • 0, 1, 3, 6, 10, 14, 17, 21 days post delivery.
• ITLC
  • Solvent 50/50 NH$_4$OAc/Methanol
• Varied conc. of ligand
  • 25 μmol to 5 picomol

Results- Excess Ligand Conc.

• 1:60000 M:L
• Generator batch received 08/06/2019
• Accelerator batch received 09/24/2019
Results - Moderate Ligand Conc.

- 1:50 M:L
- Generator batch received 11/26/2019
- Accelerator batch received 11/18/2019
Results - Low Ligand Conc.

- 1:1 M:L
- Generator batch received 11/26/2019
- Accelerator batch received 11/18/2019
Results
Results

Accelerator 50:1

Accelerator 1:1

[Graphs showing data for Days 0, 1, 3, 7, and 9 for November and June for Accelerator 50:1 and Accelerator 1:1]
Conclusions and Future Work

• Consistent radiolabeling yields across both production routes
  • At high ligand concentrations
• There is an observed reduction in labeling yield as the ligand concentration is varied
• Accelerator material shows higher labeling yields in early time points
  • 50:1 and 1:1
  • Possible contaminants?
• Evaluation between different batches of product
  • Current results show a trend of lower labeling yields with more recent batch
• Optimization of ITLC protocol
• Determination of Ac-227 content
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www.isotopes.gov