DETERMINATION OF RADIOSTRONTIUM IN FOOD AND BIOENVIRONMENTAL SAMPLES

PRINCIPLE OF THE METHOD

This method describes a procedure for the determination of strontium-89 and -90 in various bioenvironmental samples. The ash is fused as a carbonate, the strontium-calcium carbonates are dissolved in hydrochloric acid, complexed with disodium ethylenediaminetetraacetate (EDTA), passed through an ion exchange column where the strontium is adsorbed, and the complexed calcium passes through. The strontium is eluted, precipitated as a carbonate, and mounted on a planchet for beta counting. Chemical yield is determined gravimetrically.

REAGENTS

Ammonium hydroxide: concentrated
Barium carrier
Calcium carrier
Ethylenediaminetetraacetate (EDTA), disodium: 6%, 2%
Hydrochloric acid: 6N, 1.5N
Sodium acetate buffer solution
Sodium carbonate, anhydrous: 3N
Sodium chloride
Sodium hydroxide pellets
Strontium carrier

APPARATUS

Crucible with cover, nickel, 250-ml

Bath, cooling

pH meter

Funnel, separatory, graduated, 1000-ml

Column, 2.5-cm I.D. (Figure 4), 40-ml cation resin Dowex 50W-X8, 50-100 mesh

Filter paper, Millipore #URWPO 2400

PROCEDURE

A. For Food, Vegetation, or Tissue

1. Weigh amount of sample shown in table and place in a 250-ml nickel crucible. Add carriers as indicated, 50 g sodium hydroxide pellets, and 5 g anhydrous sodium carbonate. Mix and cover.

VARIOUS SAMPLE TYPES, SAMPLE SIZE, AND CARRIERS

Sample Type	Sample Size (g)	Strontium Carrier (ml)	Calcium Carrier (ml)	Barium Carrier (ml)
Food	10	2	--	5
Bone	2	2	--	5
Vegetable	2 or 5	2	1	5
Tissue	2	2	1	5

2. Carefully heat over a burner until melt dissolves. Then raise temperature and fuse for 60 minutes or until melt is red hot.

3. Transfer crucible with cover to cold water bath to crack mixture. Cool.

4. Add 200 ml hot distilled water, and boil to disintegrate the fused mixture.

5. Cool, and transfer to 250-ml centrifuge tube. Centrifuge, and discard supernatant solution. Repeat twice with 200-ml portions of hot distilled water.

6. Add 20 ml 6N hydrochloric acid and with gentle heat dissolve the residue. Add 100 ml distilled water. If insoluble residue (silica) is present, filter, wash residue twice with 100-ml portions of distilled water, and add to filtered solution. Discard residue.

7. Add filtrate to 500 ml 6% EDTA solution and adjust to pH 3.8 with concentrated ammonium hydroxide. Stir vigorously for 75 minutes to precipitate the magnesium salt of EDTA.

8. Filter, and collect the filtrate. Adjust to pH 4.6 with ammonium hydroxide. Add 20 ml buffer solution. Re-adjust pH to 4.6.

9. Quantitatively transfer to the 1000-ml graduated cylinder and dilute to 1000 ml with distilled water.

10. Adjust solution flow through resin column to 10 ml/min. Stop flow when just enough solution remains to cover resin. Discard effluent.

11. Adjust 600 ml 2% EDTA to pH 5.1 with ammonium hydroxide, place in reservoir, and let flow at 20 ml/min. Record time at end of elution as T_1 (beginning of yttrium-90 ingrowth). Wash column with 200 ml distilled water at a flow of 20 ml/min. Discard washings.

12. Place 460 ml 1.5N hydrochloric acid in reservoir, and elute at a flow rate of 8 ml/min. Discard first 60 ml of effluent. Collect the next 400 ml in a 800-ml beaker. This contains the strontium fraction.

13. Regenerate resin with 600 ml 4N sodium chloride followed by 1000 ml distilled water, both at a flow rate of 10 ml/min.

14. Add 200 ml concentrated ammonium hydroxide to the strontium fraction with stirring. Slowly add 10 ml 3N sodium carbonate, and stir 30 minutes.

15. Filter (Figure 4) using Millipore filter paper #URWPO 2400. Rinse the beaker with distilled water. Police sides and bottom of beaker. Wash walls of beaker and filter with ethyl alcohol.

16. Remove funnel and wash any precipitate on the bottom of the funnel directly into weighed planchet with minimum amount of water. Wash the precipitate from the filter paper directly into the weighed planchet.

17. Evaporate to dryness. Cool and weigh.

18. Let sample set overnight for radon daughter decay and count in a low-background beta counter.

19. Count again seven days later for yttrium-90 ingrowth.

B. For Water

Add 33.3 g EDTA, 2 ml strontium carrier, and 1 ml each barium and calcium carriers to 1000 ml of water sample. Adjust pH to 4.6 with ammonium hydroxide and proceed as in step 8 of Procedure A.

C. For Seawater

1. Add 2 ml strontium carrier, and 1 ml each barium and calcium carriers to 1000 ml of water sample. Stir and heat to boiling.

2. Adjust pH to 10.0 with 6N sodium hydroxide. Add 30 ml 3N sodium carbonate. Stir and continue heating until precipitate forms. Cool overnight and decant the supernate.

3. Dissolve residue with 200 ml 6N hydrochloric acid. Adjust volume to 1 liter with distilled water, and filter. Add 33.3 g EDTA with stirring and adjust pH to 3.8. Proceed as in step 7 of Procedure A.

D. For Bone

Weigh 2.0 grams of ash in a 1000-ml beaker. Moisten with water, and add 20 ml 6N hydrochloric acid. When ash is dissolved, add 100 ml water and proceed as in step 7 of Procedure A.

CALCULATIONS

Refer to calculations for the Rapid Ion Exchange Method for the Determination of Radiostrontium in Milk, page 5, making appropriate changes in V for aliquot size.

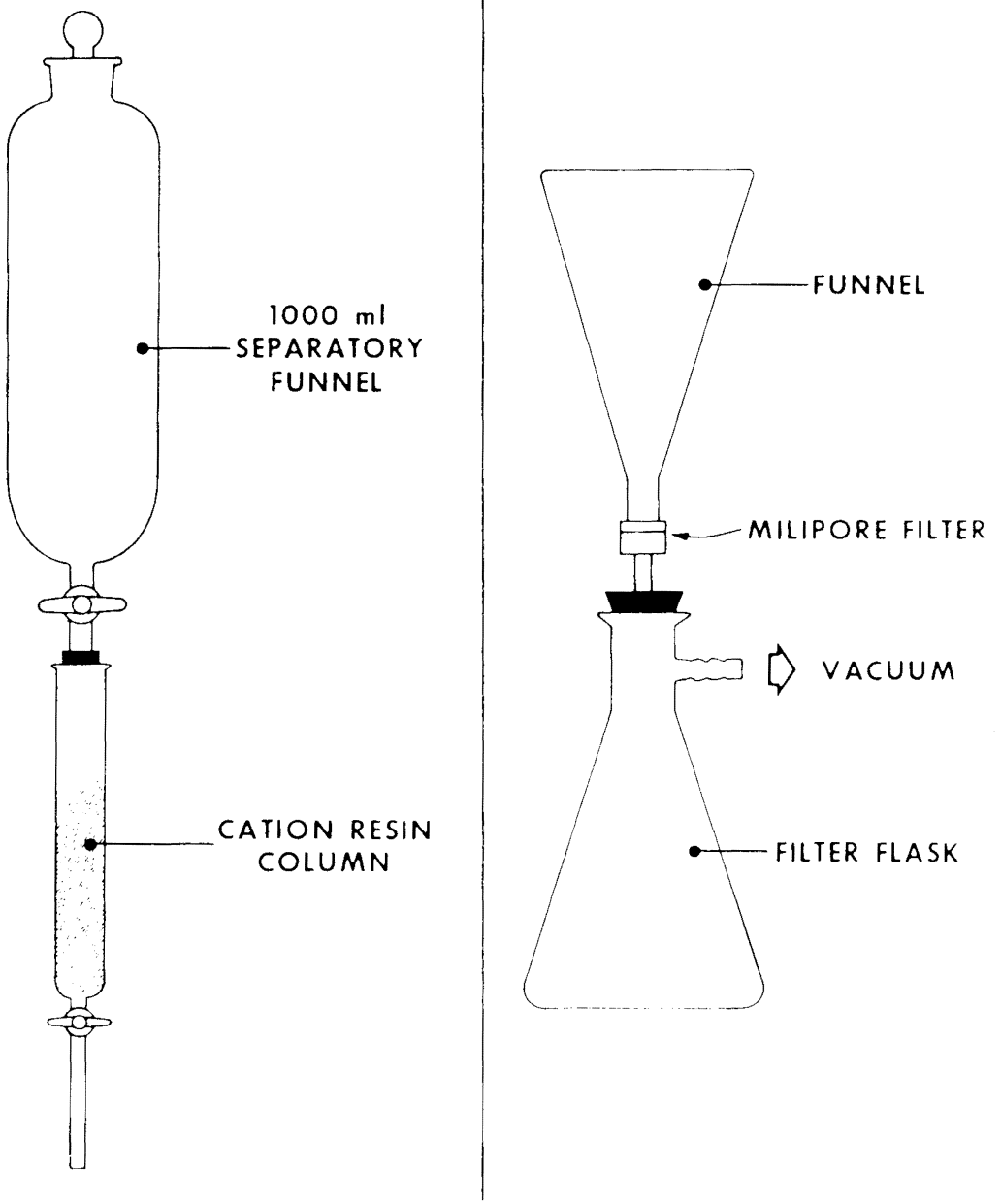

Figure 4. Strontium Adsorption Column and Filtering Apparatus

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FROM PREVIOUS PAGE REFERENCE TO
PAGE 5 CALCULATIONS

CALCULATIONS (Velton 1966)

$$\text{Strontium-90 (pCi/liter)} = \frac{DC - FA}{2.22ZYV[D(1 + EL) - F(1 + EI)]}$$

where D = decay of strontium-89 from collection to time of first count (Appendix B)

C = net cpm of total strontium on second count

F = decay of strontium-89 from collection to time of second count (Appendix B)

Velton, R. J., Resolution of Strontium-89 and Strontium-90 in Environmental Media by an Instrumental Technique. Nucl Instr Methods 42:169 (1966)

A = net cpm of total strontium on first count

2.22 = dpm/pCi

Z = fractional counting efficiency for strontium-90 including self-absorption correction

Y = fractional chemical yield

V = sample volume in liters

E = ratio of yttrium-90 counting efficiency to strontium-90 counting efficiency including self-absorption corrections

L = yttrium-90 ingrowth from time of separation to time of second count

I = yttrium-90 ingrowth from time of separation to time of first count

$$\text{Strontium-89 (pCi/liter)} = \frac{A - N(1 + IE)}{2.22DYSV}$$

where A = net cpm total strontium on first count

N = net cpm strontium-90; this is first factor in the equation for strontium-90 in pCi/liter

I = yttrium-90 ingrowth from separation to time of first count

E = ratio of yttrium-90 counting efficiency including self-absorption corrections

2.22 = dpm/pCi

D = decay of strontium-89 from collection to time of first count

Y = fractional chemical yield of strontium

S = fractional counting efficiency for strontium-89

V = sample volume in liters