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Mini review

Advancement in Extraction/Microextraction Methods using Novel Nano-sorbents

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ABSTRACT

Sample preparation is contemplated as constriction in the entire analytical process as it has its effect nearly on all later steps, and is interpretative for incontrovertible identification, corroboration, and quantification of analytes. To satisfy existing conditions in sample preparation for analytes at trace or ultra trace level in complex samples, new techniques have been devised for sample preparation. Current proclivity has involved: (1) automation via integrating sample preparation units and detection systems, (2) implementation of modern sorbents i.e. (nanomaterials), (3) application of greener perspective like solvent-reduced methods (e.g microextrartion methods). New techniques for sample preparation should be environmentally friendly but also it should be distinguished by their intelligibility of performance, as well as should be economical and time efficient. So, this review topic silhouette some of the key points regarding advancement in extraction/microextraction methods, considering these methods are widely perturbed and scrutinised.

Keywords: Sample preparation, Extraction, Microextraction methods, Nano-sorbents, Green chemistry

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INTRODUCTION

Ongoing trends in sample preparation intricate "greener" approaches by grading down analytical operations, making smaller instruments and assimilating modern and developed materials such as sorbents. Amalgamation of new material with sorbents-depended microextraction methods can empower the development of high-throughput sample preparation methods, which will ameliorate convectional extraction and clean procedures. This topic delineates about high sorption capacity and distinctive physicochemical properties of nanomaterials showing higher pre-concentration factors which gives the analytical sensitivity, selectivity, and precision which is required for target analytes in various class of matrices. Amongst the sorbents-based microextraction techniques, those reliable on the use of nanomaterial as extraction phase have gain recognition in last few years. These have larger surface area as compared to macroscopic material making it easy to synthesize and thus helping to increase their selectivity with regards to target analytes (Murtada K, 2020). This review topic will show recently performed analytical studies mainly using methods utilizing novel nanomaterial as sorbents also material that have been applied in extraction techniques and to evaluate their suitability.

LITERATURE REVIEW

Material utilized in sorbent-based extraction

In sorbent-based extraction method sorbent is pivotal for obtaining particular, explicit, unerring melioration of the analytes. Different sorbents with diverse composition and physiochemical properties have shown promising potential in maintaining the properties of original material. Furthermore, amalgamation of different material involving nanometric and micrometric materials has shown some advancement by giving rise to hybrid nanomaterial and composites. Some of the advanced materials used in microextraction methods are presented in this review. Considering nanometric material one of the most advanced materials are nanoparticles. Nanoparticles are trivial in size mostly ranging between 1 to 100 nm mainly of metallic or metallic oxide material. Mostly noble metals like (Au and Ag) (Zhao X, *et al.*, 2020) are widely seen in use as they have chemical stability, elevated adsorption and greater ratio surface/volume. Ferrite nanoparticles i.e (Fe_3O_4) have been initially used but it has low stability so it has been replaced by cobalt ferrite nanoparticles i.e. ($CoFe_2O_4$) as it has shown promising potential and stability and also in this case no additional steps are required in order to protect them (Maaz K, *et al.*, 2007). Metal-organic frameworks has been deployed as sorbent as they have shown results in microextraction methods. This nanomaterial has some unique properties such as greater chemical and thermal stability, porosity and large surface-area. At some instance the greater stability of this nanomaterial allows some of this to be used more than 100 times so this makes MOFs readily fit to be used as sorbent in microextraction methods. Like MOFs covalent organic framework also have huge surface area, greater chemical stability and also porosity other than this they also have some unique properties such as less density, modulated pore size and structure which makes them feasible for the use as sorbent in extraction method (Ding SY and Wang W, 2013; Li N, *et al.*, 2018). Besides with nanomaterial, non-nanometric sorbents are also deployed to magnify the selectivity and the extraction capacity. So basically, with this context we can say polymers can also be called as micrometric structures which are synthesized from same type of monomer or by two or more different type of monomer i.e (co-polymerization). Numerous polymers have also been used as sorbents due to their good-extraction properties (Chisvert A, *et al.*, 2019). Also, ionic solids which gets melts at temperature below 100 degree C are made from combination of different organic cation/anions and inorganic cation/anion which have been extensively used in extraction methods due to their versatile properties like high extractability, elevated thermal stability and lower vapour pressure (Ho TD, *et al.*, 2011; Trujillo-Rodríguez MJ, *et al.*, 2013).

Sorbent-based extraction methods

Each sample which is subjugated to treatment for separating analyte from the matrix, concedes towards authentic and reliable analysis. Mostly for complex samples multiple process are implemented in which pre-sample treatment becomes constriction in whole analytical process (Majors RR, 2013;

Faraji M, *et al.*, 2019; Paszkiewicz M, *et al.*, 2017). So, for this one of the most versatile extraction techniques which is still widely used for pre-concentration is Liquid-Liquid Extraction i.e., (LLE). This method, nevertheless, have some inbred drawbacks that makes this technique exorbitant or non-viable for use. This technique is laborious and also it has some requirements such as huge volumes of organic solvents which can be noxious within themselves (Majors RR, 2013; Faraji M, *et al.*, 2019; Azizi A and Bottaro CS, 2020). Another method i.e., Solid Phase Extraction (SPE) has remarkable edge as it amalgamated to circumvent its drawback. It needs less amount of solvent, requires less time and is not much complex to operate, it is efficacious and selective as it is fully automated and mostly it can be combined with other analytical processes. Solid-phase extraction by its complete rectification and reiteration like Solid phase microextraction, stir bar sorptive extraction, matrix solid phase dispersion has been successfully used for sample preparation techniques for solid and liquid samples (Majors RR, 2013; Faraji M, *et al.*, 2019; Azizi A and Bottaro CS, 2020; Anastassiades M, *et al.*, 2003). Another point which is to be highlighted is that Dispersive solid phase extraction provides a large area of contact between the adsorbent and the sample thereby achieving a fast extraction equilibrium. This technique is comparatively fast and has proven to be efficious as it requires very less amount of sorbent and solvent so it can be said that it is more environmentally friendly than standard Solid phase extraction technique (Majors RR, 2013; Anastassiades M, *et al.*, 2003; Ma Y, *et al.*, 2018).

Sorbent-based on magnetic nanoparticle

Recently, utilization of magnetic nanoparticles as sorbents in extraction methods has gained enormous recognition. These material show excellent uniform fragmentation, high surface area to volume ratio, also due to their super-paramagnetic nature they can be easily isolated without retention of residual magnetization. For the protection of the material from oxidation the material is coated with organic or inorganic coatings, which opens up the choice of magnetic nanoparticle (Pashaei Y, *et al.*, 2017; Qi X, *et al.*, 2017; González-Sálamo J, *et al.*, 2017). Scientific studies on magnetic nanoparticle-based sorbents have shown their extraction methods to be precise, with the recovery value closely resembling to 99%. Magnetic nanoparticles are developed for enhancing and advancement in extraction methods which has become a innovative point of research. The precise extraction with magnetic nanoparticle based sorbent was seen in a research of the determination of arsenic speciation analysis in water by making use of poly (methacrylic acid). This sorbent has been proven as most stable as it does not show any substantial loss of sorption potentiality (Ahmad H, *et al.*, 2017).

CONCLUSION

Concentrating on the type of microextraction methods, Dispersive solid phase extraction method has been highly employed for extraction. Its intelligibility and low cost has made it most effective technique compared to other well-known methods of extraction, in addition for reducing the analysis period use of magnetic nanomaterial should be gradually increased. The high surface area with regards to the thermal and chemical stability, with improved fabrication/functionalization, makes nanomaterial as most efficient sorbents for any matrix. So, the goal is to develop sorbents by combining the properties of two or more different material such as magnetic nanoparticles, polymers and carbon-based nanoparticles. As seen above the amalgamation of new material as sorbents in extraction methods is the most reliable approach to advance sample preparation process. By lowering the process, it is possible to advance less-time taking and more cost-effective analytical techniques for the extraction purpose. In contemplation for obtaining reduced scale and micro extractive techniques, attempt must be made in coming years to not only advance sorbent-based extraction methods but also reduce solvent volume for the elution step. In this was we will definitely obtain environmentally friendly analytical techniques which will contribute to improve sample preparation procedures by scaling down use of samples, solvents and will be both time-efficient and cost-effective.

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