Investigating the sorption of selected pharmaceuticals, personal care products and endocrine-disrupting compounds to different types of microplastics

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Introduction

Microplastics

- Polystyrene (PS) and Polyethylene (PE) are two important categories of microplastics that are widely used in numerous applications.
- PS and PE have been detected in drinking water, raw and treated wastewater, as well as in sewage sludge, worldwide .
- Previous studies have shown their tension to sorb organic micropollutants such as PAHs and PBDEs.

Emerging Micropollutants

- Pharmaceuticals (PhCs), personal care products (PPCPs), and endocrine disrupting compounds (EDCs) are characterized as emerging contaminants and they are commonly detected to water and wastewater.
- **Limited information** is so far available for the sorption of these micropollutants to PS and PE.

The ***main objective*** of current research was to examine the sorption potential of valsartan (VAL), losartan (LOS), sulfamethoxazole (SMX), methyl paraben (methyl-P), ethyl paraben (ethyl-P), propyl paraben (propyl-P), butyl paraben (butyl-P) and bisphenol A (BPA) to PS and PE. The role of pH and ion strength on their sorption potential was also assessed.

Fig 1: Sorption experiments

Fig 2: HPLC system used for the analysis.

Materials & Methods

- Batch experiments were initially performed to check the tension of target micropollutants to sorb onto the studied microplastics **(Fig. 1)**.
- Specific amounts of PS or PE were added to serum bottles containing 100 mL of bottled drinking water and 1 mM NaN_3 was added to prevent microbial degradation.
- The target micropollutants were spiked at an initial concentration of 500 μg L^{-1}.
- Samples were collected using glass syringes at specific time intervals (0, 24, 36, 48, 72, 96, 120, 144, 168 and 216 h).
- For the determination of target compounds in aqueous samples, a High Performance Liquid Chromatography (HPLC, Waters Alliance 2695) system was used **(Fig. 2).**
- Control experiments (no addition of microplastics) were also prepared to determine possible abiotic degradation of studied micropollutants.
- For examining the role of pH, experiments were conducted at pH values of 4, 7.5 and 10.
- The role of ionic strength was evaluated in experiments with NaCl and $CaCl_2$. Three different salt concentrations were tested: 0.1, 0.01 and 0.001M.
- All experiments were conducted in triplicates.

Results & Discussion

- According to the Control experiments, none of the compounds are hydrolysed or sorbed to the serum bottles. Concerning their sorption to microplastics, important sorption was noticed for VAL and LOS, when PS was used as sorbent material **(Fig 3)**.
- The sorption of VAL and LOS to PS seems to be a slow process. During the first 72 h, only 5% of VAL and 19% of LOS had been sorbed, while their sorption was gradually increased reaching 31% and 66% up to 216 h.

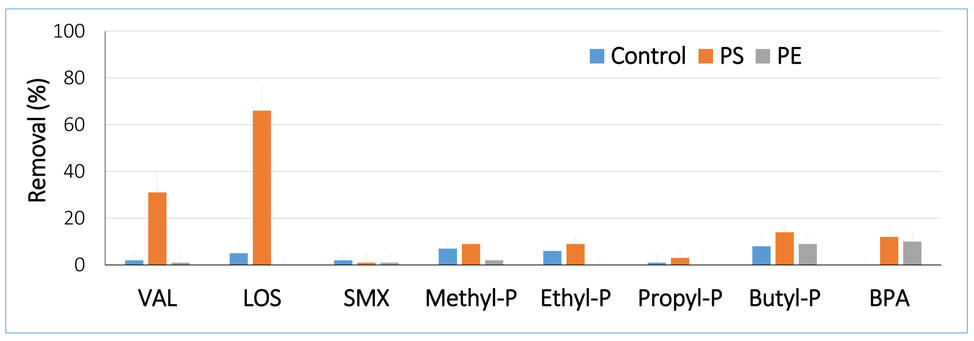

Fig 3: Sorption of target organic micropollutants to polystyrene (PS) and polyethylene (PE) microplastics. The duration of the experiments was 216 h.

- The experiments at different pH values showed that water pH affects significantly the sorption of target pharmaceuticals to PS.
- The highest sorption was observed at pH 4 and it was equal to 63% and 73% for VAL and LOS, respectively **(Fig 4).**
- On the other hand, under alkaline conditions (pH 10), the sorption of these compounds to PS was negligible **(Fig 4).**

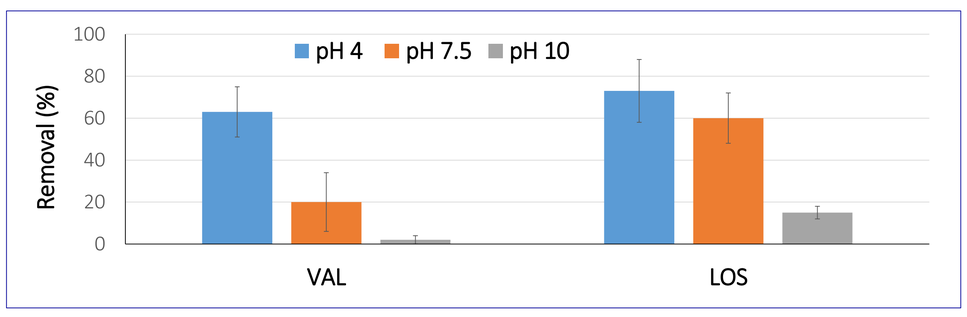

Fig 4: Effect of pH on the sorption of VAL and LOS to PS microplastics. The duration of the experiments was 216 h.

- Concerning the role of ionic strength, when different concentrations of NaCl were added, no differences of VAL sorption were noticed.
- On the other hand, the increase of the ionic strength enhanced LOS sorption to PS. The highest removal (58%) was observed when 0.1 M of NaCl was added **(Fig 5).**

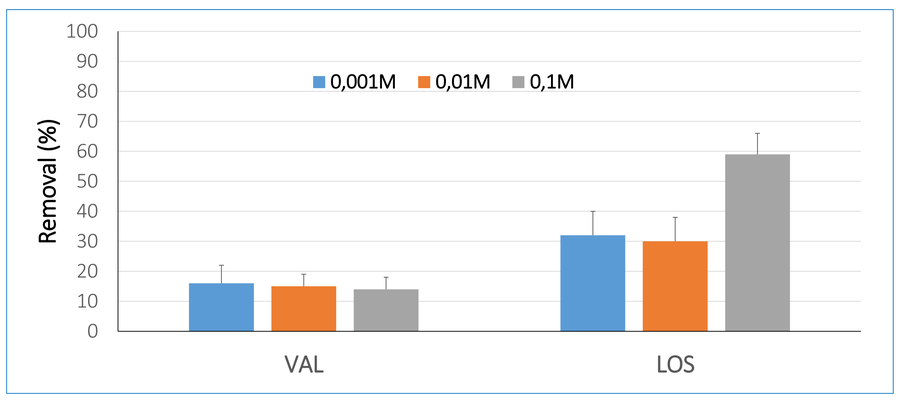

Fig 5: Effect of ionic strength on the sorption of VAL and LOS to polystyrene (PS) microplastics. The duration of the experiments was 216 h. NaCl was used at different concentrations (0.001 M, 0.01 M, and 0.1 M).

- When different concentrations of $CaCl_2$ were added, an increase of VAL sorption was observed with the increase of ionic strength.
- A similar trend was observed for LOS. The highest removal (92%) was observed when 0.1 M of $CaCl_2$ was added **(Fig 6).**

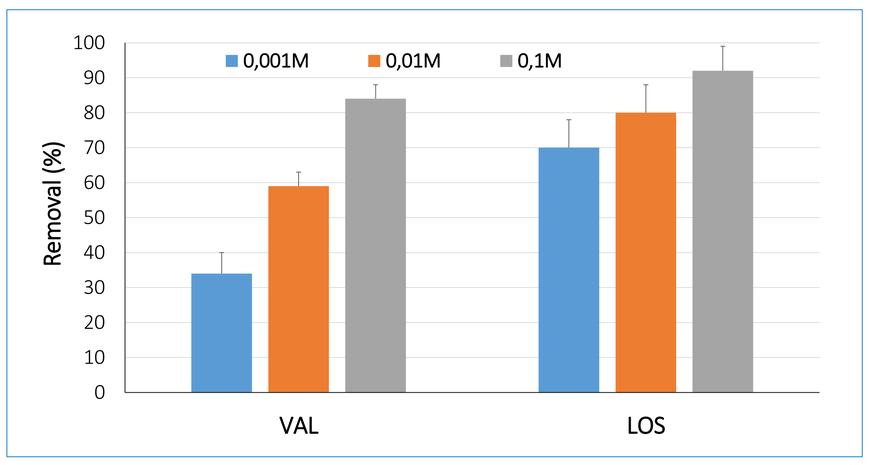

Fig 6: Effect of ionic strength on the sorption of VAL and LOS to polystyrene (PS) microplastics. The duration of the experiments was 216 h. $CaCl_2$ was used at different concentrations (0.001 M, 0.01 M, and 0.1 M).

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