



# Solvent selection in ultrasonic-assisted emulsification microextraction: Comparison between high- and low-density solvents by means of novel type of extraction vessel



Saeed Nojavan<sup>a,\*</sup>, Tayebeh Gorji<sup>a</sup>, Saied Saeed Hosseiny Davarani<sup>a</sup>, Amin Morteza-Najarian<sup>b,\*\*</sup>

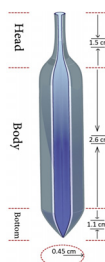
<sup>a</sup> Faculty of Chemistry, Shahid Beheshti University, G. C., 1983963113, Evin, Tehran, Iran

<sup>b</sup> Department of Chemistry, University of Alberta, Edmonton, AB T6G 2G2, Canada

## HIGHLIGHTS

- Design novel type of extraction vessel for USAEME procedure.
- Comparison between low- and high-density extraction solvents.
- Pre-consideration in selection of extraction solvents in USAEME.
- Viscosity and interfacial tension of solvents play decisive roles in extraction.
- Light hydrocarbons were efficient for extraction of analytes with high log *P* values.

## GRAPHICAL ABSTRACT



## ARTICLE INFO

### Article history:

Received 2 May 2014

Accepted 3 June 2014

Available online 5 June 2014

### Keywords:

Dispersive liquid phase microextraction

Extraction vessel

Urine analysis

Plasma analysis

Ultrasonic assisted emulsification

microextraction

## ABSTRACT

There are numerous published reports about dispersive liquid phase microextraction of the wide range of substances, however, till now no broadly accepted systematic and purpose oriented selection of extraction solvent has been proposed. Most works deal with the optimization of available solvents without adequate pre-consideration of properness. In this study, it is tried to compare the performances of low- and high-density solvents at the same conditions by means of novel type of extraction vessel with head and bottom conical shape. Extraction efficiencies of seven basic pharmaceutical compounds using eighteen common organic solvents were studied in this work. It was much easier to work with high-density solvents and they mostly showed better performances. This work shows that although exact predicting the performance of the solvents is multifaceted case but the pre-consideration of initial selection of solvents with attention to the physiochemical properties of the desired analytes is feasible and promising. Finally, the practicality of the method for extraction from urine and plasma samples was investigated.

© 2014 Elsevier B.V. All rights reserved.

**Abbreviations:** EME, electromembrane extraction; FID, flame ionization detector; HF-LPME, hollow fiber-liquid phase microextraction; SLM, supported liquid membrane; SPME, solid-phase microextraction; USAEME, ultrasonic assisted emulsification microextraction.

\* Corresponding author. Tel.: +98 21 22431662; fax: +98 21 22431662.

\*\* Corresponding author.

E-mail addresses: [s\\_nojavan@sbu.ac.ir](mailto:s_nojavan@sbu.ac.ir) (S. Nojavan), [mortezan@ualberta.ca](mailto:mortezan@ualberta.ca) (A. Morteza-Najarian).

## 1. Introduction

Sample preparation is a crucial step in analysis and it is a bottleneck to obtain accurate and sensitive results. Isolation of analytes from the matrix and pre-concentrations are important aspects of this process. Hence, many studies on separation science and related fields have been focused on the development of

sample preparation techniques. Ease, quickness, cost and reliability are the most motivations and goals that drive the field of microextraction.

In last decade, a lot of new sample preparation methods have been developed, such as solid-phase extraction (SPE) [1,2], molecular imprinting technique (MIT) [3,4], solid-phase microextraction (SPME) [5,6], single-drop microextraction (SDME) [7,8], hollow fiber based liquid phase microextraction (HF-LPME) [9,10] and most recently electromembrane extraction (EME) [11,12].

A technique that does not involve the use of either fiber or syringe is called dispersive liquid–liquid microextraction (DLLME). From the time of its introduction by Assadi et al. in 2006 [13], this easy to operate approach has gained significant popularity as a fast sample preparation technique. This reported model showed that the mixture of ternary solvents might possess unique properties that could be employed in order to accomplish an efficient extraction to organic solvents. DLLME is a simple and fast microextraction technique, which is based on a ternary component solvent system like homogeneous liquid–liquid extraction (HLL) [14] and cloud point extraction (CPE) [15]. The field of dispersive microextraction rapidly developed following these initial reports [16,17]. In this method, a mixture solution containing a few microliters of water-immiscible extractant solvent and water-miscible disperser solvent is rapidly injected into an aqueous solution. In this case, the surface area between the extraction solvent and aqueous phase (sample) is infinitely large and phase transition of analyte into the organic phase is fast. Consequently, equilibrium state achieves quickly, leading to a very short extraction time, which is the remarkable advantage of DLLME in comparison with other techniques [16].

In spite of undeniable advantages of DLLME, the use of disperser solvent usually decreases the partition coefficient of analytes into the extractant solvent. Moreover, the disperser solvent can complicate the phase separation process. These efforts are and were motivated, in part, by a multitude of advances that might be feasible when disperser solvents could be eliminable using ultrasonic irradiation as the emulsifier force. Garcia-Jares et al. [18] proposed a novel method based on ultrasound-assisted emulsification microextraction (USAEME) without the addition of an emulsifier [19,20]. Ultrasound radiation can lead to a process named cavitation. Cavitation is the creation and then immediate implosion of bubbles in a liquid. The physical process of cavitation is similar to boiling. The major difference between boiling and cavitation is the thermodynamic paths that precede the formation of the vapor. In cavitation process, bubble in a liquid rapidly collapses, producing a shock wave. Sufficient energy of this shock can break down the droplet of dispersed phase and generate a smaller droplet size immediately after disruption, thus enhancing the emulsification [21,22].

It is clear that in DLLME and USAEME techniques, the most challenging case is the selection of an appropriate extraction solvent [16,19]. This selection can affect the entire procedure and play the most decisive role in efficiency and applicability of the method. In dispersive microextraction techniques, the extraction solvents are categorized into two main types according to the specific gravity: low-density and high-density solvents. Traditionally, the range of solvents that could be used as the extraction solvents was limited to the organic solvents with lower density than water. This was due to the difficulty of collecting micro volumes of low-density solvents after completion of extraction. Although, high-density solvents has limitations such as incompatibility with some instruments (ICP-OES and reverse-phase HPLC). By designing a new extraction vessel with capillary conical head, Saleh et al. succeeded in performing a DLLME using safe and nontoxic solvents, such as hydrocarbons that are lighter than water [23].

Although both types of organic solvents were used for extraction of broad range of analytes, they have not been compared with each other. Designing novel type of extraction vessel with conical head and bottom enabled us to make a comprehensive comparison between low-density and high-density solvents. Also, this work intended to examine possible explanations for the observed diversity in extraction efficiencies of analytes by different solvents. To reach better insight into fundamental affecting parameters, extraction of seven basic pharmaceutical compounds using wide range of common organic solvents in liquid–liquid extraction were studied. Finally, the performance of optimized solvents for extraction from biological samples was investigated.

## 2. Experimental

### 2.1. Materials and chemicals

Imipramine, desipramine and rivastigmine were obtained from Tofigh Daru pharmaceutical company (Tehran, Iran). Sertraline, tramadol, codeine and galantamine were kindly donated from Sobhan Daru (Tehran, Iran). All of pharmaceutical compounds were used without any further purification. 1-Hexanol, 1-heptanol and 1-octanol were purchased from Fluka (Buchs, Switzerland) whereas potassium hydroxide (NaOH), hydrochloric acid (HCl), 1-nonanol, toluene, nitrobenzene,

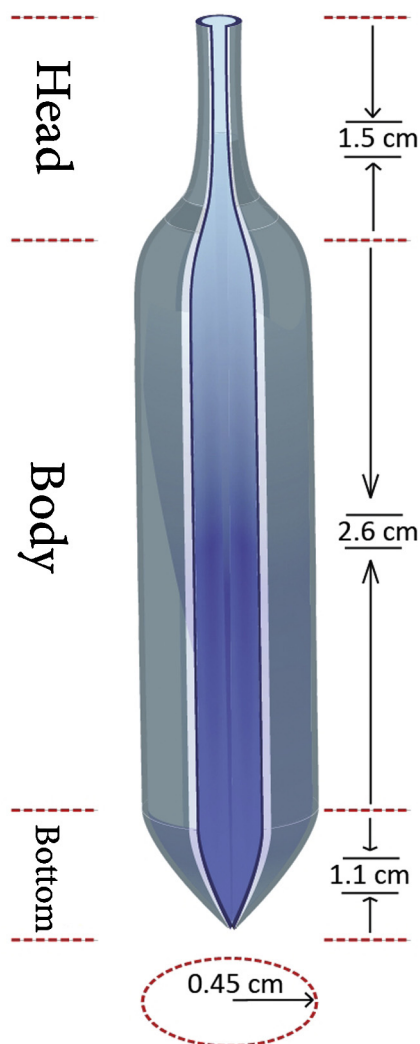


Fig. 1. Schematic illustration of utilized extraction vessel.

Download English Version:

<https://daneshyari.com/en/article/1163912>

Download Persian Version:

<https://daneshyari.com/article/1163912>

[Daneshyari.com](https://daneshyari.com)