SBSE/SFE-SFC-MS/MS System to Analyze Migrating Plastic Additives in Medical Solutions and Biological Matrices

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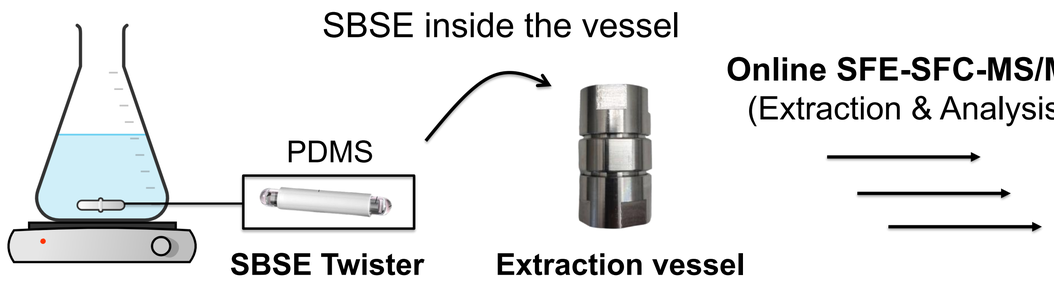
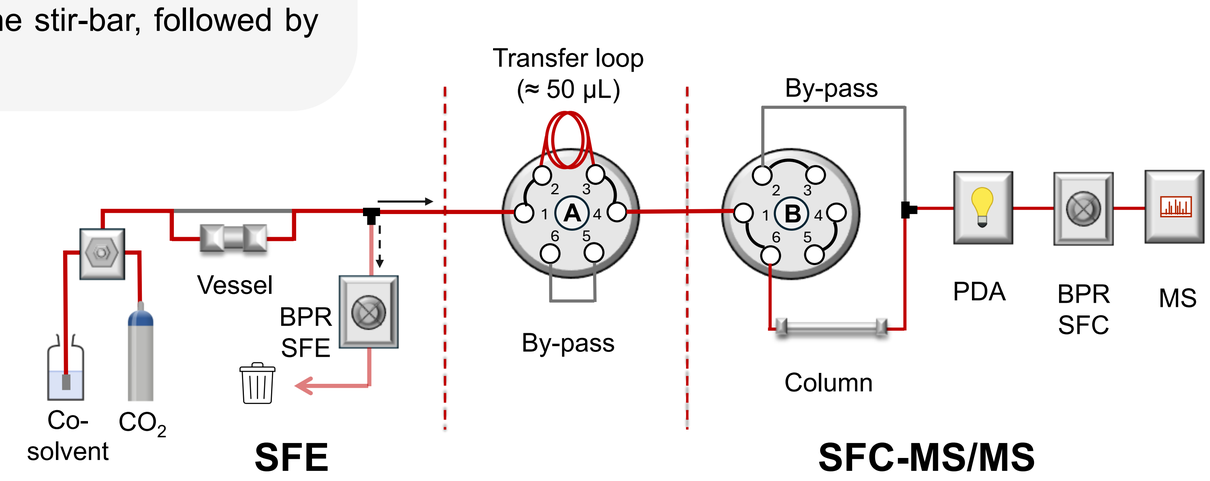
The use of **plastic additives** in the formulation of plastic materials is essential to obtain specific physico-chemical properties. However, certain compounds such as plasticizers can **migrate** from a plastic container to the content and can be **harmful for health** especially in the context of medical devices. Stir Bar Sorptive Extraction (SBSE) well described in literature as a technique to adsorb lipophilic compounds such as phthalates, which are common plasticizers. Thermo-desorption or solvent extraction is usually employed to desorb the stir-bar, followed by GC or LC analysis. The use of **supercritical CO_2 ($scCO_2$)** is an innovative way to desorb analytes from the stir-bar, followed by **online analysis by SFC-MS/MS,** offering several advantages.

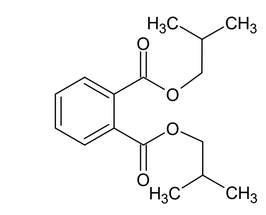
Nexera UC



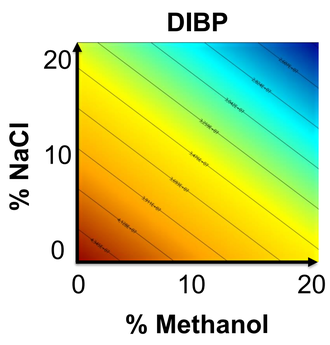


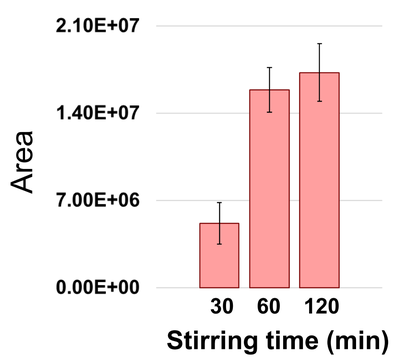
Design of Experiments

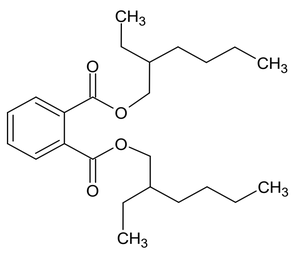
Equilibrium between the solution and the PDMS phase is an important factor to optimize in SBSE. The addition of methanol, salt, and stirring time can be adjusted to modify the equilibrium and enhance the extraction yield. A **Box-Behnken design** was performed using these **three factors**. For many plasticizers, such as DiBP and DEHP, neither methanol nor NaCl was required, but a minimum stirring time of 60 minutes was necessary to obtain optimal adsorption. An **aqueous solution of glucose** was spiked with plastic additives and used as sample to mimic a **hospital nutritive bag**.



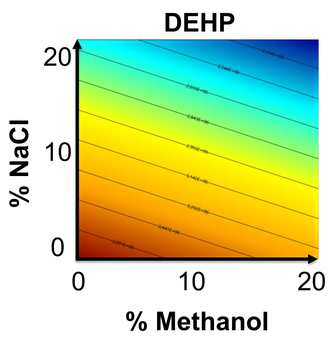
DiBP
(Log P : 3.1)

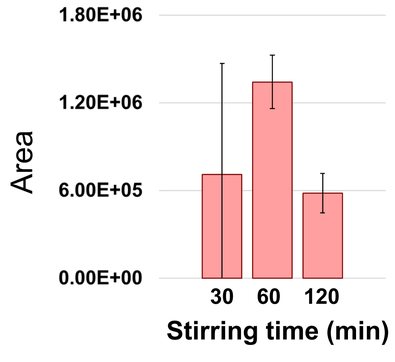






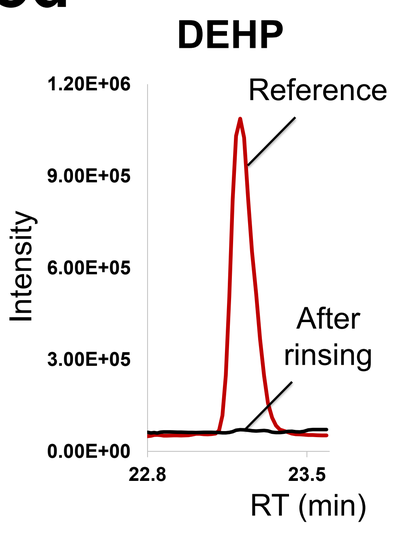
DEHP
(Log P : 6.4)





SBSE Rinsing method

Normally, stir-bars are “cleaned” with solvents or at high temperatures to completely desorb residual contaminants. Here, it is proposed to use the **online SFE-SFC-MS/MS** system to directly **clean the adsorbent**, followed by an analysis for blank checking. To clean the stir bars, $scCO_2$ with methanol followed by **pure $scCO_2$** was used (for less than one hour). The eluent composition and and cleaning time would need to be optimized depending on the contaminants.



Biological matrices

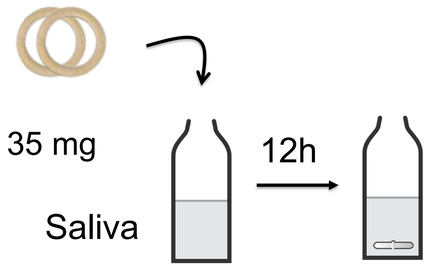
Saliva

The SBSE method was applied to biological matrices such as saliva. The objective was to analyze the composition of orthodontic elastic bands using the online **SFE-SFC-MS/MS** method with pure $scCO_2$ to extract plastic additives and to compare this composition with the **migrated compounds** extracted and analyzed using the **SBSE-SFE-SFC-MS/MS** method. Two orthodontic bands were immersed in saliva to simulate long-term use in real-life conditions.

Orthodontic elastic bands

SFE-SFC-MS

SBSE-SFE-SFC-MS

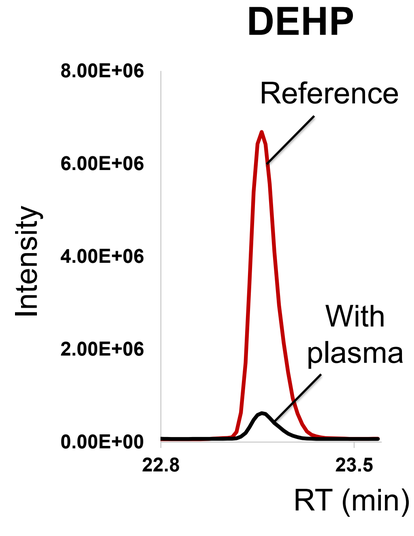


Categories	Compounds	% Relative area	
		Raw material	Migrated compounds
Plasticizers	DBP	27%	34%
	DiBP	17%	14%
	DEHP	7%	10%
	DEHA	1%	-
Antioxidant	Irganox PS800	1%	< 1%
Lubricant	Erucamide	36%	33%

% relative area is calculated in function of targeted compounds

Human plasma

The SBSE method was applied to **human plasma** as a biological matrix. Some compounds were adsorbed onto the stir-bar and then desorbed using **pure $scCO_2$**. However, the signal area was reduced due to **matrix effects**. Plasma macromolecules can directly interact with analytes and modify the adsorption equilibrium, or macromolecules can get adsorbed onto the stir-bar and compete with the analytes.



The use of **SBSE** allows the adsorption of **migrated plastic additives** in liquid matrices such as **medical solutions** (nutritive bags) or **biological matrices** (saliva, plasma). The use of **supercritical CO_2 ($scCO_2$)** is an innovative approach to desorb analytes from the stir-bar, followed by **online analysis using SFC-MS/MS**. The next objective is to reduce matrix effects from biological samples in order to **improve extraction efficiency** and **sensitivity**.