Fast detection of apple juice adulteration by parallel chromatography and chemometric data analysis

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INTRODUCTION

Apple juice is a nutritious beverage commonly consumed for its refreshing attributes, taste, flavor, nutritional properties and health benefits; being rich in carbohydrates, minerals, vitamins and many other phytonutrients, it contributes to a good health status, while playing an important role in a wholesome diet [Landon, 2007; Eisele and Drake, 2005]. Unfortunately, the temptation for a fast economic gain can lead to food frauds, such adulterations; for juices, adulteration is accomplished usually by practices such as dilution with water, using cheaper ingredients (mainly different combinations of sugar solutions and syrups), addition of peel and/ or pulp wash [Fidelis et al, 2017].

Research objective: to provide a method for fast detection of apple juices' adulteration based on parallel chromatography, followed by chemometric data analysis.

MATERIALS & METHODS

Commercial apple juices were obtained from the local supermarkets; after dilution 1/ 10 (v/v) with ultrapure water and filtration through 0.45 μm Millipore membrane filters, chromatographic analyses were performed on a hybrid Shimadzu system, consisting of two Prominence LC-20AP solvent delivery modules, a Prominence DGU 20As online degasser, an automatic sample injector SIL-10AF, an RID-10A differential refractive index detector, a CDD-10Avp dual channel conductivity detector, a Prominence CTO-20A column oven, an FCV-10AH2 valve unit and a Prominence CBM-20A system controller. Isocratic separations were conducted at 40^0C, using a Universal Cation 7u column for cation analysis, while carbohydrates were separated using an EC 250/4 Nucleodur 100–5 NH_2 RP column; the external standard method was used for quantification. Two genuine apple juices were obtained from Starkinson and Red-Star apples using a centrifugal juice-extractor; after homogenization, the freshly-made juices were processed as mentioned before. The external standard method was used for quantification, all the samples being analyzed in triplicates; recoveries were established by spiking several samples with known concentrations of analytes. Instrument control, data acquisition and data analysis were accomplished by „LCsolution" software. Multivariate data analysis was completed on autoscaled chromatographic data using Matlab (The Mathworks Inc., USA).

RESULTS

• The proposed configuration delivered simultaneously the concentrations of sodium, potassium, calcium, magnesium, fructose, glucose and saccharose (figure 1) .
• Principal component analysis of the data matrix using seven variables (the concentrations of fructose, glucose, saccharose, potassium, sodium, magnesium and calcium) lead to a model with three principal components (PC), from which the first two describe the maximum variances: PC1- 47.16% and PC2-19.18% (figure 2), highlighting four classes of apple juices:

- juices sweetened with saccharose (P1, P2, A3, A4) –green stars;
- juices sweetened with glucose-fructose syrup (H1, H2, R3, R4, A5, A6, P7, P8) – blue squares;
- unsweetened apple juices (the biggest cluster, which contains also the genuine, laboratory-extracted juices) – red triangles;
- adulterated apple juices (P3, P4, R11, R12) – light blue crosses.

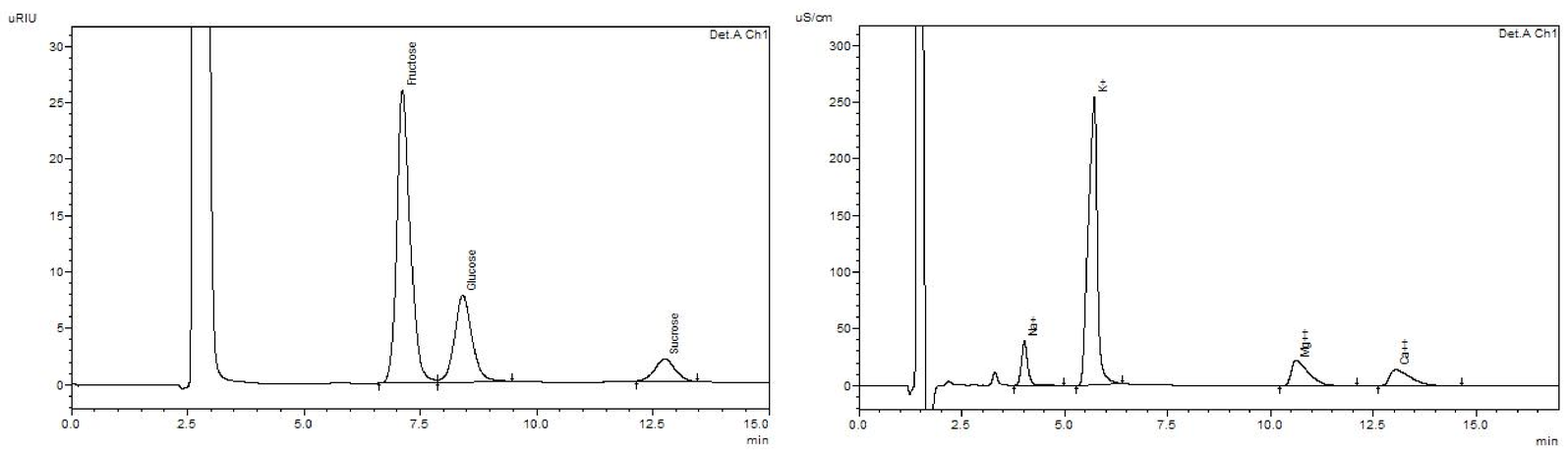

Figure 1. Representative chromatograms for genuine apple juices

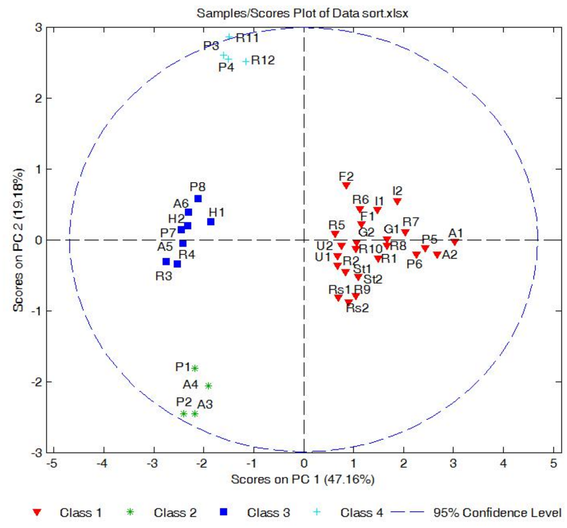

Figure 2. Scores' plot obtained for the seven variables' variables model

CONCLUSION

Parallel chromatographic analysis in conjunction with multivariate data analysis proved to be appropriate complimentary tools in discriminating between sweetened and non-sweetened apple juices, between genuine and adulterated products - with minimal sample workup, separations being achieved in less than 20 minutes.

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