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# RAPID METHOD FOR THE DETERMINATION OF RADIOSTRONTIUM IN MILK

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$^{89,90}$Sr and $^{90}$Y are beta emitters. Other radionuclides must be separated out.

Milk: Difficult analysis due to the presence of significant quantities of

- Proteins
- Fats
- Minerals (calcium)

and these must be removed first.

IAEA/AQ/27:
Simultaneous determination of $^{89}Sr$ and $^{90}Sr$

S.L.Maxwell III and B.K.Culligen
(JRNC, 279, 757-760, 2009)

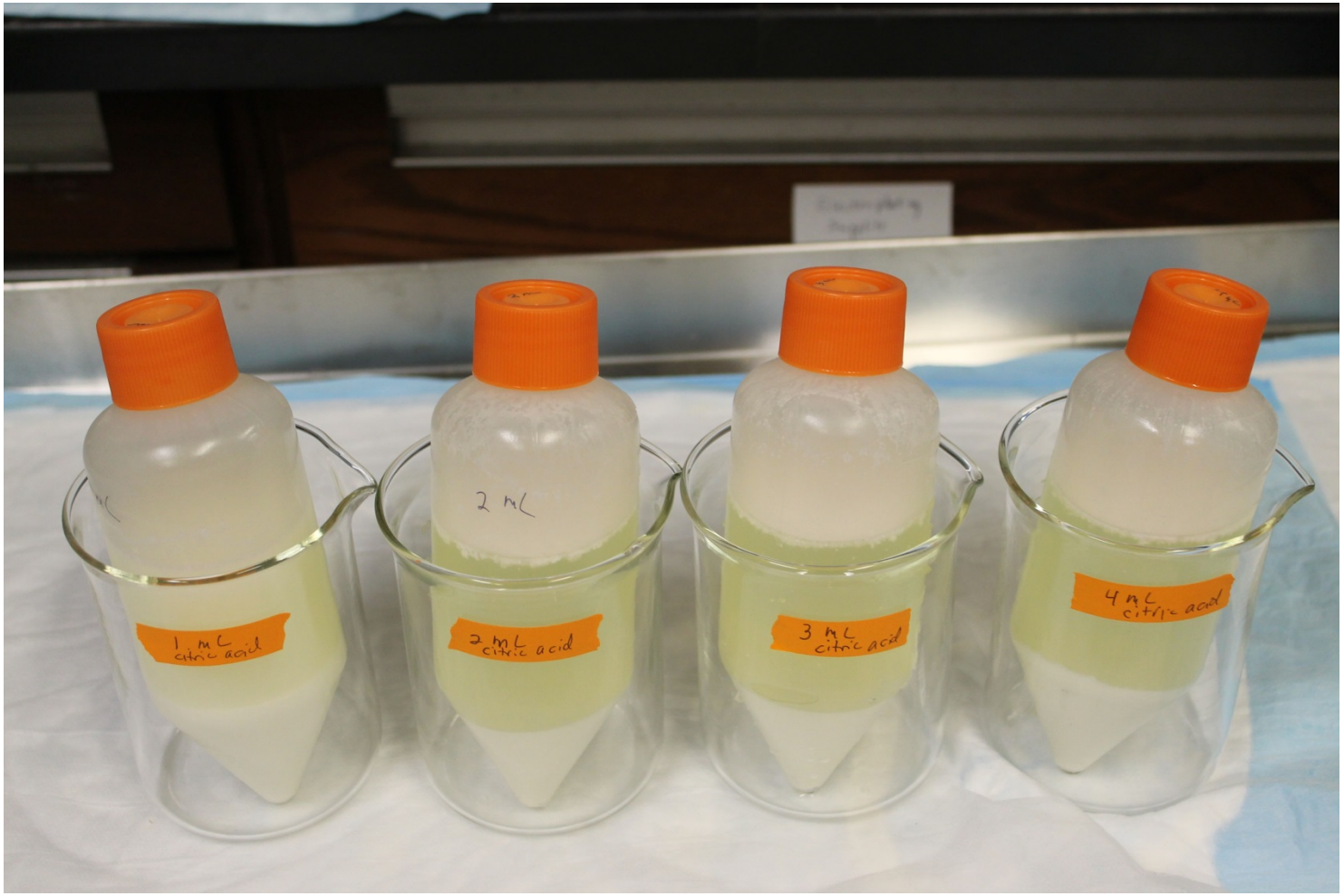
Zhichao Lin and Stephanie Healey (WEAC)
Analysis of $^{241}Am$, $^{238, 239, 240}Pu$, and $^{90}Sr$ in Foods

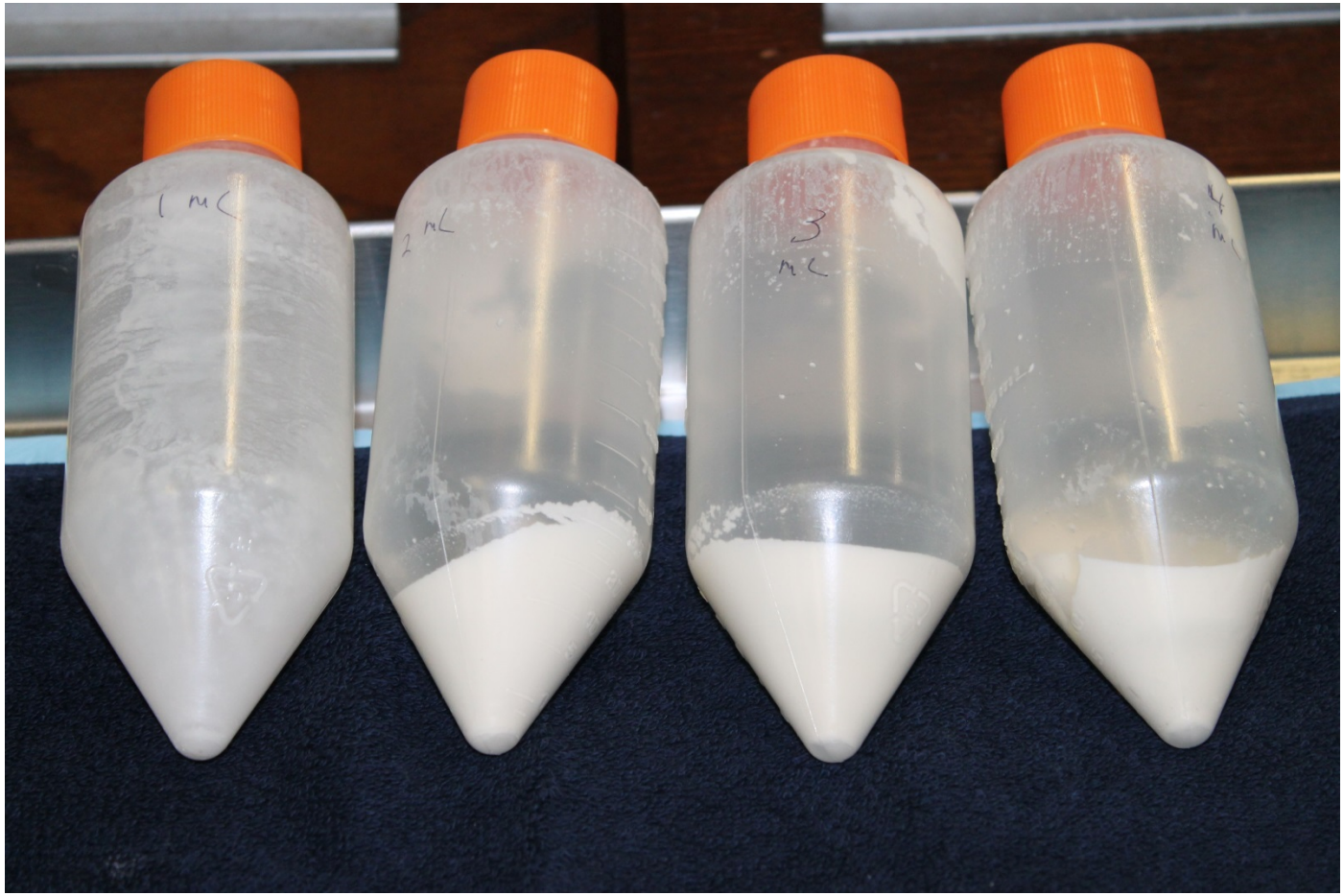
Mikulaj and Svec (1993) proposed to precipitate and remove proteins and major part of fats by adding concentrated $HNO_3$.

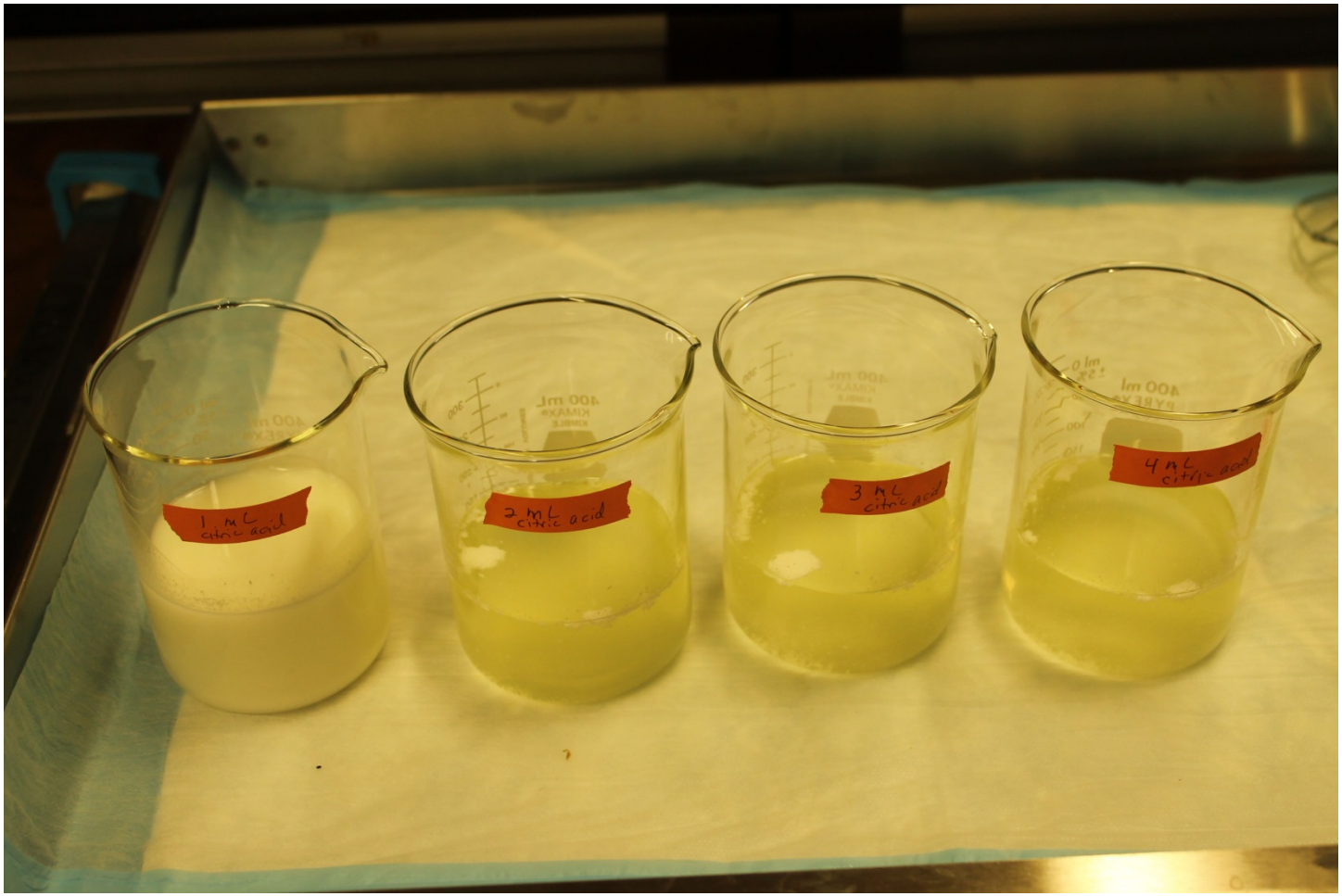
Wadsworth Center:

To see if citric acid can act as a coagulant for fats and proteins

- 100 mL milk (homogenized)
- 50 mg strontium carrier
- 1, 2, 3, and 4 mL 25% citric acid,
- Centrifuged, decanted


1 mL
citric acid
2 mL
2 mL
citric acid
3 mL
citric acid
4 mL
citric acid


1 mL
2 mL
3 mL


1 mL
citric acid
2 mL
citric acid
3 mL
citric acid
4 mL
citric acid

Citric acid as coagulant for fats and proteins

- 100 mL milk (homogenized)
- 50 mg strontium carrier
- $^{85}$Sr tracer, mixed for 20 min
- 2 mL 25% citric acid,
- Centrifuged, decanted, supernatant counted

## $^{85}$Sr recovery

- 69.4 %
- 66.4 %
- 51.4 %
- 69.4 %

- 65.3 % (1.2 g lactic acid)
- 65.3 % (1.3 g lactic acid)

If the residue was rinsed with 1% $HNO_3$, centrifuged, decanted, supernatants were mixed and counted. The recovery of $^{85}Sr$ increased from 64.6 % to 92 %

100 mL milk, 50mg Sr carrier, $^{85}Sr$ tracer

- coagulation
- carbonate precipitation
- strontium nitrate precipitation using fuming nitric acid
- dissolved in $HNO_3$ and counted

$^{85}Sr$ recovery:

- 81.9 %
- 81.0%
- 82.5%
- 78.8%

100 mL milk, 5mg Sr carrier, $^{89}Sr$ tracer

- coagulation
- carbonate precipitation
- dissolved in 8M $HNO_3$
- 1g Sr-resin
- elution with 0.05M $HNO_3$
- carbonate precipitation,
- GP counter

$^{89}Sr$ recovery:

- 79.7 %
- 54.1 %
- 33.1 %
- 34.2 %

100 mL milk, 15mg $Sr^{2+}$, 100 mL DI water, $^{89}Sr$ tracer,

- coagulation
- carbonate precipitation
- dissolved in $HNO_3$ , dried
- muffle furnace at $450^0C$, dissolved in 8M $HNO_3$
- 3g Sr-resin
- Sr eluted with 0.05 M $HNO_3$
- evaporated, and counted on GP counter

$^{89}Sr$ recovery:

- 86.4 %
- 82.8 %

## $^{89}Sr$ (3g Sr-resin, 15mg Sr carrier)

| added (pCi) | exp (pCi) | % recovery | % bias |
|---|---|---|---|
| 99.2 | 102.7 | 86.2 | 3.5 |
| 99.2 | 105.0 | 80.8 | 5.9 |
| 87.7 | 92.0 | 84.1 | 4.9 |
| 87.7 | 94.0 | 79.8 | 7.2 |
| 81.9 | 78.2 | 81.7 | -4.4 |
| 81.9 | 76.3 | 82.7 | -6.9 |

100 mL milk, 15mg $Sr^{2+}$, 100 mL DI water, $^{90}Sr$ tracer,

- coagulation
- carbonate precipitation
- dissolved in $HNO_3$ , dried
- muffle furnace at $450^0C$
- dissolved in 8M $HNO_3$
- pass through 1g DGA resin
- wash DGA resin with 8M $HNO_3$
- pass the effluent and wash through 3g Sr-resin
- Sr eluted with 0.05 M $HNO_3$
- evaporated, and counted for $^{90}Sr$ on GP counter
- Y eluted from DGA resin with 0.1M HCl-0.1M oxalic acid
- evaporate to dryness, muffle furnace
- dissolve in $HNO_3$, evaporate, count for $^{90}Y$

$^{90}Sr$ (1g DGA-resin, no recovery correction)

| added (pCi) | exp (pCi) | % bias | |
|---|---|---|---|
| 37.1 | 34.3 | -7.6 | |
| 37.1 | 35.1 | -5.5 | |
| 37.1 | 22.8 | -38.5 | added 1 mg $Y^{+3}$ |
| 37.1 | 19.3 | -48.1 | added 1 mg $Y^{+3}$ |
| 74.2 | 67.9 | -8.5 | |
| 74.2 | 66.8 | -10.0 | |
| 37.0 | 31.1 | -16.0 | |
| 37.0 | 29.5 | -20.4 | |
| 37.0 | 28.5 | -23.1 | |
| 37.0 | 29.3 | -20.9 | * |

# $^{90}Sr$ (3g Sr-resin, 15 mg Sr carrier)

| added (pCi) | exp (pCi) | % recovery | % bias |
|---|---|---|---|
| 37.1 | 33.7 | 68.5 | - 9.2 |
| 37.1 | 35.6 | 65.8 | - 4.0 |
| 37.1 | 32.8 | 75.5 | -11.7 |
| 37.1 | 33.8 | 77.9 | - 8.8 |
| 74.2 | 73.9 | 69.8 | - 0.3 |
| 74.2 | 68.8 | 65.6 | - 7.2 |
| 37.0 | 31.1 | 68.3 | -10.7 |
| 37.0 | 35.3 | 66.1 | - 4.7 |
| 37.0 | 36.4 | 63.2 | - 1.7 |
| 37.0 | 32.2 | 70.5 | -12.9 |

# $^{90}Sr$

| added (pCi) | DGA-resin % bias | Sr-resin % bias |
|---|---|---|
| 37.1 | - 7.6 | - 9.2 |
| 37.1 | - 5.5 | - 4.0 |
| 37.1 | - 38.5 | -11.7 |
| 37.1 | - 48.1 | - 8.8 |
| 74.2 | - 8.5 | - 3.0 |
| 74.2 | - 10.0 | - 7.2 |
| 37.0 | - 16.0 | -10.7 |
| 37.0 | - 20.4 | - 4.7 |
| 37.0 | - 23.1 | - 1.7 |
| 37.0 | - 20.9 | -12.9 |

# $^{89/90}$Sr (1g DGA; 3g Sr-resin)

Added: $^{90}$Sr (18.5 pCi); $^{89}$Sr (353.0 pCi);
Total (371.5pCi)

| $^{90}$Sr (pCi) | $^{89}$Sr (pCi) | Total (pCi) |
|---|---|---|
| 14.8 | 360.1 | 374.9 |
| 14.0 | 336.2 | 351.0 |
| 14.2 | 337.1 | 316.8 |
| --- | --- | 350.9 |

# $^{89/90}$Sr (1g DGA; 3g Sr-resin)

Added: $^{90}$Sr (73.9 pCi); $^{89}$Sr (75.2 pCi);
Total (149.1pCi)

| $^{90}$Sr (pCi) | $^{89}$Sr (pCi) | Total (pCi) |
|---|---|---|
| 65.8 | 67.6 | 136.8 |
| 65.0 | 69.2 | 138.3 |
| 64.3 | 72.8 | 137.1 |

Note:
Sr-resin was reused up to 4 times without compromising recovery. In future experiments, we will explore the number of times the resin can be used successfully.

| $^{90}Sr$ (18 pCi) | $^{89}Sr$ (353 pCi) | Total (372 pCi) |
|---|---|---|
| % bias | % bias | % bias |
| -19.9 | 7.6 | 6.2 |
| -24.3 | 0.5 | - 0.6 |
| -23.1 | 0.8 | -10.2 |
| --- | --- | - 0.6 |
| (73.9 pCi) | (75.2 pCi) | (149.1 pCi) |
| % bias | % bias | % bias |
| -10.9 | -10.1 | -8.2 |
| -12.0 | -8.0 | -7.2 |
| -13.0 | 3.7 | -4.8 |

# Ferric hydroxide scavenging

added before the solution was passed through resins

| | Isotopes added | Total counts before chemical separation | Total counts after chemical separation |
|---|---|---|---|
| **Exp 1** | Pb-210 | 14369 | 37 |
| | Po-210 | 5062 | 15 |
| **Exp 2** | Sb-125, Eu-154/155 | 212013 | 22 |
| **Exp 3** | Cd-109, Co-57/60, Zn-65 | 10817 | 17 |
| | Am-241 | 19331 | 30 |
| **Exp 4** | Sr-89 | 15494 | 10659 |

# Conclusions

- A new coagulant (citric acid) is used for removal of proteins and fats.
- Allows determination of total radiostrontium
- Allows simultaneous determination of $^{89}Sr$ and $^{90}Sr$
- The method is reasonably fast for emergency response (less than 36 hours)
- Up to 1000 g sample can be analyzed

Drawback

- $^{90}Y$ recovery not measured, assumed as 100% for $^{90}Sr$ determination.

# WEAC method for $^{90}Sr$ DGA-resin, LSC (with out recovery)

| **Food Matrix** | **% bias** |
|---|---|
| Mixed vegetable and beef | -14.82 |
| Baby formula | -10.97 |
| Baked beans | -18.51 |
| Ground beef | -13.99 |
| Mixed vegetables | -10.61 |
| Ave | -13.78 |
| Stdev | 3.2195 |