Hes·so
Haute Ecole Spécialisée de Suisse occidentale
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Master of Science HES-SO in Life Sciences

# Entrepreneurial development of capillary electrophoresis in Food and Nutrition domain

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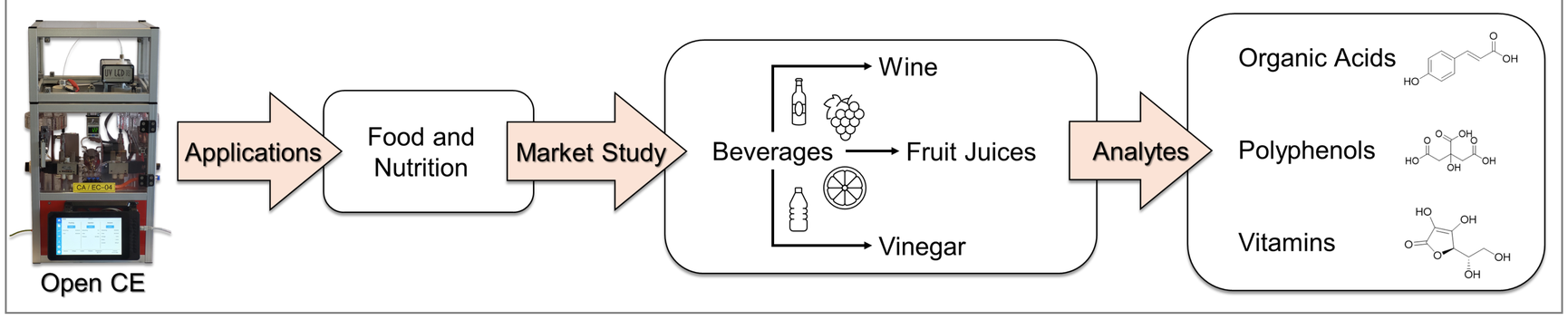
**CHEMICAL DEVELOPMENT & PRODUCTION**

***HEIA-FR***

Advisor: Prof. Olivier Vorlet // Expert: Danielle Burkhard (HEG-FR)

## DESCRIPTION

HEIA-FR has developed low-cost, open-source capillary electrophoresis equipment (OpenCE) for use in developing countries to detect fake medicines. As part of a funding programme launched by the HEIA-FR and the HEG-FR to "develop entrepreneurial skills in engineering sciences and business management sciences", the goal is to focus on the food and nutrition field to provide an economic analysis tool in response to development needs in this sector.




## OBJECTIFS

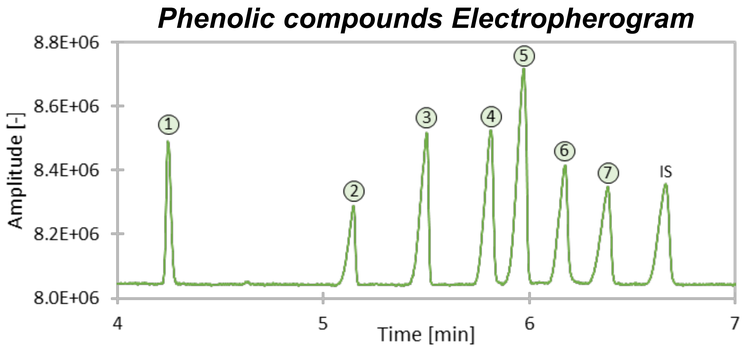
The goal of this project is to explore the opportunities for entrepreneurial development of ECB prototypes produced at HEIA-FR in the field of food and nutrition. The following objectives are to be achieved :

- Testing a method with indirect UV detection
- Determine the feasibility of a method in the literature with a negative polarity, i.e. the opposite of that of OpenCE
- Developing analytical methods in the food sector, particularly for beverages

## RESULTS

### Direct UV detection and positive polarity :

***Phenolic compounds Electropherogram***




1 Vanillin
2 Sinapic acid
3 Ferulic acid
4 Caffeic acid
5 p-Coumaric acid
6 Gallic acid
7 3,4-dihydroxybenzoic acid
SI p-anisic acid

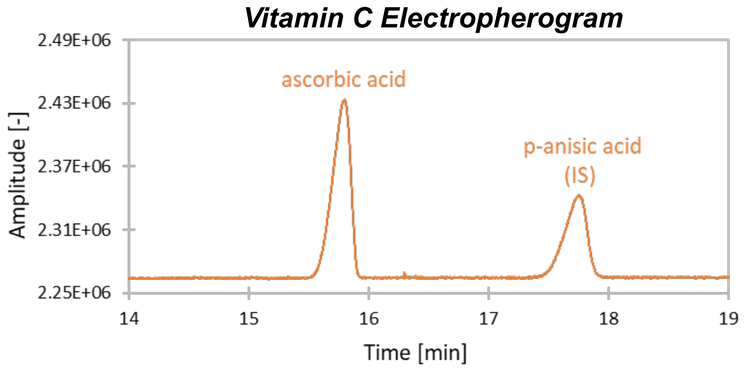
**Conditions :** BGE bicarbonate 100 mM pH 7.3, 20 kV, hydrodynamic injection (50 mbar, 8 s), direct UV detection (255 nm)

**Calibration results:**

| analytes | Migration time absolute [min] | RSD (n=5) [%] | relative [-] | RSD (n=5) [%] | Area acid/IS $R^2$ | Linearity | Recovery [%] |
|---|---|---|---|---|---|---|---|
| 1 | 4.25 ± 0.05 | 1.7 | 0.63 ± 0.01 | 1.8 | 0.9994 | | 104.2 |
| 2 | 5.15 ± 0.17 | 2.6 | 0.77 ± 0.01 | 1.3 | 0.9989 | | 105.1 |
| 3 | 5.50 ± 0.20 | 3.5 | 0.82 ± 0.01 | 1.1 | 0.9986 | | 103.7 |
| 4 | 5.81 ± 0.21 | 3.1 | 0.87 ± 0.01 | 2.2 | 0.9991 | | 104.0 |
| 5 | 5.98 ± 0.21 | 2.9 | 0.90 ± 0.01 | 0.9 | 0.9990 | | 102.9 |
| 6 | 6.18 ± 0.23 | 3.4 | 0.93 ± 0.01 | 2.0 | 0.9993 | | 98.0 |
| 7 | 6.39 ± 0.25 | 2.3 | 0.96 ± 0.01 | 2.3 | 0.9987 | | 104.7 |

### Direct UV detection and positive polarity :

***Vitamin C Electropherogram***



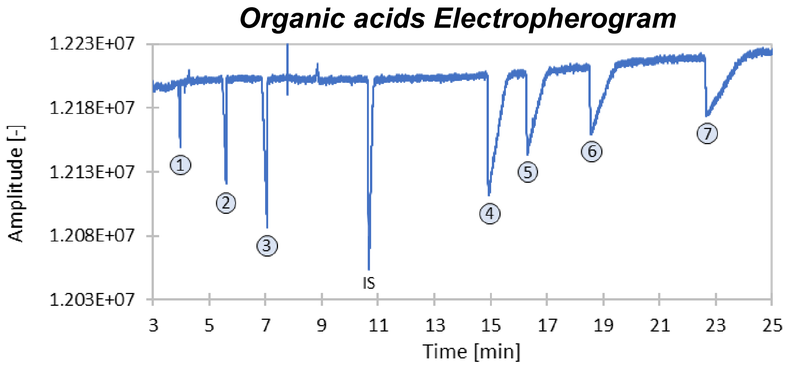

**Conditions :** BGE phosphate 50 mM pH 8.5, 10 kV, hydrodynamic injection (50 mbar, 8 s), direct UV detection (255 nm)

| | Migration time absolute [min] | RSD (n=5) [%] | relative [-] | Area acid/IS RSD (n=5) [%] | Linearity $R^2$ | Recovery [%] |
|---|---|---|---|---|---|---|
| Ascorbic acid | 16.01 ± 0.91 | 5.5 | 0.89 ± 0.01 | 3.4 | 0.9980 | 102.5 |

### Indirect UV detection and reversed polarity :

Increased analysis time
Peak asymmetry
Loss of sensitivity

***Organic acids Electropherogram***

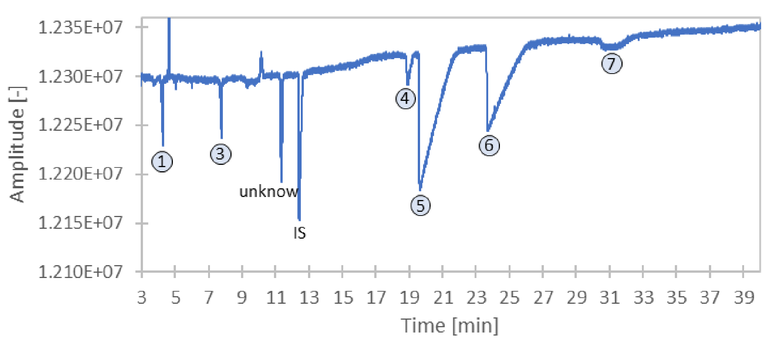



1 Gluconic acid
2 Lactic acid
3 Acetic acid
4 Succinic acid
5 Malic acid
6 Tartaric acid
7 Citric acid
IS Glutaric acid

**Conditions :** BGE PDC (2,6-pyridinedicarboxylique acid) 15 mM pH 8.8, 20 kV, hydrodynamic injection (50 mbar, 8 s), indirect UV detection (255 nm)

| analytes | Migration time absolute [min] | RSD (n=5) [%] | relative [-] | Area acid/IS RSD (n=5) [%] | Linearity $R^2$ | Recovery [%] |
|---|---|---|---|---|---|---|
| 1 | 3.96 ± 0.12 | 3.0 | 0.37 ± 0.01 | 4.6 | 0.9978 | 103.7 |
| 2 | 5.56 ± 0.15 | 2.7 | 0.52 ± 0.01 | 2.2 | 0.9949 | 101.1 |
| 3 | 7.01 ± 0.26 | 3.7 | 0.66 ± 0.01 | 3.3 | 0.9937 | 95.4 |
| 4 | 14.94 ± 0.42 | 2.8 | 1.40 ± 0.01 | 1.9 | 0.9940 | 101.0 |
| 5 | 16.33 ± 0.49 | 3.0 | 1.53 ± 0.01 | 1.4 | 0.9963 | 101.3 |
| 6 | 18.57 ± 0.61 | 3.3 | 1.74 ± 0.02 | 5.7 | 0.9923 | 109.7 |
| 7 | 22.68 ± 0.69 | 3.0 | 2.12 ± 0.02 | 5.1 | 0.9925 | 109.7 |

***Grape juice Electropherogram***




**Conditions :** BGE PDC (2,6-pyridinedicarboxylique acid) 15 mM pH 8.8, 20 kV, hydrodynamic injection (50 mbar, 8 s), indirect UV detection (255 nm)

## CONCLUSION

Three different methods were used to detect fifteen analytes. The quantification of vitamin C and phenolic compounds using direct UV detection and positive polarity, and the determination of organic acids using indirect UV detection and reverse polarity. A method described in the literature as having negative polarity has been shown to work on the school's ECBs, which have positive polarity, despite a significant increase in analysis time and peak asymmetry. Indirect UV detection has also been tested and works, but with a loss of sensitivity. To ensure that the right analyte is quantified in the samples, it would be interesting to develop HPLC methods that could eliminate potential matrix effects. This step would have been potentially feasible without the numerous technical problems encountered with OpenCE, which resulted in a considerable loss of time. In the future it would be useful to modify OpenCE by adding the possibility to work with negative polarity and add code allowing data processing directly on the device. In addition, the Raspberry screen failure must also be resolved by modifying its code.

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