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Aqueous Two-Phase Extraction using Choline Salts: A Green Strategy for Tackling Pharmaceutical Pollution in Water

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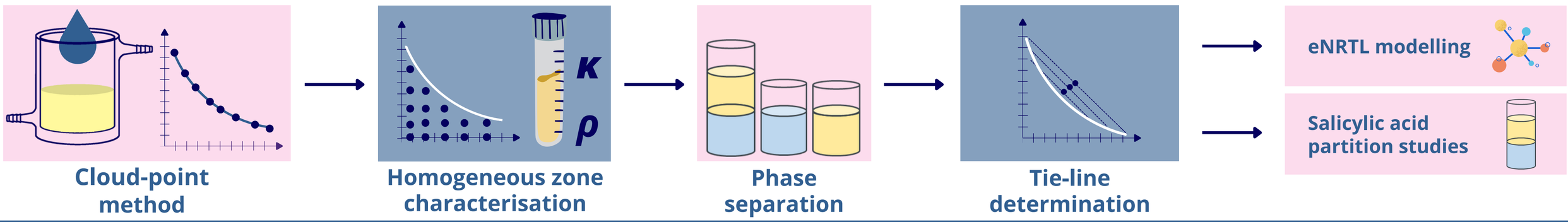
INTRODUCTION

Aqueous Two-Phase Systems (ATPSs) based on choline salts represent a promising and environmentally friendly alternative to conventional liquid–liquid extraction methods due to their high water content, biocompatibility, and non-toxic nature [1-2]. These characteristics make them particularly suitable for the recovery of **active pharmaceutical ingredients (APIs)**, such as antibiotics and antipyretics, from contaminated water streams [3].

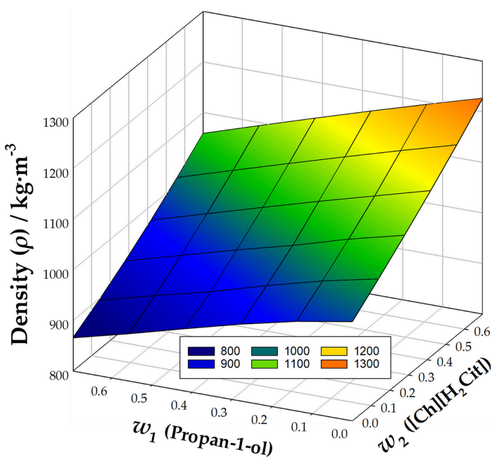
In this work, the liquid–liquid equilibria (LLE) of ATPSs composed of propan-1-ol, **choline dihydrogen citrate** or **choline bicarbonate**, and water were determined at 298.15 K and 0.1 MPa. Solubility curves were estimated using the cloud-point method, while tie-line compositions were established using third-degree polynomial correlations of electrical conductivity and liquid density data. The experimental data were successfully described using the **electrolyte-Non-Random Two-Liquid (eNRTL)** thermodynamic model [4]. Partition studies were also performed, by using **salicylic acid** to simulate an API contaminated stream, obtaining promising performance indicators.

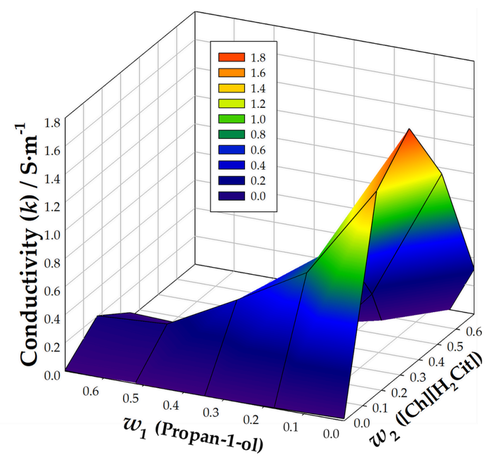
METHODOLOGY

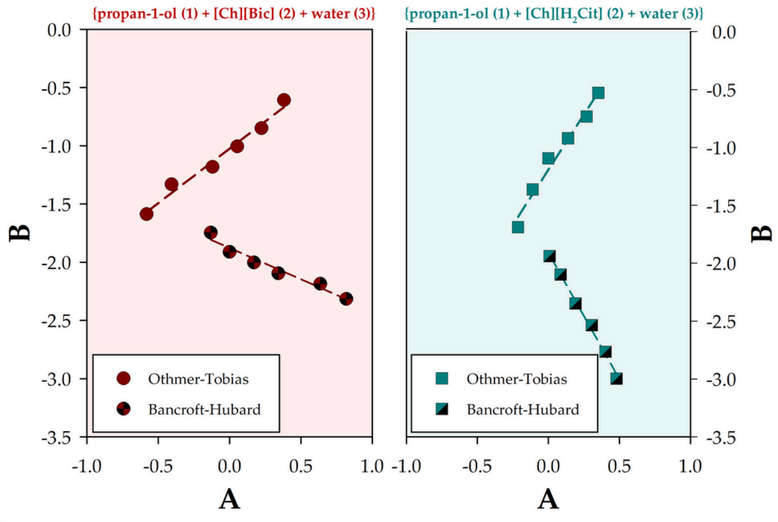


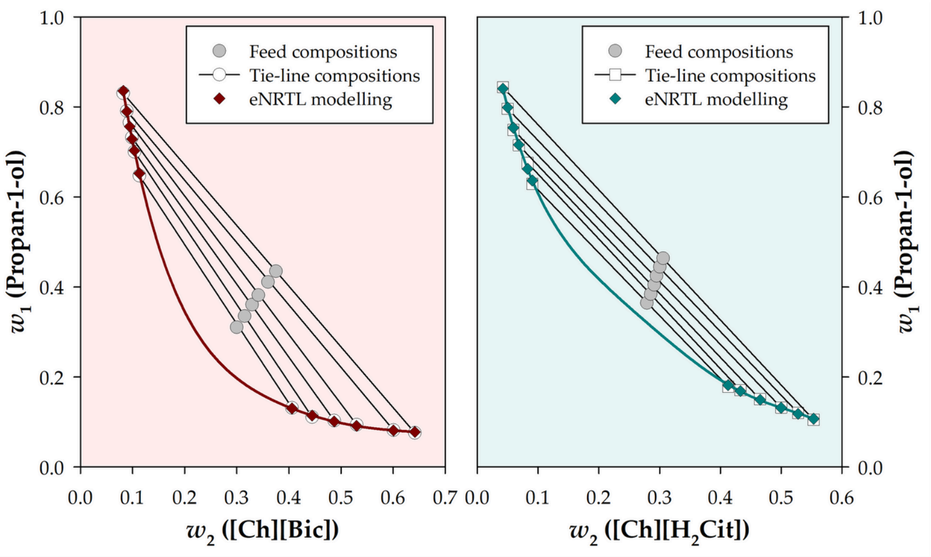
RESULTS AND DISCUSSION

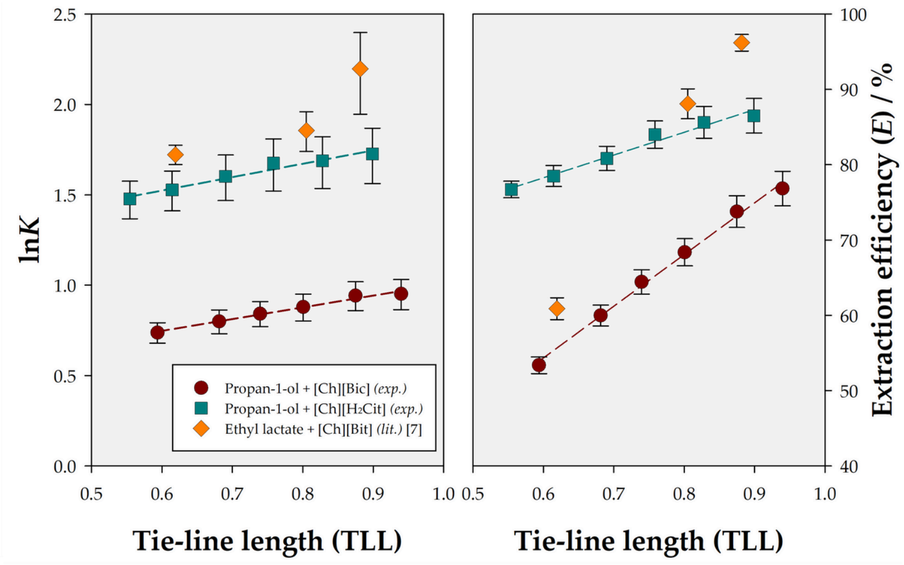
As expected, liquid density increased with higher concentrations of salt and solvent. A similar trend was observed for electrical conductivity up to a mass fraction of 0.29 in salt, beyond which ionic crowding effects became significant. Regarding the tie-line compositions, the experimental data were correlated using the Othmer–Tobias [5] and Bancroft–Hubard [6] empirical models to alow accurate interpolation.











Othmer-Tobias

$$A = \log\left(\frac{1 - w_{2,\mathrm{II}}}{w_{2,\mathrm{II}}}\right), B = \log\left(\frac{1 - w_{1,\mathrm{I}}}{w_{1,\mathrm{I}}}\right)$$

Bancroft-Hubard

$$A = \log\left(\frac{w_{2,\mathrm{II}}}{w_{3,\mathrm{II}}}\right), B = \log\left(\frac{w_{2,\mathrm{I}}}{w_{1,\mathrm{I}}}\right)$$

Extraction Efficiency and Partition Coefficient

$$E = \frac{m^{\mathrm{top}}}{m^{\mathrm{feed}}} \cdot 100 \qquad K = \frac{C^{\mathrm{top}}}{C^{\mathrm{bot}}}$$

CONCLUSIONS

- New ATPSs containing choline bicarbonate and choline dihydrogen citrate were successfully determined.
- Both ATPSs exhibited promising performance indicators for API extraction, achieving ***K*** values of 5.6 ± 0.9 and ***E*** values of 87 ± 3 %.

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