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Design and development of flow analysis methods as sustainable alternatives to study dynamic systems: application to environmental and biological systems

The chemical analysis of environmental and biological samples poses a significant challenge due to their known complexity and variability. Commonly the analytes of interest are in extremely low levels and the potential interferences in quite high quantities. So, processes of sample clean-up and analyte pre-concentration are quite often required. In this context, my research has been focussed in developing comprehensive flow methodologies including in-line tackling of sample handling. Within the available flow analysis tools, sequential injection (SI) analysis has been a preferential choice as a versatile, robust way to combine many processes within the same manifold. The application to environmental samples, namely seawaters, and to biological samples, namely urine, requires adapting processes such as solid phase extraction, dialysis, gas diffusion, digestion, and so on to in-line procedures. Furthermore, it is essential to avoid the paradigm of polluting more with the analysis, and following up green chemistry principles of avoiding and minimizing the toxic effluent production.

When targeting natural waters as seawater, estuarine water, and interstitial waters, to handle the expected complexity, in-line physical and chemical processes were explored with effective results. The incorporation of in-line physical processes such as sample dilution [1], gas diffusion for molecular separation [2-4] and solid phase extraction, SPE [5-9], could result in pre-concentration of the analyte when discarding the matrix [3-9]. In SPE, the resins are packed into reusable columns to minimize waste production, maintaining a green chemistry approach. When combined with micro-SI/lab-on-valve (μ SI-LOV) and miniaturised spectrophotometers, the detection can be made on the resin surface in a solid phase spectrophotometry approach (SPS) [8,9]. However, handling matrix complexity may also require in-line chemical processes such as redox reduction [10-13] or digestion [4] to attain an efficient sample pre-treatment. Even then, well-established methods, like cadmium reduction of nitrate, can be replaced by greener approaches like UV aided reduction [13]. Tackling the sample problems with in-line approaches enabled the direct introduction of the sample, even to samples with intrinsic absorption where a sample blank [14] or kinetic determination were performed [15]. Still, when the limit of detection obtained impaired the direct application, the in-line adaptation of the standard addition procedure was explored with improved time and reagent saving compared to the conventional procedure [16,17]. The choice of sequential injection analysis as a preferential flow method, also enabled to attain multi-parametric determinations, essential for a comprehensive understanding of environmental quality of natural waters [9-13,17-20]. A couple of reviews resulted of all the work combining flow methods, natural waters and in-line sample handling [21,22].

A parallel line of research, was devoted to developing monitoring tools to evaluate the efficiency of: bioreactors set to study biodegradation of emerging pollutants [23-27]; and constructed wetlands set to treat industrial liquid effluents [28].

As a consequence of the underling importance given to green approaches, a recent collaboration with an inorganic synthesis group was initiated and has promoted the application of greener alternative reagents specially designed for target analytes, namely iron(III) [29,30] considering its environmental role.

In an also recent redirection of targeting complex samples, biological samples namely urine has been addressed. In fact, the successful improvement of well-established procedure [31] has facilitated the participation in an international inter-laboratory EQUIP program Centers for Disease Control and Prevention, Atlanta, USA. In addition, acknowledging the importance of iodine determination in urine with energy restrains, combined with the recognized effectiveness of flow methods, as fast, reliable and robust methods, a flow injection procedure with potentiometric detection and potential to run on batteries has been developed to carry out iodide determination in urine [12].

Overall, I would emphasize the sequential injection approach qualities in providing robust, reliable and versatile methods for multi-determinations, for attaining different dynamic ranges with the same manifold and for facilitated sample handling, particularly useful for complex treatments like digestions. When used in the miniaturized version μ SI-LOV the improvement of reagent consumption is notorious, fully incorporating the green chemistry principles. Also noteworthy is the flow injection useful feature to work with low energy, potentially on batteries, due to its independence of computer control; potentiometry can be combined with flow procedure increasing the portability of the apparatus.

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References. 1. *J. Environ. Monit.*, 2002, 4, 458-461. 2. *Talanta*, 2005, 68, 268-273. 3. *Anal. Methods*, 2011, 3, 2049-2055. 4. *Anal. Chim. Acta*, 2013, 778, 38-47. 5. *Talanta*, 2004, 62, 395-401. 6. *Talanta*, 2012, 98, 203-210. 7. *Talanta* 2016, 148, 633-640. 8. *Talanta*, 2015, 133, 15-20. 9. *Anal. Chim. Acta*, 2015, 831, 171-178. 10. *Anal. Methods*, 2009, 1, 195-202. 11. *Anal. Methods* 2016, 8, 1973-1980. 12. *Talanta*, 2017, 167, 688-694. 13. *Anal. Methods*, 2017, 9, 1876-1884. 14. *J. AOAC Int.*, 2005, 88, 1511-1515. 15. *J. Braz. Chem. Soc.*, 2008, 19, 1171-1179. 16. *Anal. Methods*, 2012, 4, 1452-1457. 17. *Talanta*, 2015, 133, 7-14. 18. *Talanta*, 2017, 167, 703-708. 19. *Anal. Sci.*, 2004, 20, 1205-1210. 20. *Talanta* 2015, 143, 359-365. 21. *Anal. Chim. Acta*, 2009, 648, 7-22. 22. *LCGC*, 2015, 33 (10). 23. *Talanta*, 2011, 84, 1291-1297. 24. *J. Environ. Manage.*, 2013, 128, 877-882. 25. *Water Res.*, 2013, 50, 101-113. 26. *J Hazard. Mater.* 2015, 287, 93-101. 27. *Anal. Methods* 2016, 8, 5457-5465. 28. *Ecol. Eng.*, 2015, 79, 1-7. 29. *Talanta*, 2013, 108, 38-45. 30. *Polyhedron*, 2015, 101, 171-178. 31. A. Machado, L. Lima, R.B.R. Mesquita, A.A. Bordalo, *Clin. Chem. Lab. Med.* 2017, published on-line 17-03-2017.