Semi-quantitative LC/ESI/MS analysis using predictive models of ESI ionization efficiencies

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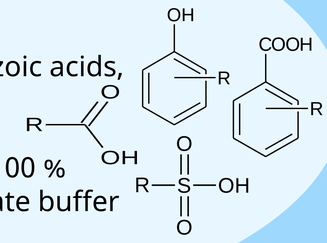
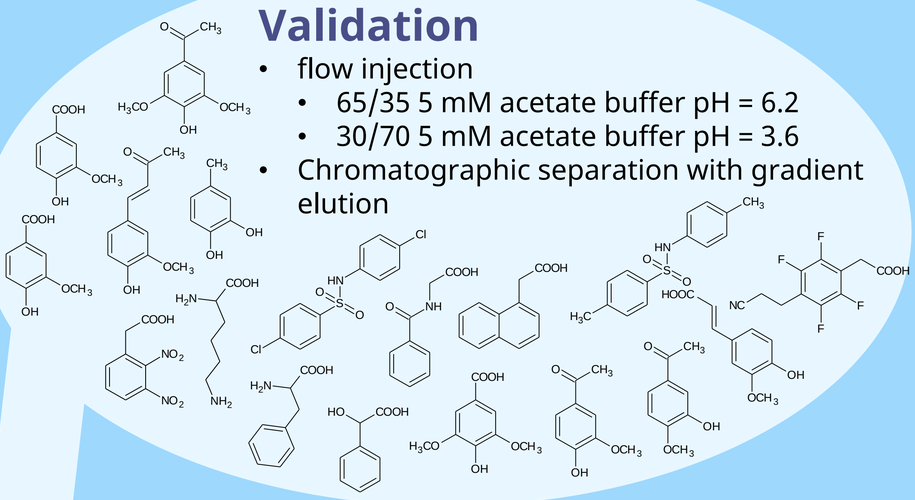
Studied Compounds and Eluents

- Training set:
  - 62 substituted phenols and benzoic acids, carboxylic and sulfonic acids
  - 10 eluent compositions
    - Acetonitrile percentage 20 – 100 %
    - Additives: NH_3, HCOOH, acetate buffer
    - pH = 2.7 – 10.7



Validation

- flow injection
  - 65/35 5 mM acetate buffer pH = 6.2
  - 30/70 5 mM acetate buffer pH = 3.6
- Chromatographic separation with gradient elution



Electrospray Ionization Efficiency (*IE*)

- shows **how efficiently** analyte **ions from liquid phase** form **gas phase ions**
- allows to study **processes** occuring during **ESI plume** and in **droplet**, giving more insight into ESI **mechanism**
- depends on **physico-chemical properties** of **analyte** and **eluent**
- Relating analyte and eluent physico-chemical parameters to *IE* gives the power to predict *IE*
- Ability to **predict *IE*** allows to carry out **standard substance free quantification** with any needed analyte in any preferable medium

Descriptors

- **PaDEL**
  - 1444 1D and 2D
  - 431 3D
  - freeware
  - quick and easy
  - hard to explain chemical meaning
  - trivial descriptors (e.g nN)
  - uses gas phase geometry
- **COSMO-RS**
  - descriptors have chemical meaning
  - Possible to calculate for solvent mixtures
  - 20 3D descriptors
  - time-consuming geometry optimization
  - licensed software

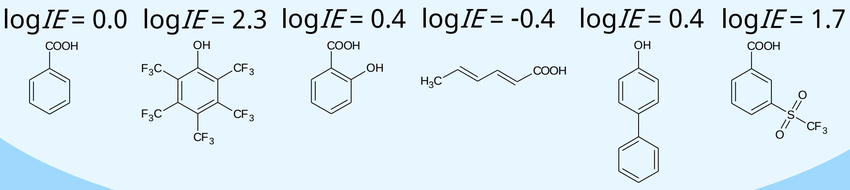
Model Development

$$\log IE = (2.72 \pm 0.13) + (-0.46 \pm 0.02) \cdot WAPS + (0.69 \pm 0.07) \cdot \alpha + (-0.018 \pm 0.004) \cdot HBA + (0.0039 \pm 0.0011) \cdot \%MeCN$$

WAPS - charge delocalization parameter, α - ionization degree in solution, *HBA* - hydrogen bond acceptor ability, *%MeCN* - acetonitrile content

Calibrating the Setup of Interest

log*IE* = 0.0 log*IE* = 2.3 log*IE* = 0.4 log*IE* = -0.4 log*IE* = 0.4 log*IE* = 1.7



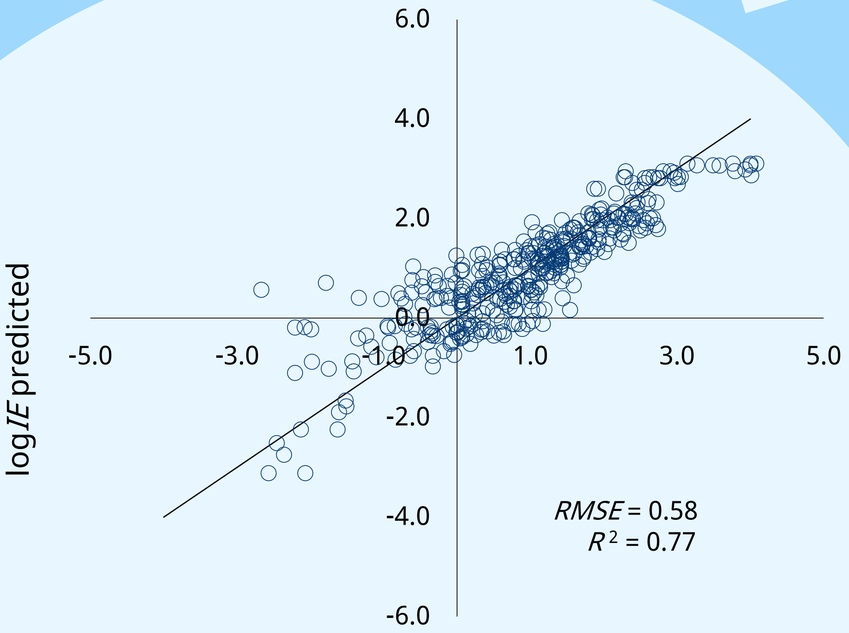


Figure 1: Fit obtained for the log*IE* values over all tested mobile phases. Straight line shows ideal fit.

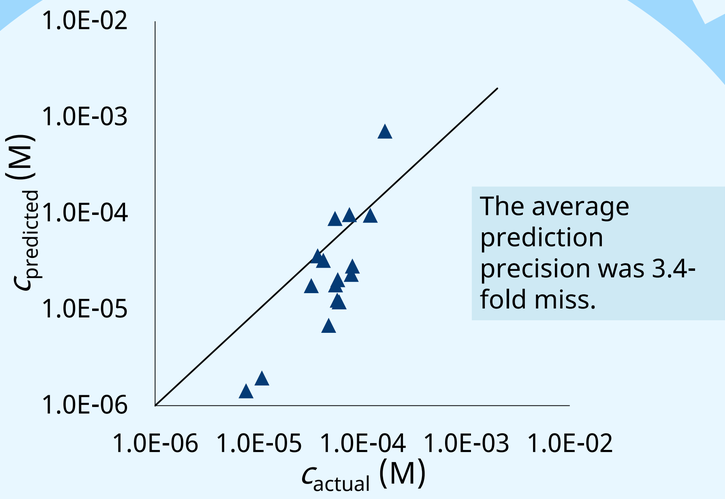


Figure 2: Correlation between the predicted concentrations and measured concentrations for the 16 acids in chromatographic mode.

References

- Kruve and Kaupmees *Anal Chem* 89(9), 2017
- Liigand et al *Anal Chem* 89(11), 2017
- Liigand et al *J Am Soc Mass Spectrom* 28(3), 2017
- Kruve et al *J Am Soc Mass Spectrom* 28(5), 2017

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