Double-flow or stopped-flow conditions as different operating working modes for microfluidic devices in sample preparation depending on the application field

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Abstract

This experimental work reports the study based on two working modes that can be used when liquid phase micro extraction is integrated into a microfluidic-chip device. The study compares enrichment factors, extraction efficiencies and detection and quantification limits. The microfluidic device has been tested with acid drugs as model analytes. Transport phenomena are faster on the micro-scale, and therefore extractions can be carried out quickly. This comes from the fact that the transport in LPME is governed by diffusion and that the time required for mixing scales with the square of the length, and then, the diffusion path is much shorter in microfluidic devices on chip. The study was carried out using a microfluidic device consisting on two patterned plates of poly (methyl methacrylate), which are symmetrical. In the front side, a channel was used as donor (sample) solution whereas in the back side, the channel was used as acceptor phase. Five non-steroidal anti-inflammatories were extracted from acid sample solution (pH 1.5), through the SLM, and into alkaline solution functioning as acceptor phase (pH 12). Two different working modes were tested: double-flow mode and stopped-flow mode. For double-flow working mode, a donor flow rate within the range of 1-30 µL min^{-1} was tested, keeping the acceptor flow rate at 1 µL min^{-1} (table 1). However, the acceptor flow rate was stopped during the extraction (stagnant conditions). As seen in table 1, when the acceptor flow is turned off during the extraction time, high enrichment factor significantly increases with the extraction time for all compounds. As an example, the IBU is enriched by a factor of 75 after 25 minutes extraction consuming only 500 µL of sample. On the other hand, a double-flow working mode is preferred when very high extraction efficiencies are desired.

Image

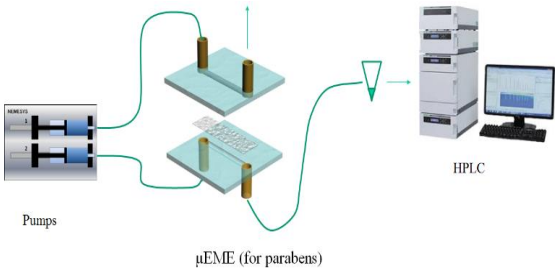


Figure Description

Table

	Double-flow conditions[a,c]		Stopped-flow conditions[b]	
	EE*	EF	EE*	EF
SAC	35 (2)	3	9 (2)	29
KTP	38 (1)	4	8 (2)	25
NAX	42 (2)	4	10 (1)	34
DIC	42 (2)	4	13 (1)	45
IBU	80 (1)	7	22 (2)	75

Table 1: Results: *% Extraction efficiency (%RSD, n=4)
[a] Extraction time: 5 min
[b] Extraction time: 25 min
[c] Acceptor flow rate of 1 µL min^{-1} and donor flow rate of 9 µL min^{-1}

Recent Publications

1. Maria Ramos Payan, Santiago Maspoch, Andreu Llobera (2016) An effective microfluidic based liquid-phase microextraction device (µLPME) for extraction of non-steroidal anti-inflammatory

drugs from biological and environmental samples. Anal Chim Acta doi: 10.1016/j.aca.2016.09.040.
2. Maria Ramos Payan, Santiago Maspoch, Andreu Llobera (2017) A simple and fast double-flow microfluidic device based liquid-phase microextraction (DF-μLPME) for the determination of parabens in water samples. Talanta 165: 496-501.
3. Maria Ramos Payan, Henrik Jensen, Nicolaj Petersen, Steen Honoree, Sig Pedersen Bjeergard (2017) Liquid-phase microextraction in a microfluidic-chip – high enrichment and sample clean-up from small volumes of biological fluids. Analytica Chimica Acta 735: 46-53.



Biography

Maria Ramos Payan has expertise in improving sample preparation techniques focused on microfluidic-chip devices as miniaturization. The novelty of her microfluidic devices offer more advantages than the existing methodologies. The devices work either using biological and environmental samples and can be coupled on-line to HPLC or Mass Spectrometry. She has also demonstrated the applicability of microchip devices for diagnostic diseases as diabetes. She has worked at different institutions (University of Seville, University of Huelva, University of Lund, University of Copenhagen and University of North Carolina, USA). Currently, she works at Microelectronic National Center of Barcelona and Universitat Autonoma of Barcelona with the aim of implementing optical detection into microfluidic devices for multiple applications.

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Notes/Comments: