Application of Liquid Chromatography / Mass Spectrometry to the Analysis of Sugars and Sugar-Alcohol

Application

Food

Author

Hiroki Kumaguai

Abstract

Sugars and sugar alcohols were successfully analyzed by liquid chromatography / mass spectrometry using atmospheric pressure chemical ionization in negative ion mode.

Background

Sugars, quantitatively the largest organic compound group on earth, are widely distributed among both flora and fauna. Higher classes of vegetation and algae contain large quantities of sugars, and the shells of arthropods, represented by crabs and shrimp, are made of chitin, which are polysaccharides.

Although sugars represent a huge biomass; they also exist in very small amounts within individual living organisms. Various kinds of sugars and compound sugars are involved in bodily functions, and as sources of energy. Sugars are used as raw materials within the textile, food processing and pharmaceutical industries.

Sugars have been analyzed by various methods:

- Gas chromatorgraphy/mass spectrometry (GC/MS) methods require preliminary derivatization to increase sugar's volatility.
- High-performance liquid chromatography (HPLC) methods have limitations, including detector sensitivity. Commonly, one of two different detectors is used.
  - differential refraction detector
  - ultraviolet (UV)/fluorescence detector, following application of pre- or post-column derivatization; without derivatization, sugars are not UV detectable
- Liquid chromatography/mass spectrometry (LC/MS) methods using electrospray ionization (ESI) also require pre- or post-column derivatization to obtain a high level of sensitivity.
- LC/MS method, described here, using atmospheric pressure chemical ionization (APCI) does not require pre- or post-column derivatization to attain high sensitivity. However, this method does require $CHCl_3$ and CH_2Cl_2 to be added in the post-column stage.

Methods using derivatization are the most sensitive, with a minimum detectability of several to tens of picograms (pg). Although the APCI method, employing post-column addition, has a lower sensitivity (several hundred picograms), it is an easy and versatile method of analysis, with superior ionization repeatability, generated by the $[M+Cl]^-$ ion.

Method

- Instrument: HP 1100[1] LC/MS with APCI
  Negative ion mode
  Drying gas: N_2 13 L/min and 350 °C
  Nebulizer: N_2 40 psi
  Fragmentor: 20 V
  Corona current: 30 µA
  Mass range: 100–500 *m/z*
  Mode: SIM (*m/z*) negative

  Sorbitol 217, 219
  Glucose, Fructose 215, 217
  Xylitol 187, 189
  Sucrose 377, 379
- LC Conditions:
  Mobile phase: CH_3CN/H_2O (75/25) at 0.2 mL/min
  Oven temperature: 40 °C
  Injection volume: 10 µL
  Post-column addition: $CH_3CN/CHCl_3$ (50/50) at 0.2 mL/min
- Column: Asahipak NH_2-50 2D, 2.0 mm id × 150 mm long

[1]Now available as the Agilent 1100 LC / MS from Agilent Technologies, Inc.

Sample Analysis

Selected sugars and sugar alcohols in some standards and common beverages were measured using this LC/MS method with APCI in negative ion mode. The three figures below illustrate both the sensitivity and applicability of this method.

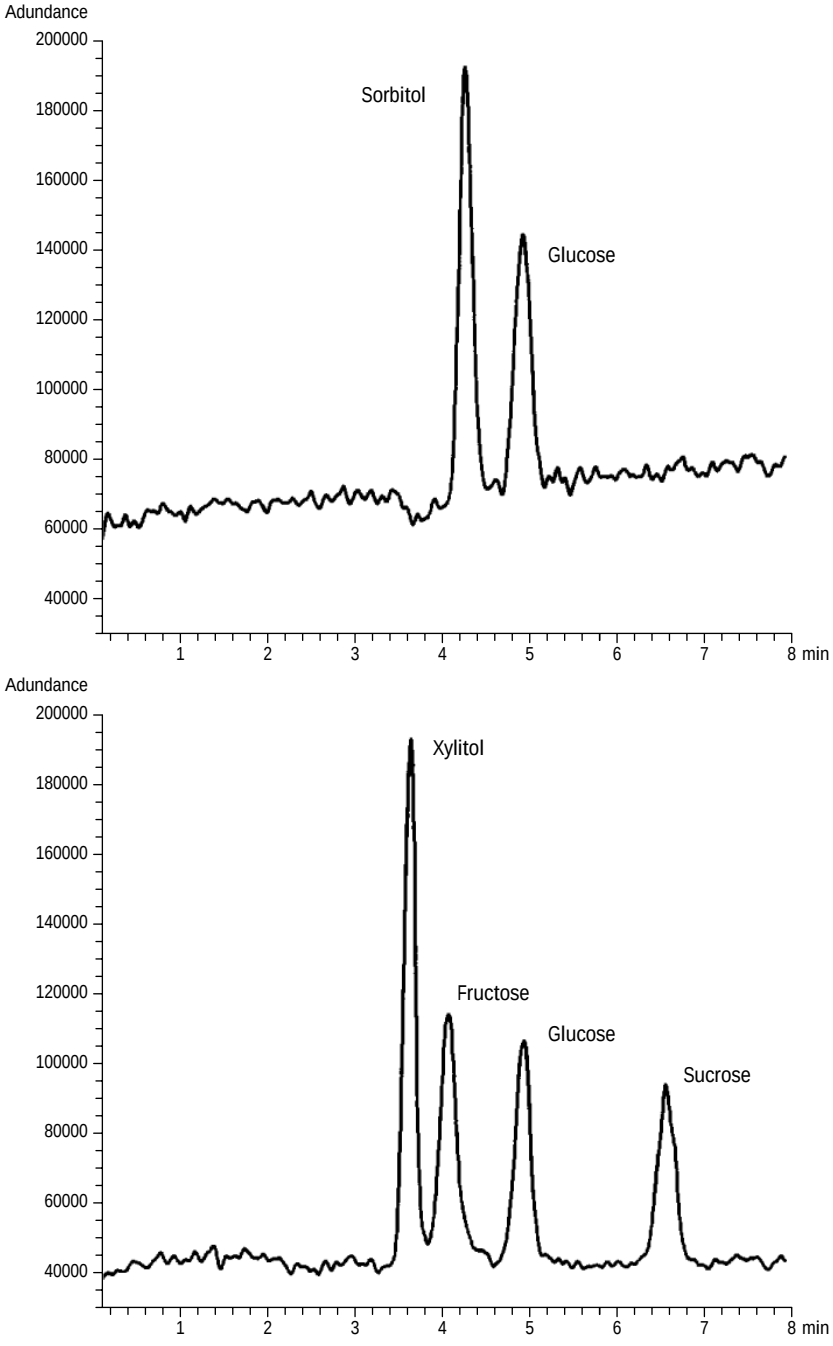

Figure 1. Stacked SIM chromatograms of sugar standards at 1 µg / mL each.

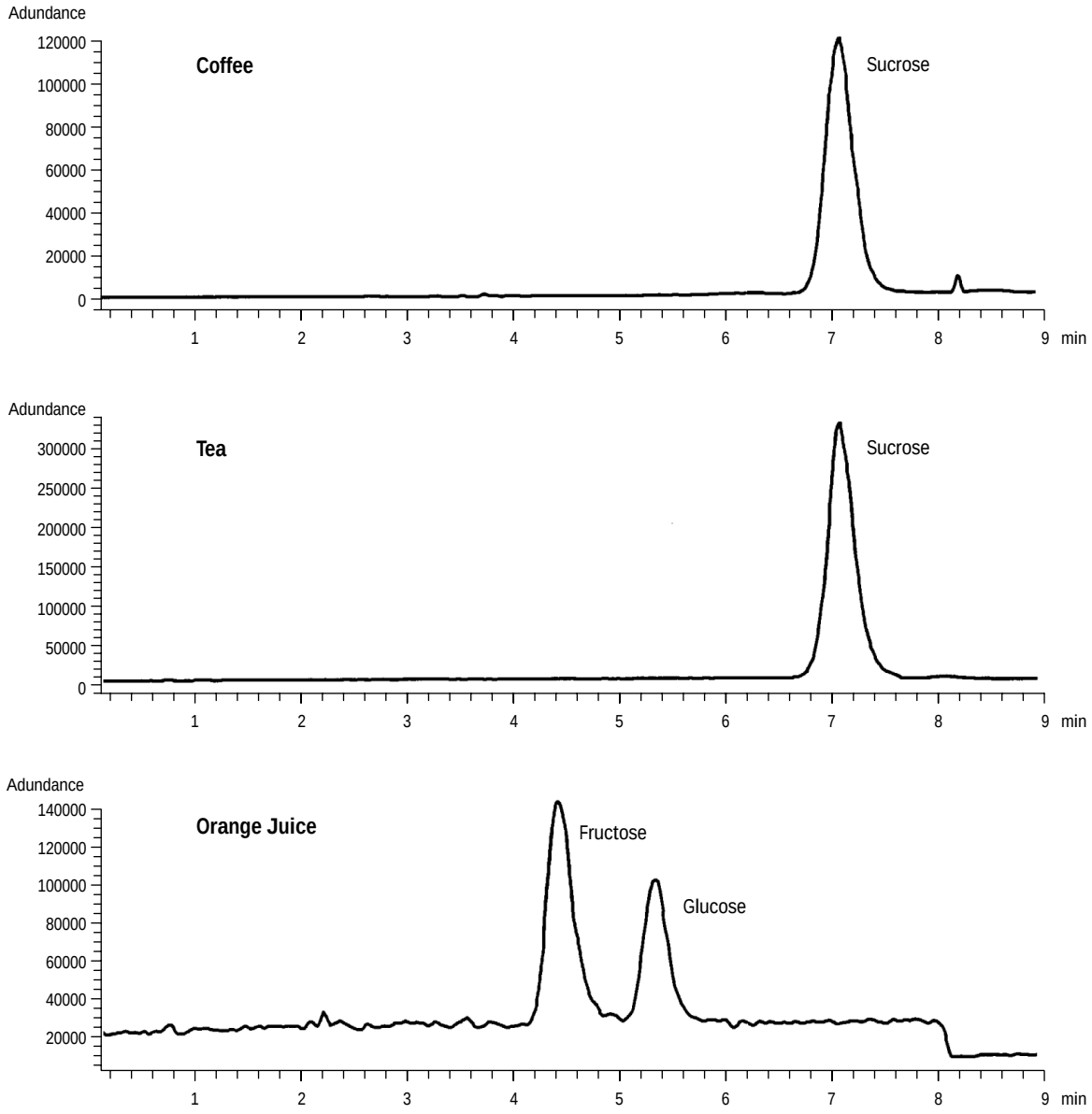

Figure 2. Stacked SIM chromatograms for typical sugars in three common beverages.

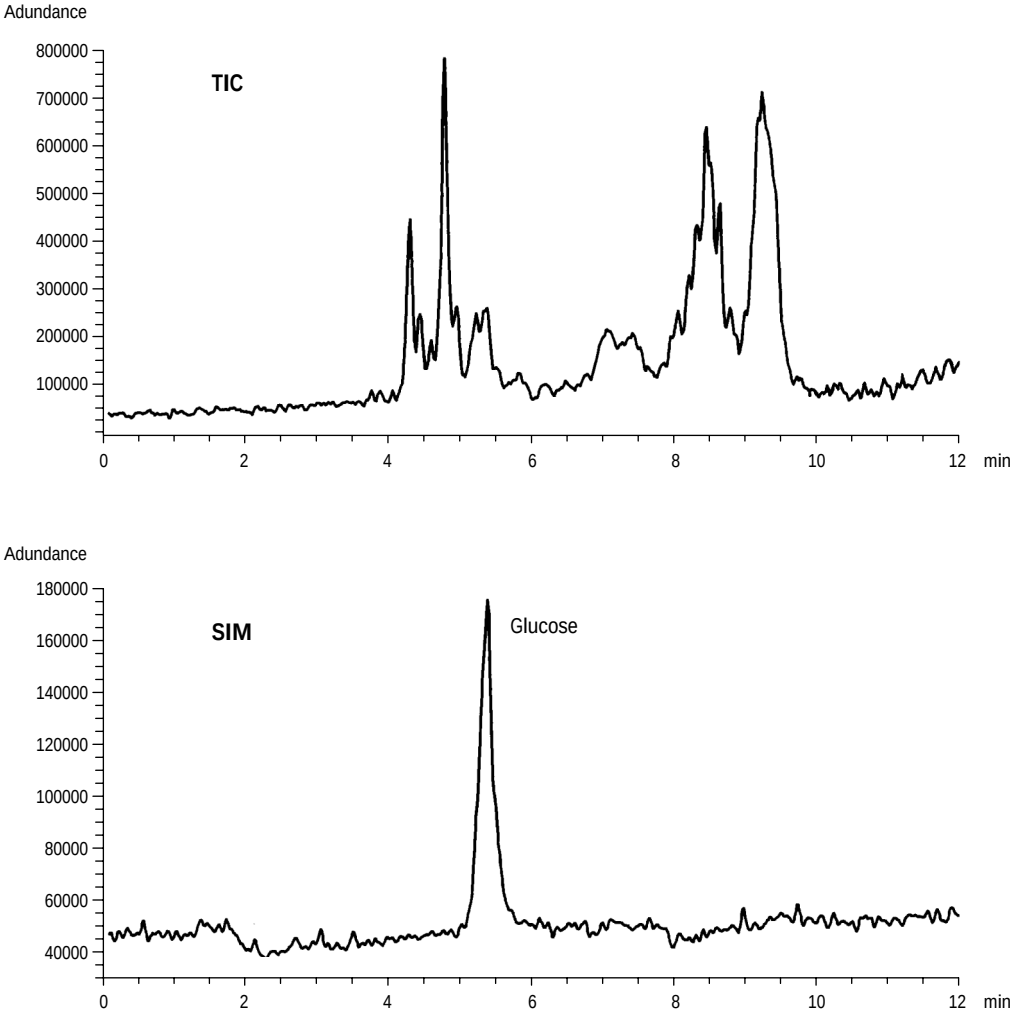

Figure 3. Stacked TIC and SIM chromatograms for Sake (Japanese rice wine).

Conclusion

Underivatized sugars and sugar alcohols can be successfully analyzed by LC/MS using atmospheric pressure chemical ionization (APCI) in negative ion mode.

Hiroki Kumagai is an application chemist at Agilent/Yokogawa Analytical Systems, Tokyo, Japan.

www.agilent.com/chem

Printed in the USA
October 4, 2001
5988-4236EN

Agilent Technologies