Improving the sustainability of trace element analysis through plastic vial re-use

Bamikole W Osungbemiro*, Declan D Reid, Daniel E Enenche and Christine M Davidson

Department of Pure and Applied Chemistry, University of Strathclyde, 295 Cathedral Street, Glasgow G1 1BX, UK *Presenting Author: bamikole.osungbemiro@strath.ac.uk

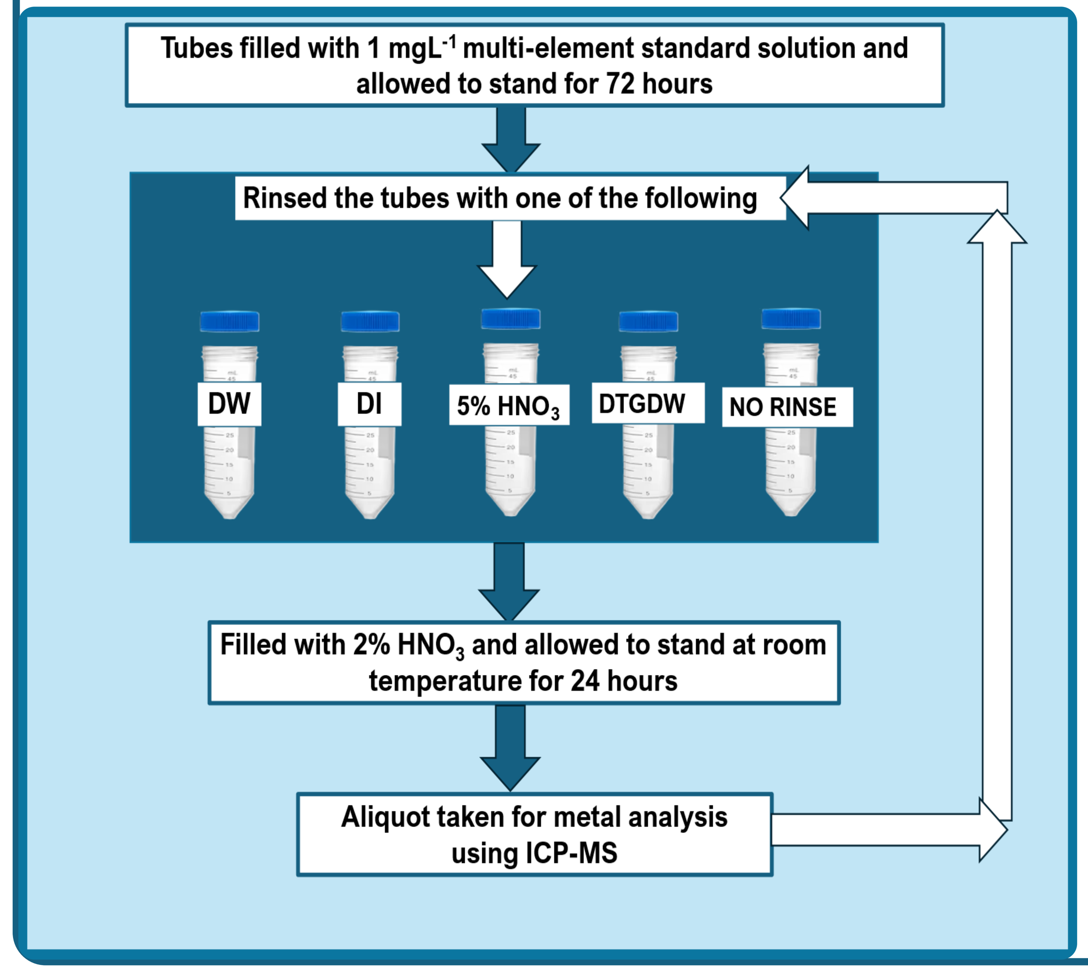
Introduction

In many analytical chemistry laboratories, large amounts of plastic waste are generated by single-use vials used by analysts to avoid cross-contamination[1].

Many instruments for trace-element analysis are highly sensitive in detecting residual element concentrations. It has thus become necessary to explore cleaning protocols that eliminate cross-contamination and allow the reuse of these plastic vials.

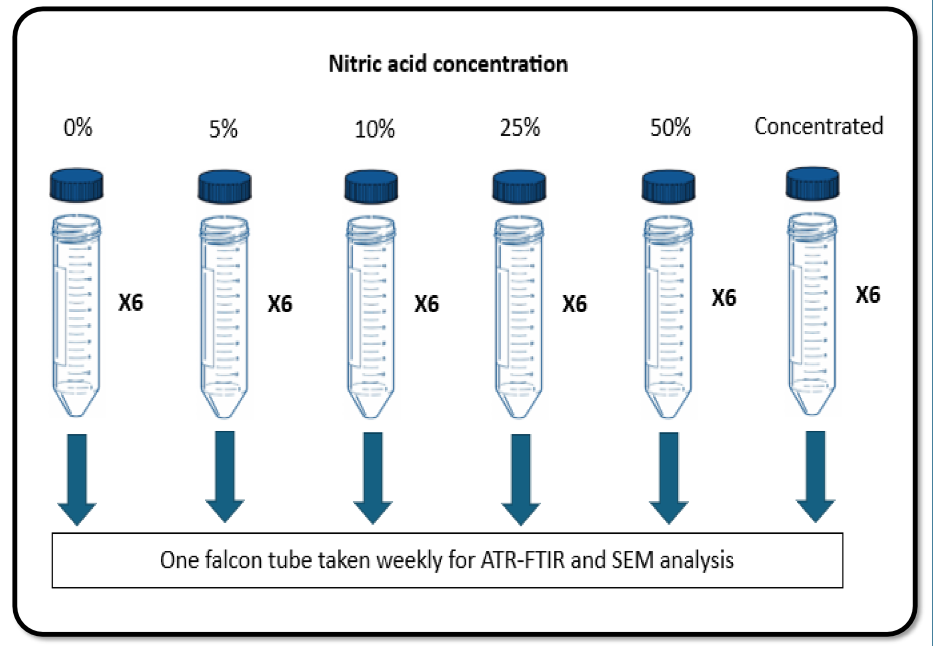
Methods

Comparing the effectiveness of distilled water (DW), deionised water (DI), 5% nitric acid (HNO_3), and detergent followed by distilled water (DTGDW) cleaning regimens in removing residual trace elements from used polypropylene vials (Falcon®) tubes.



Samples are often stabilised with acid during storage prior to analysis.

Therefore, there is a need to determine the effects of 5, 10, 25, 50% and 65-70 % (v/v) HNO_3 concentrations on Falcon tubes over six weeks.



Results and Discussion

A. Effect of repeated rinsing on residual trace element concentration in Falcon tubes

The results in Figure 1 showed that the residue concentration of the analytes reduced with repeated rinsing. However, there were no significant differences in protocol efficiency in reducing trace element concentrations after four rinses, although DI was consistently the best.

All protocols were ineffective at completely removing residual analyte concentrations, except for cadmium.

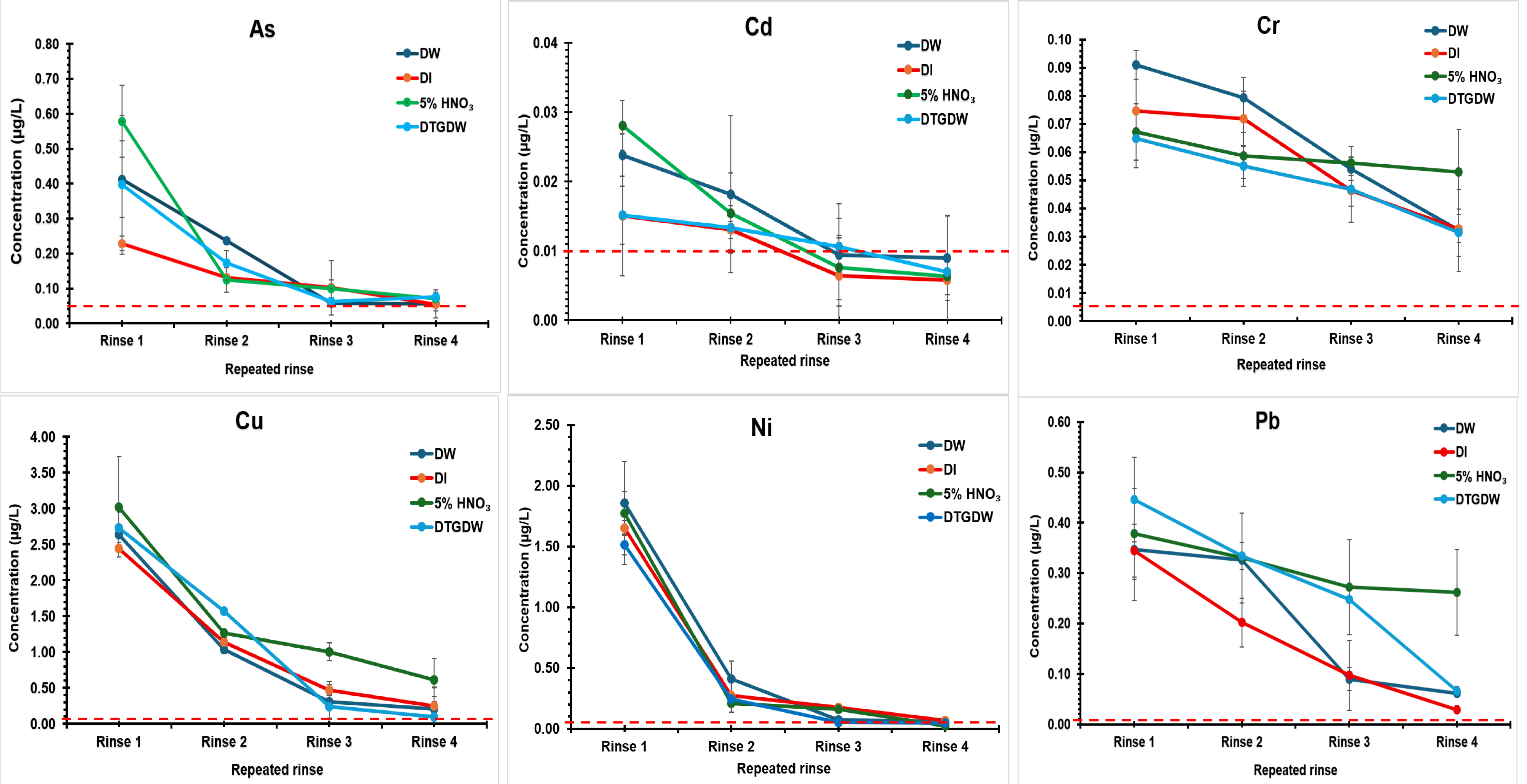


Figure 1: Effect of repeated rinsing on residual trace element concentration in Falcon tubes

----- indicates ICPMS limits of detection (LOD) for each element

Analyte	Detection limits (µg/L)	
	ICP-MS	FAAS
As	< 0.050	< 500
Cd	< 0.01	< 5
Cr	< 0.005	< 10
Cu	< 0.01	< 5
Ni	< 0.005	< 20
Pb	< 0.005	< 20

The analyte's highest residue concentrations after 4 rinses were greater than the LOD of ICP-MS (sensitive technique) but less than the LOD of FAAS (less sensitive technique).

B. Effects of exposure to acid

No evidence of changes was observed in the FTIR spectra of the polymer after six weeks of exposure to different concentrations. Example spectra from tubes exposed to 0% and concentrated HNO_3 are shown in Figure 2.

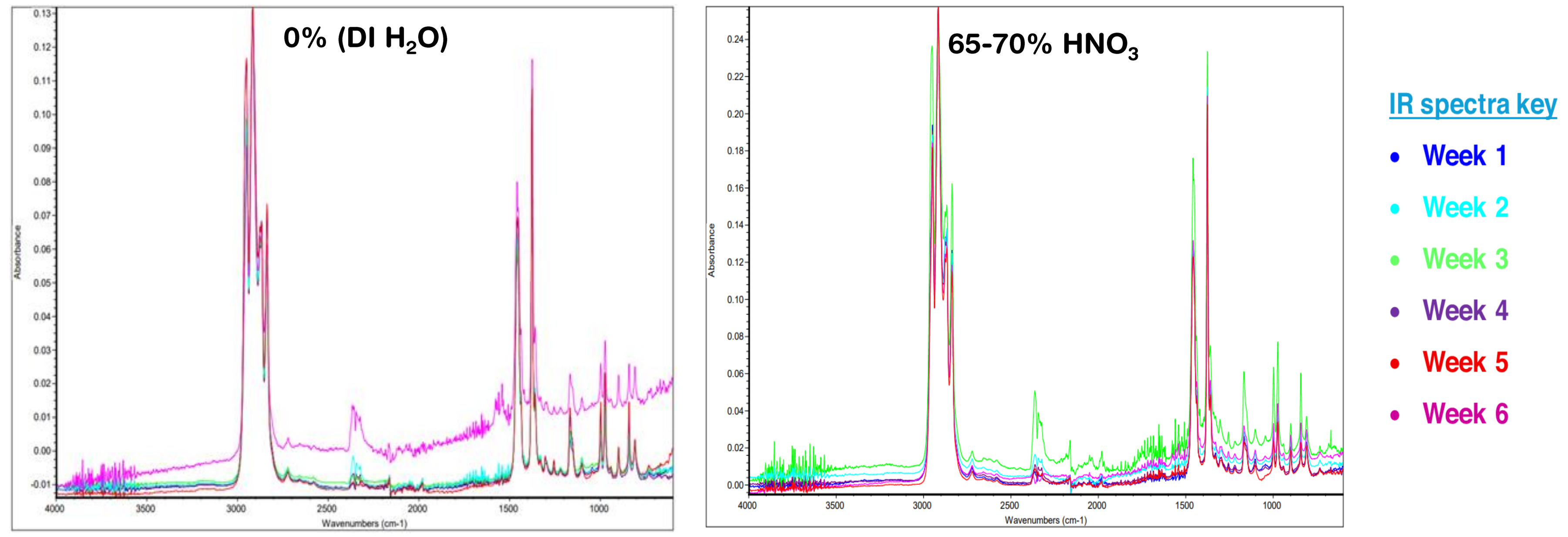
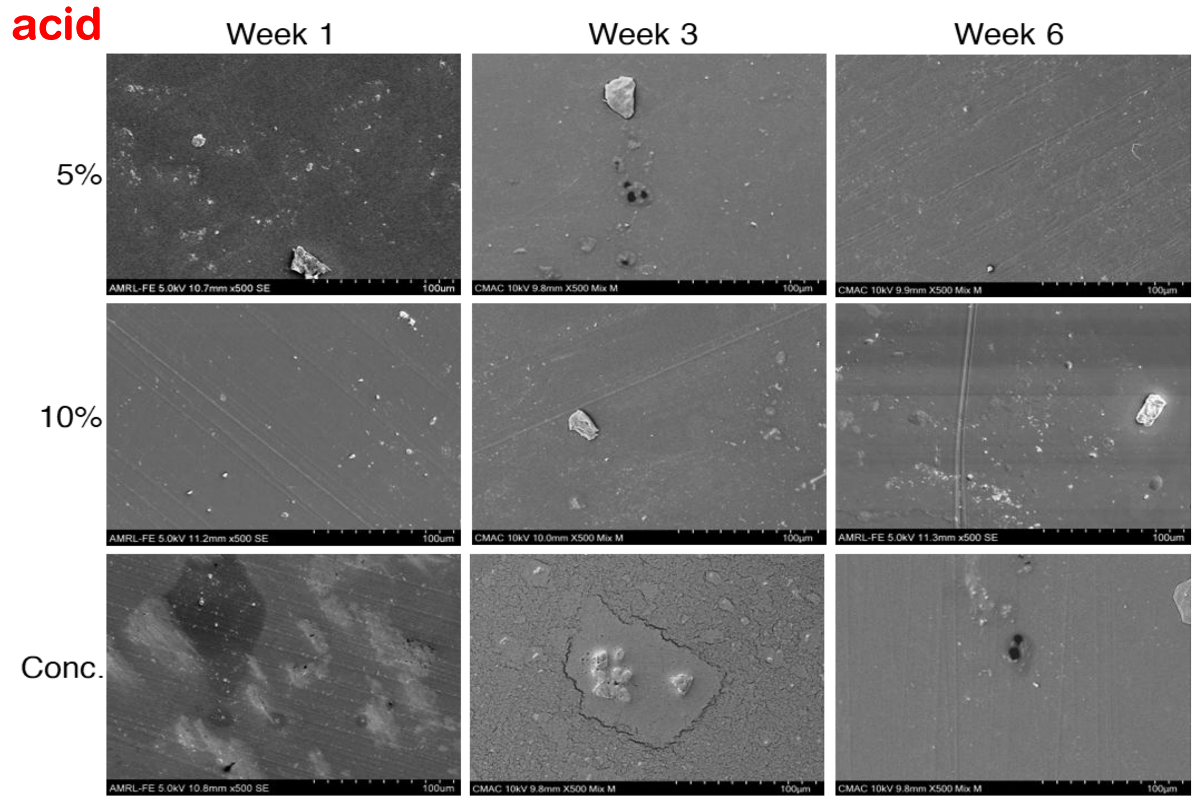


Figure 2: FTIR spectra of Falcon tubes filled with 0% and conc. (65 – 70 v/v) nitric acid



As shown in Figure 3, the SEM images revealed minor surface damage as the acid concentration and exposure time increased.

Figure 3: SEM images of tubes after 1, 3, 6 weeks exposure to 5%, 10% and 65 – 70 % v/v HNO_3 at a magnification of 500x and electron beam energy of 5kV.

Conclusion and recommendation

- The washing regimens did not adequately decontaminate the tubes for sensitive techniques, but they can still be used for less sensitive applications to reduce plastic waste.
- Falcon tubes exposed to nitric acid for up to six weeks showed no structural changes.
- Future work will establish the environmental impact of reusing tubes against single-use practice.

Reference

Y. H. Tan, H. C. Ong, R. A. Raja Ali and L. T. Gew, Cleaner Waste Systems, 2025, 12, 100389

ROYAL SOCIETY OF CHEMISTRY
UNIVERSITY of STRATHCLYDE ADVANCED MATERIALS RESEARCH LABORATORY
University of Strathclyde Science
PAC Mass Spectrometry Facility Team
Commonwealth Chemistry Federation of Chemical Sciences Societies