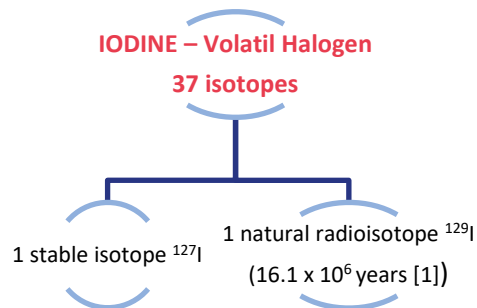




QUANTIFICATION OF ^{129}I IN MILK AT LOW LEVEL FOR ENVIRONNEMENTAL MONITORING

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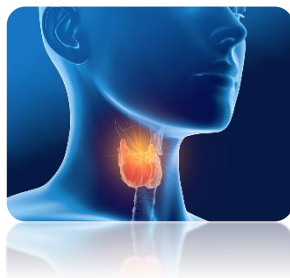
Iodine in milk : Origin and interest



Released by reprocessing plants in atmosphere and marine environment or in case of Nuclear Power Plant accident [2]



Iodine 129 can be transferred to grass and then in milk after ingestion by mammals (e.g. cows, goats)



Iodine is an essential constituent of the thyroid gland [3]

^{129}I could therefore bind to the thyroid gland and cause thyroid cancer

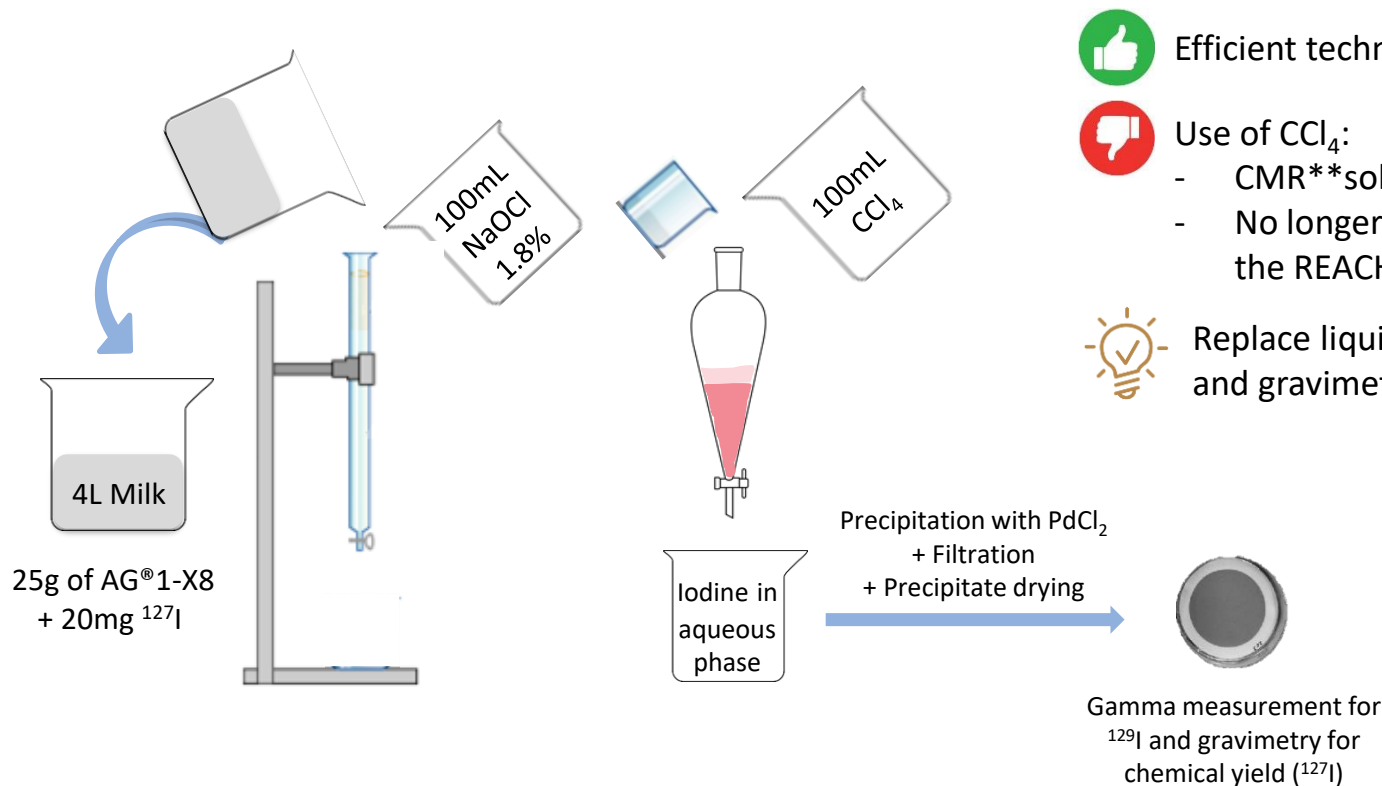
Iodine 129 quantification is important

[1] E. García-Toraño et al., 'The half-life of ^{129}I ', Appl. Radiat. Isot., vol. 140, pp. 157–162, Oct. 2018, doi: 10.1016/j.apradiso.2018.06.007.

[2] K. Markou, N. Georgopoulos, V. Kyriazopoulou, and A. g. Vagenakis, 'Iodine-Induced Hypothyroidism', Thyroid, vol. 11, no. 5, pp. 501–510, May 2001, doi: 10.1089/105072501300176462.

[3] M. Kadowaki et al., 'Impacts of anthropogenic source from the nuclear fuel reprocessing plants on global atmospheric iodine-129 cycle: A model analysis', Atmos. Environ., vol. 184, pp. 278–291, Jul. 2018, doi: 10.1016/j.atmosenv.2018.04.044.

Usual protocol



Efficient technic → LOD* = 0.01Bq/L



Use of CCl₄:

- CMR** solvent
- No longer marketed in France under the REACH regulation

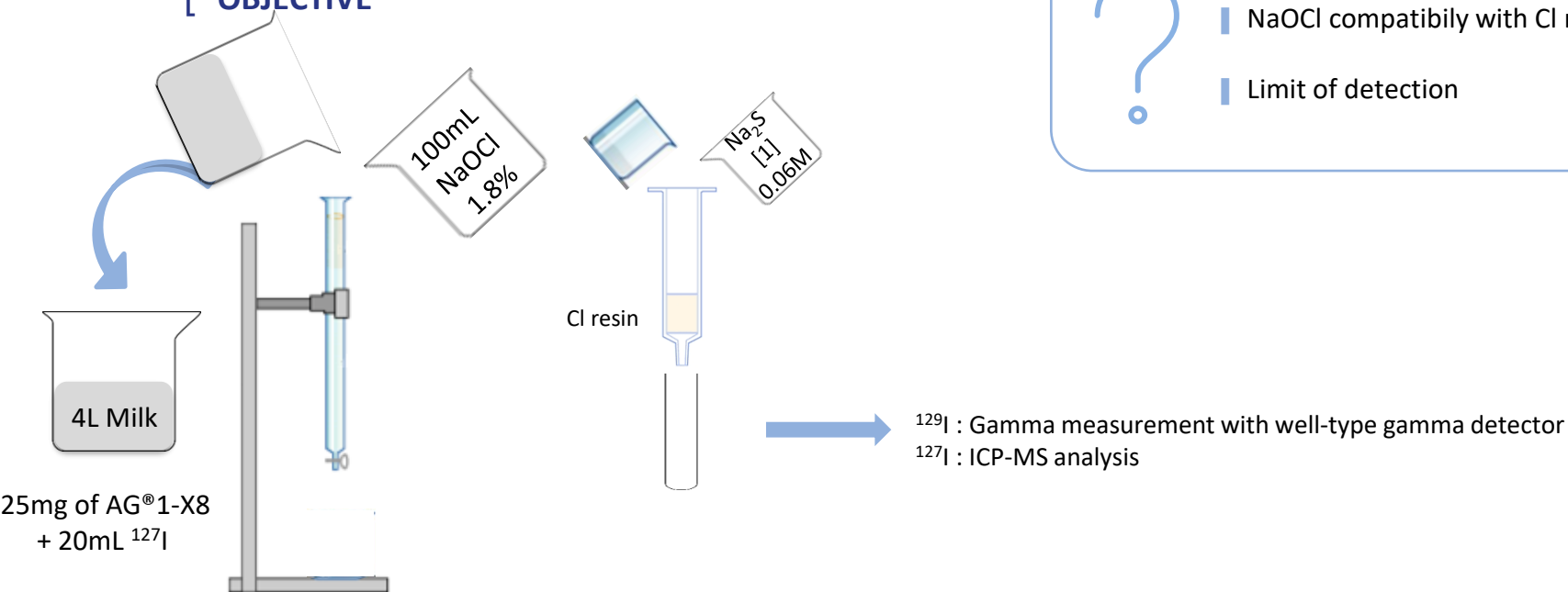


Replace liquid-liquid extraction by SPE*** and gravimetry by ICP-MS measurement

*LOD: Limit of Detection **CMR: Carcinogenic, Mutagenic, or toxic for Reproduction ***SPE: Solid Phase Extraction

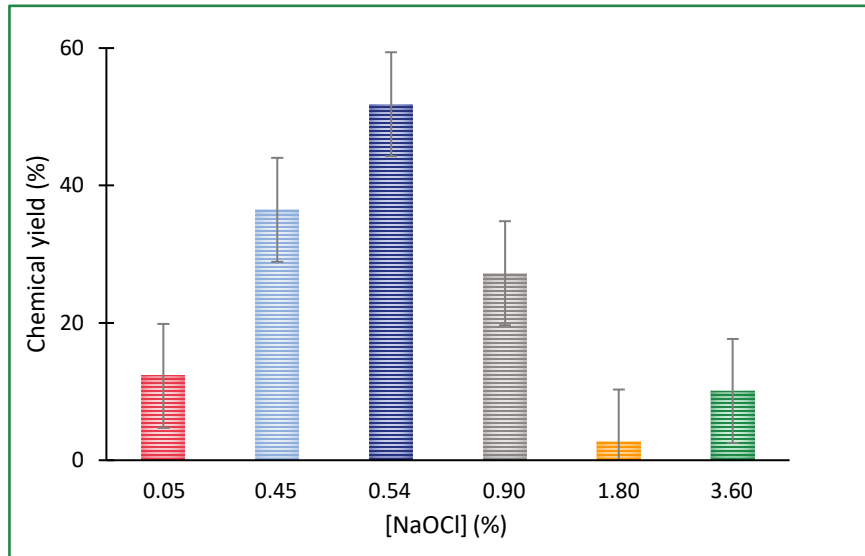
New protocol development

[OBJECTIVE



- NaOCl compatibility with Cl resin
- Limit of detection

NaOCl compatibility with CL resin

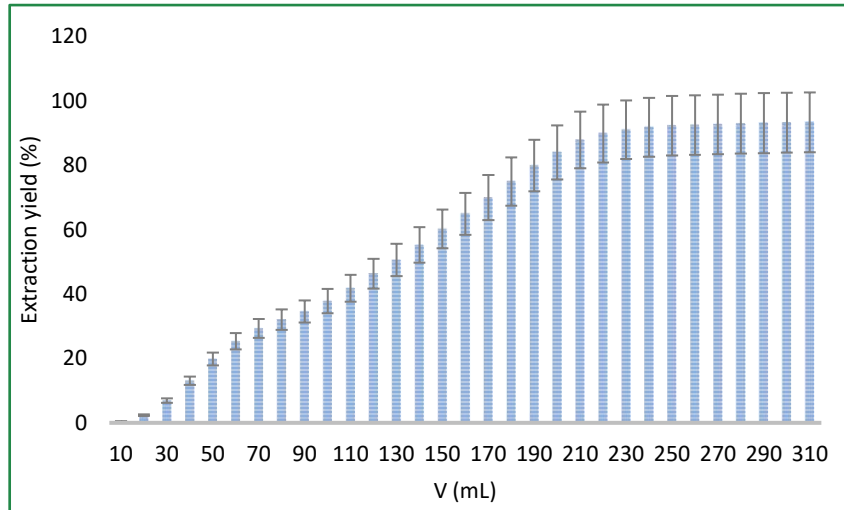


Solutions : 10mL of iodine 50 μ g/L
1mL of Cl resin
Measurement by ICP-MS

- NaOCl 1.8% not compatible with Cl resin
- 0.54% improves the chemical yield

Extraction yield on AG[®]1-X8 with NaOCl 0.54%?

Elution of iodine from AG[®]1-X8 resin

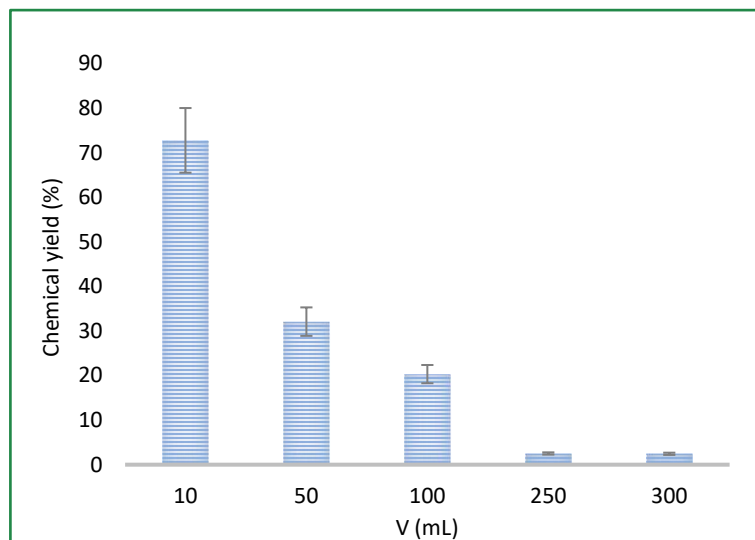


Solutions : 10mL of iodine 50 μ g/L
0.54% NaOCl
Measurement by ICP-MS

- 230mL : Extraction yield of iodine from AG[®]1-X8 resin > 90%
- Dilution by 3.33 factor (1.8/0.54) of 1.8% solution after elution ?

End-of-fixing volume of Cl resin?

End-of-fixing volume of Cl resin



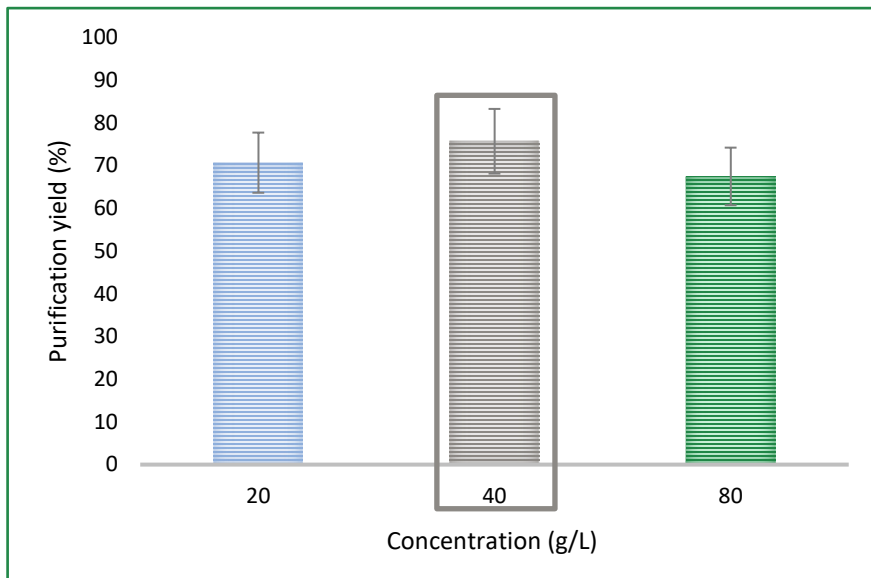
Solutions : Iodine 100 μ g/L
0.54% NaOCl
Measurement by ICP-MS

50% iodine loss between 10mL and 50mL

- Dilution not compatible with end-of-fixing volume
- 1.8% NaOCl concentration is maintained to elute iodine from the AG[®]1-X8 resin

Improvement of percolation step?

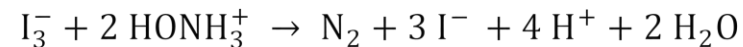
Improvement of the purification yield



Adding a reducing agent

After NaOCl elution : iodine is in I_3^- form

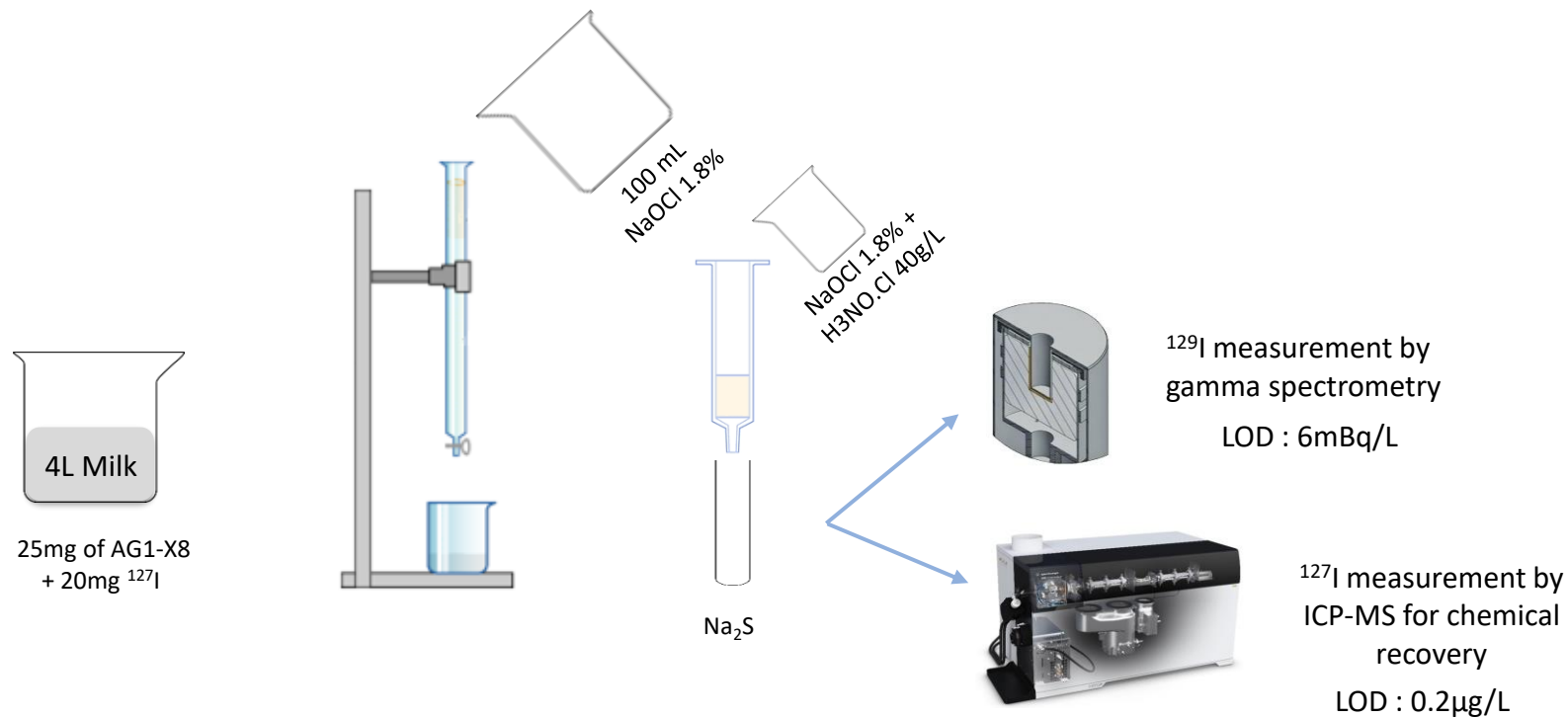
Hydroxylamine hydrochloride ($E^\circ = -1.87V$)
 I_3^-/I^- (0.54V)



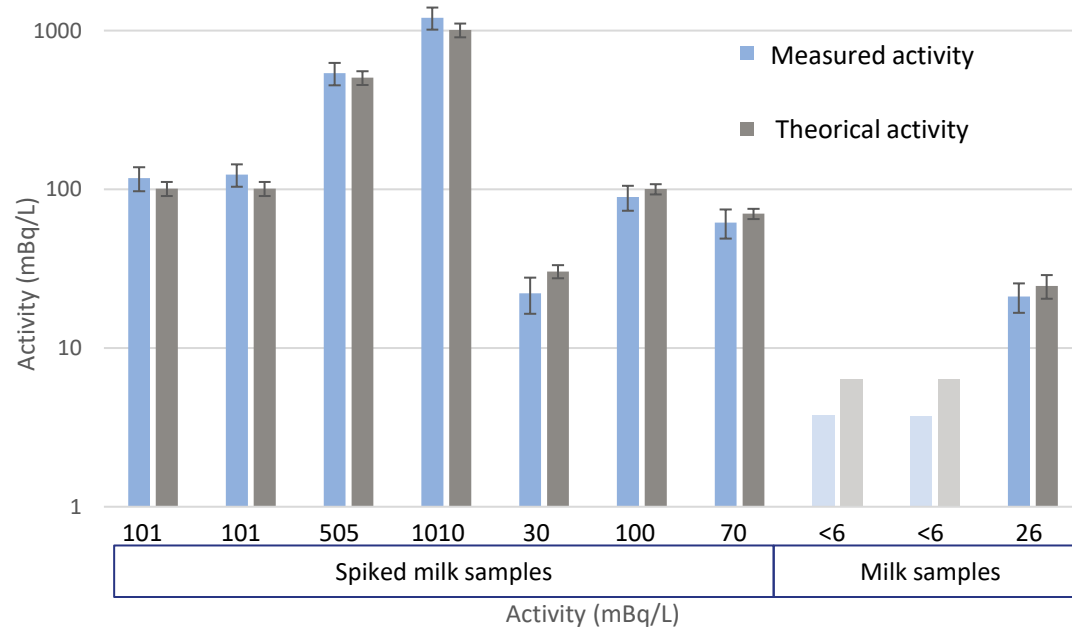
- Purification yield from 20 to 75%
- Selected concentration : 40g/L

Percolation medium in Cl resin retained :
NaOCl 1.8% + $H_3NO.HCl$ 40g/L

Developed protocol



Validation of the new method



■ Spiked milk samples

■ Milk samples : comparison of the old and the new method in milk collected in the environment

→ Excellent results



Conclusion

- ✓ Elimination of liquid-liquid extraction with CCl_4
→ SPE on Cl resin with recovery yield > 80%
- ✓ Conclusive work to make AG[®]1-X8 resin compatible with Cl resin
→ Elution in AG[®]1-X8 with 100 mL of NaOCl 1.8%
→ Percolation on Cl resin with NaOCl 1.8% + $\text{H}_3\text{NO.HCl}$ 40g/L
- ✓ Improvement of the LOD with well-type detector : 6mBq/L
- ✓ Accurate chemical yield by ^{127}I ICP-MS analysis

What's next?

- ^{129}I determination by ICP-MS/MS
→ Application of the protocol for milk :

C. Carrier et al., 'Determination of environmental gaseous ^{129}I trapped in charcoal cartridges by ICP-MS/MS', J. Radioanal. Nucl. Chem., Mar. 2023, doi: 10.1007/s10967-023-08845-0.
- Work on freeze-drying to increase the sample size
Iodine in water? Organically bound?
- Better knowledge of ^{129}I level in environmental samples under and outside nuclear site influence



THANK YOU FOR YOUR ATTENTION

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