PhD Open Days

Fatty acids-based Eutectic Solvents Liquid Membranes for Removal of Sodium Diclofenac from Water

Chemistry Doctoral Program

João Afonso (joaopmafonso@tecnico.ulisboa.pt)

Introduction

Pharmaceuticals have a main role on health and life quality of humans and animals. Nevertheless **30% to 90% of all oral administrated drugs are excreted as active compounds**, leading the worldwide occurrence of active compounds in water sources, soils, and biota. As these compounds are designed to have a biological response to small dosages, they are an important threat to public health and ecosystem stability even at low concentration [1]. Additionally, their relative high stability is even more concerning, as the continuous ingestion of small doses can lead to accumulation. On the other hand, **conventional wastewater treatment plants (WWTP) are not designed to remove these compounds that enter the environment**. Despite the report of diverse cases of life-threatening biological effects of these drugs on wildlife, about **88% of all pharmaceuticals do not have environmental toxicity data** [2]. Diclofenac is a non-steroidal anti-inflammatory drug with the highest acute toxicity of this class of compounds and is extensively used to relief patients of pain and inflammation, reason why is commonly found in water sources and WWTPs [3]. Deep eutectic solvents (DES) are mixtures of compounds that by intermolecular interactions, present a lower melting temperature than any of the neat components and have been considered green solvents despite of their toxicity. To overcome this problem, **eutectic solvents based on natural products** were developed as **natural deep eutectic solvents** (NADES) with the assumption that they would exhibit lower toxicity and have a higher biocompatibility. In fact, some of these NADES are present on nature with common examples like flower's nectar and bee's honey [4].

Methodology

In this work, NADES based on fatty acids were impregnated on porous PVDF membranes by soaking and used to remove sodium diclofenac from water. UV-Vis spectroscopy was used to quantify the extraction efficiency of the supported NADES. Experimental parameters such as contact time, number of membranes, pH and initial concentration of pharmaceutical were optimized. Following optimization, 10 cycles of repeated extractions were used to assess the capacity of the membranes to be reused.. Each experiment was carried out thought three replicas.

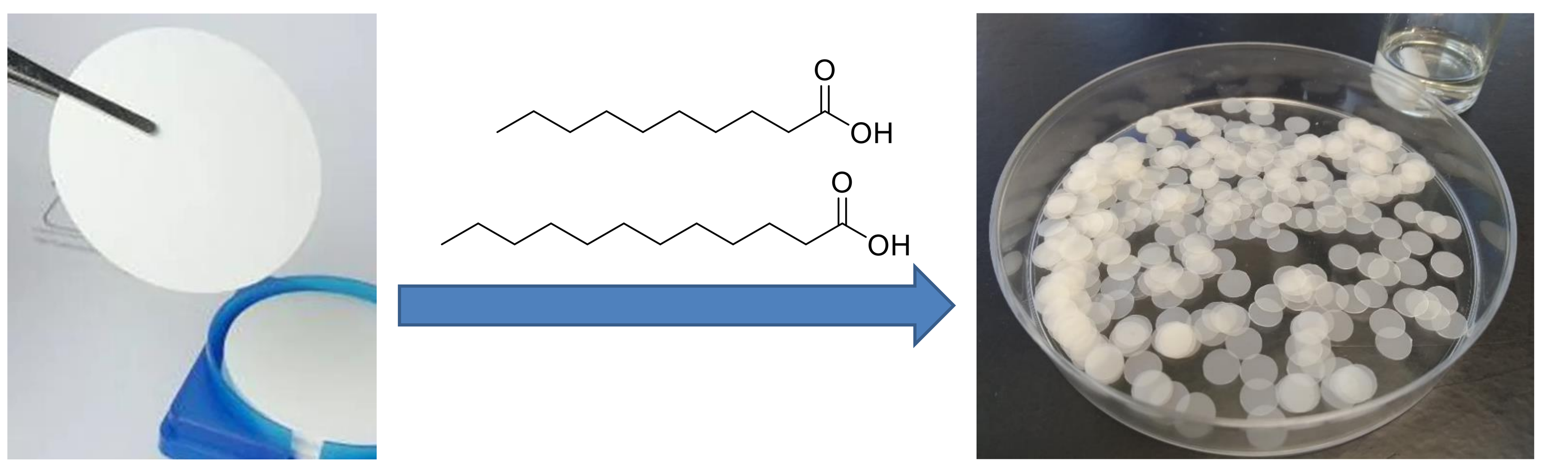

Figure 1. Schematic representation of the impregnation process of the porous PVDF membranes with the prepared NADES.

Results

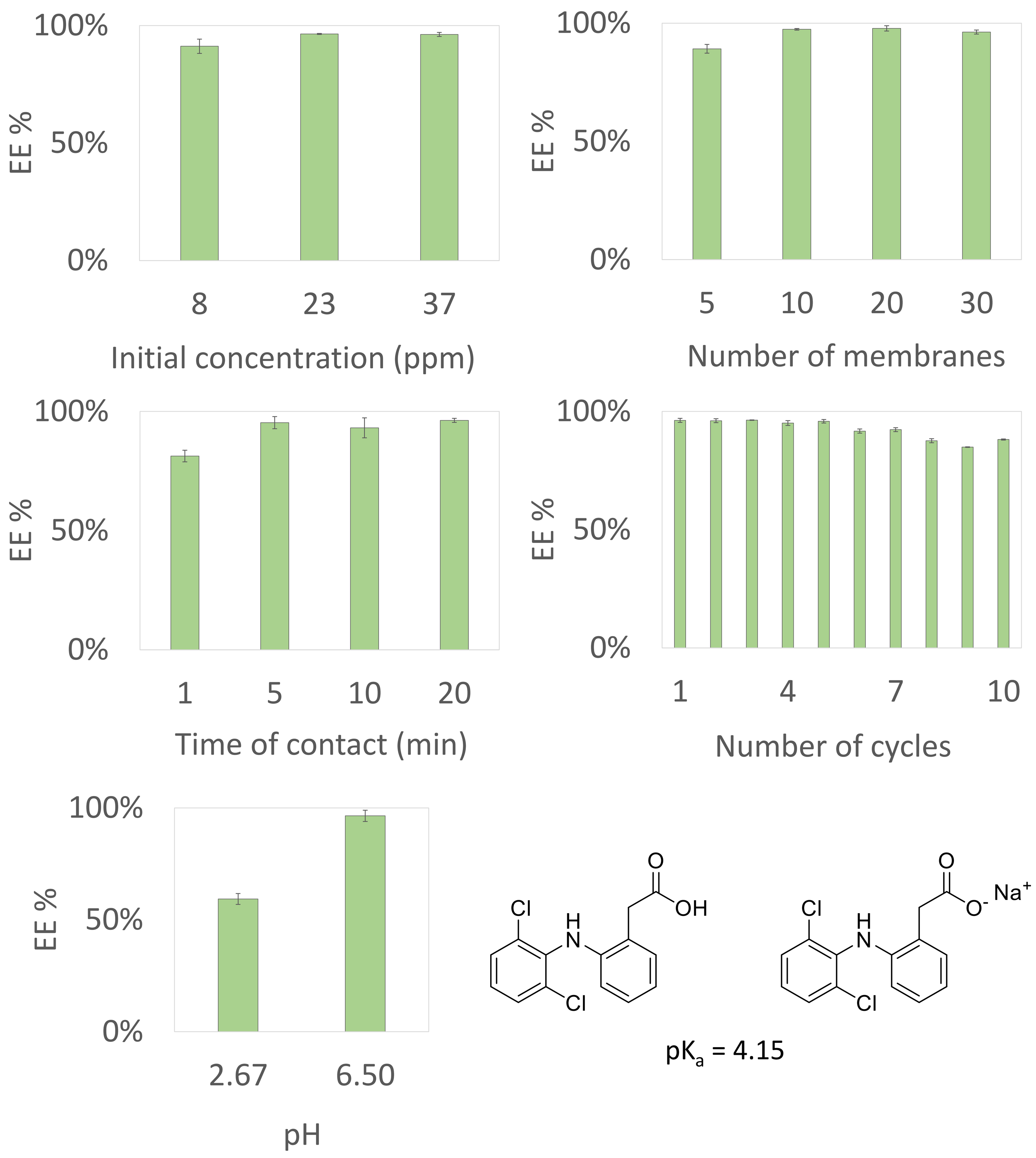

Figure 2. Graphical representation of the influence of the initial concentration of sodium diclofenac, number of membranes, time of contact and pH over the extraction efficiency and representation of the extraction efficiency over 10 cycles of membranes reutilization at optimal conditions.

Conclusion

A remarkable **extraction efficiency of 97**% was achieved for the optimal conditions of extraction for sodium diclofenac in water. These membranes were **re-used over 9 more cycles** of extraction without decreasing the efficiency. Moreover, Moreover, **less than 2 g of NADES are required for the treatment of 1 L of polluted water**. Additionally, the applicability of this technology for different pollutants is being evaluated.

References

[1] OECD, Pharmaceutical Residues in Freshwater: Hazards and Policy Responses, OECD Publishing, 2019.
[2] M. Ibáñez, Trends in Environmental Analytical Chemistry, 2021, 29, e00118.
[3] M. A. E. de Franco, Journal of Cleaner Production, 2018, 181, 145–154.
[4] Y. Dai, Analytica Chimica Acta, 2013, 766, 61–68.

Acknowledgments

Centro de Química Estrutural is a Research Unit funded by Fundação para a Ciência e Tecnologia through projects UIDB/00100/2020 and UIDP/00100/2020. Afonso J. gratefully acknowledges the financial support of FCT/MCTES (Portugal) for PhD fellowship 2021.07949.BD and the CQE project PTDC/EAM-AMB/2023/2021.