Advances in Sample Preparation 7 (2023) 100087

Contents lists available at ScienceDirect

Advances in Sample Preparation

journal homepage: www.elsevier.com/locate/sampre

Green sample preparation 2023

The adoption of the concepts of green analytical chemistry and green sample preparation, is spreading fast. There are numerous ways to introduce these concepts into analytical practice. These are summarized by the twelve principles of green analytical chemistry [1], and the ten principles of green sample preparation (GSP) where the sample preparation is also taken into consideration [2]. The main focus in this area is on miniaturization, speed, application of benign solvents and reagents, automation that results in decreased analyst exposure, and simplification of sample preparation. GSP with clearly formulated 10 principles is a specific guideline to make sample preparation more sustainable. The number of papers dealing with reduction of negative impacts of sample preparation activities is recently growing rapidly.

Unfortunately, together with this very positive trend, some contributions smuggle unjustified statements on the greenness of these procedures. These statements refer to green sample preparation assumptions but are left without justification or the justification is misleading. For proper justification of sample preparation greenness, authors should refer to the greenness complexity of this analytical procedure step. Here, a good guideline can be following the 10 GSP principles, either with detailed greenness justification with text description in the text of article or dedicated software [3,4]. There are also other greenness metric tools [5] that can be helpful in this area.

Another important aspect is to show the greenness of a newly developed sample preparation procedure is the proper context. This means the greenness parameters of the newly developed procedure should be compared with those of previously published procedures for the same purpose. A good practice in preparation of scientific papers in this area is the comparison of analytical merits of analytical procedure with previous ones. In many cases, the greenness of sample preparation should be compared in similar way. The papers published within the frame of Green Sample Preparaion 2023 Special Issue follow the 10 principles of sample preparation.

If the aim of the authors is to develop greener sample preparation procedure, the added value is the proper procedure greenness assessment. The papers gathered in this topical collection [6–9] apply metrics such as NEMI, GAPI, Green certificate, Analytical Eco-scale, HPLC-EAT, AGREE or AGREEprep, or apply global assessment by Hexagon based assessment and RGB model. Additionally, authors of one paper present very interesting life-cycle analysis of separation systems, based on aqueous ethanol, ethanol modified $scCO_2$ and two CO_2 coexisting phases [10].

The analysis of urine samples with microextraction by packed sorbent and ion mobility mass spectrometry is advantageous in the light of GSP. The sample preparation is partially automated and can be performed on-site, the extraction is with low volumes of sample and solvent [7].

Sample preparation of swine feed samples before elements determination can go along with principles of GSP. The application of ultrasound assisted extraction or infrared assisted extraction applied to these complex matrices allows to use lower amounts of less concentrated, thus greener, reagents and consequently lower amounts of wastes [8].

The application of L-menthol-based deep eutectic solvent as extractant in supported liquid membrane hollow fibre microextraction fullfils some of the 10 principles of GSP. It results in the use of safer solvents, L-menthol is considered to be sustainable and renewable compound, its application results in safer application for the operator and reduced waste genetation. It is clearly proved when compared to application of toluene [9]. Besides, the developed procedure for multi-residue pesticides analysis with thin film microextraction falls into the scope of GSP. The procedure incorporates labmade hydrophilic-lypophilic balanced particles as sorbent that can be applied in very small masses. At the stage of sorbent conditioning, green solvents are used and thermal desorption is possible [11].

The variety of sample preparation examples proves that greenness assessment methods are quite universal tools. Authors of the topical collection show the improvement of greenness of their proposed solutions by comparisons with previously reported ones. The reviews included in this special issue also discuss their main topics within the scope of GSP. They include green sorbents applied in SPE [12], fabric phase extraction systems [13], green sample preparation in food analysis [14], and 3D-printing applications in green analytical chemistry [15].

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Available online 11 August 2023

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