Electromembrane extraction and spectrophotometric determination of As(V) in water samples

Arsenic is an important environmental element because of its high toxicity at the level of parts per billion. According to World Health Organization (WHO) guideline on drinking water quality, the maximum permitted concentration of arsenic in drinking water is 10 $\mu g.L^{-1}$ Therefore, simple, rapid, highly sensitive, and accurate methods required for the determination of trace amounts of arsenic especially in environmental samples. Electromembrane extraction (EME) is a new microextraction method in which an electrical voltage is applied to enhance the transport of charged species across a hollow fiber membrane.

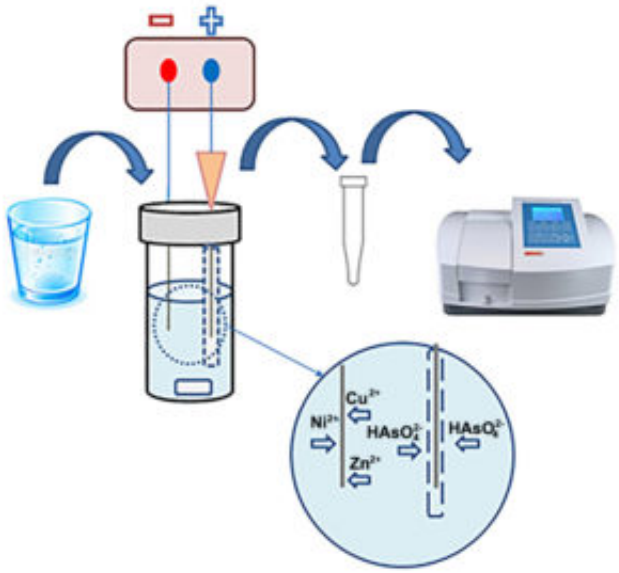

Fig. 1. Schematic presentation of determination of As(V) using EME followed by UV-Vis spectrophotometry

In this Study, for the first time EME was used as a highly efficient sample pre-treatment method for the UV-Vis spectrophotometric determination of As(V) in water samples. This new analytical approach has advantages of both EME and spectrophotometric determination including a good selectivity and cleanup, low cost, simplicity and easy operation.

To a 50 ml sample solution, 1 ml of 0.1 $molL^{-1}$ Bis–Tris buffer solution (pH 7.3) was added and the mixture was passed through an ion exchange resin column at a flow rate of 2 $mL.min^{-1}$ in order to remove the phosphate ion which may be present in sample solution. 5 mL of the sample solution pretreated as described above was transferred into the sample vial. A short piece of polypropylene hollow fiber (3.5 cm) dipped in 1-octanol with 2.5% (v/v) DEHP for 10 s and then the excess

amount of solvent was removed with a medical wipe. 10 µL of a 100 mM sodium hydroxide solution, as acceptor solution, was injected into the lumen of the hollow fiber using a microsyringe. One of the electrodes, the anode, was placed inside the lumen of the fiber and the lower end of the hollow fiber was sealed with small piece of aluminum foil (thickness of 280 µm). The other electrode, cathode, was directly placed inside the sample solution. The electrodes were then coupled to the power supply and the extraction vessel was placed on a magnetic stirrer with a stirring rate of 700 rpm. A voltage of 70 V was turned on and extraction was performed for 15 minutes.

Under the applied voltage, the As(V) migrated from sample solution (donor phase) into acceptor phases through the SLM. After the extraction was completed, the acceptor solution was collected by a microsyringe and transferred directly to a microvial for further analysis by UV-Vis spectrophotometery. The method allowed the determination of As(V) in the range of 5–300 ng.mL$^{?1}$. The relative standard deviation was found to be within the range of 6.1–10.6%. The limit of detection, corresponding to a signal to noise ratio of three, was 1.5 ng.mL$^{?1}$.

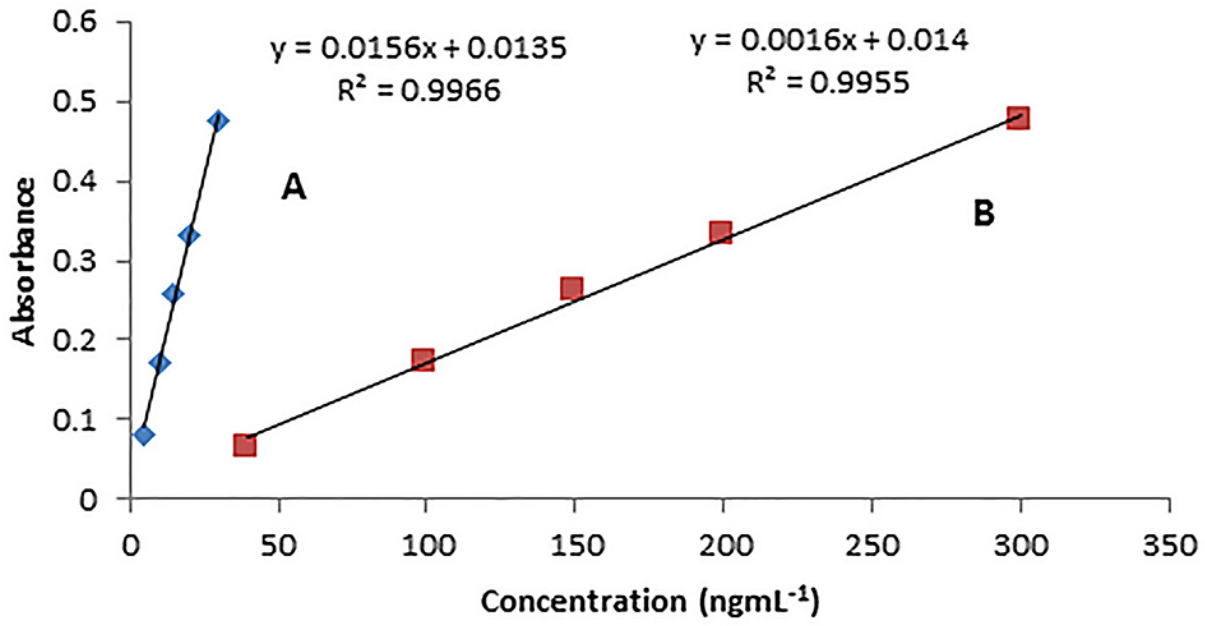

Fig. 2. Calibration curves for determination of As(V) in the range of 5–30 ngmL-1 (A) and 30-300 ngmL-1 (B) in the optimum conditions.

The extraction recovery and enrichment factor were investigated in deionized water under optimized conditions of EME using three standard solution of arsenic (10, 20 and 50 ngmL^{-1}). The enrichment factor was measured between 30 and 32.5 which correspond to extraction recoveries

from 60-65%. The proposed method was finally applied to the determination of As(V) in water samples and relative recoveries ranging from 87 to 102 % were obtained. To investigate the selectivity of the method, various ions commonly found in natural waters such as Mg^{2+}, Ca^{2+}, CO_3^{2-}, PO_4^{3-} as well as some heavy metals (Cu^{2+},Co^{2+},Zn^{2+}, Ni^{2+}) were investigated. No significant interference observed up to a concentration ratio of 1:100.

In conclusion, the proposed method can be a good choice for determination of arsenic in environmental analysis.

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