Detecting 'sugar-free' in foods and beverages

More than three thousand legal chemicals are used as additives to food and beverages. These include the various sugars and sugar alcohols. Of course these added sugars are supplementary to those occurring naturally within foods and beverages.

Cecil Instruments' electrochemical detector.

For various reasons, including genetics, some persons need to avoid some or all sugars. This may be due to serious allergies or intolerances. Lactose and galactose are sugars which respectively, are of particular interest in intolerance and serious allergic situations. And of course, the maintenance of blood glucose levels in diabetics is paramount.

Consequently the use of food products with reduced or zero sugar levels is of interest for the food and beverage industry.

Chocolate and confectionary for diabetic people is of particular interest to consumers who need to monitor their blood glucose levels.

Lactose intolerance has stimulated the development of a large number of products of dairy origin which are pre-treated by techniques including enzymatic, chromatographic, ultrafiltration, centrifugation and hydrolysis to remove lactose.

There is also a growth in soya, rice, almond, soy protein isolate and coconut milk type of beverages and foods which would naturally contain trace amounts of lactose and its monosaccharide galactose.

These dairy origin and alternative milk beverages have triggered the debate of the definition of 'lactose free'. Some schools of thought state that for an infant formula milk, a lactose content of less than or equal to 1000 ppm may be considered to be lactose free. Others state that no lactose or galactose should be present. Hence there is a need for laboratories to measure and certify the concentration of lactose, galactose, glucose and other sugars and sugar alcohols, at extremely high sensitivities.

Within laboratories dedicated to production/processing environments, accurate, highly sensitive, fast, reproducible, reliable and specific measurements of sugars and sugar alcohols are required for samples in a variety of matrices, particularly those involving fats and oils.

Several analytical methods may be considered. Gravimetric and Infra-Red spectrophotometric methods are not specific for the various sugars and sugar alcohols. Enzymatic methods where the final results are measured with UV/Visible spectrophotometry have sensitivities of around 100 ppm. These methods often require much sample pre-treatment.

Capillary electrophoresis with electrochemical detection does produce higher sensitivities of around 100 ppb and can be specfic. However, this technique and its instrumentation is not as common as High-Performance Liquid Chromatography (HPLC).

HPLC can produce accurate, fast, reproducible, reliable, and sensitive detection of specific sugars and sugar alcohols without too much sample pre-treatment. The choice of HPLC detector is important; the limit of quantitation of refractive index detection for sugars is around 100 ppm and therefore does not provide sufficient sensitivity for these 'sugar free' analyses.

HPLC with pulsed electrochemical detection will provide the higher of sensitivities of less than 100 ppb. Here the sugars and sugar alcohols are ionized at high pH levels so that they may be oxidized at a gold electrode.

A Cecil Instruments' electrochemical detection HPLC system may be used in the determination of sugars and sugar alcohols. This particular commercial system includes a pulsing electrochemical detector, isocratic pump and chromatography control and acquisition software.

Experimental

A 100 ppb standard solution of sugars and sugar alcohols was prepared in 200 mM sodium hydroxide.

This solution was injected onto a Cecil Adept HPLC system, under the conditions listed in the following table:

Column:	*Hamilton RCX-30, 250 x 4.6 mm.*
Mobile Phase:	*200 mM sodium hydroxide.*
Flow Rate:	*2.0 mL/min.*
Detection:	*Pulsed Electrochemical. Gold working electrode, 316 stainless steel auxiliary electrode, palladium-hydrogen reference electrode.*
Detector Gain	*2*
Detector range	*2,000 nA*
Pulse Waveform:	
0 to 150 ms (oxidation)	*+750 mV.*
150 to 300 ms (reduction)	*-800 mV.*
300 to 1,000 ms (stabilisation and measure)	*+530 m.*
Measure time (time constant)	*100 ms.*
Detector Temperature:	*30 °C.*
Column Temperature:	*30 °C.*
Injection Volume:	*10 µL*
Run Time:	*20 minutes.*

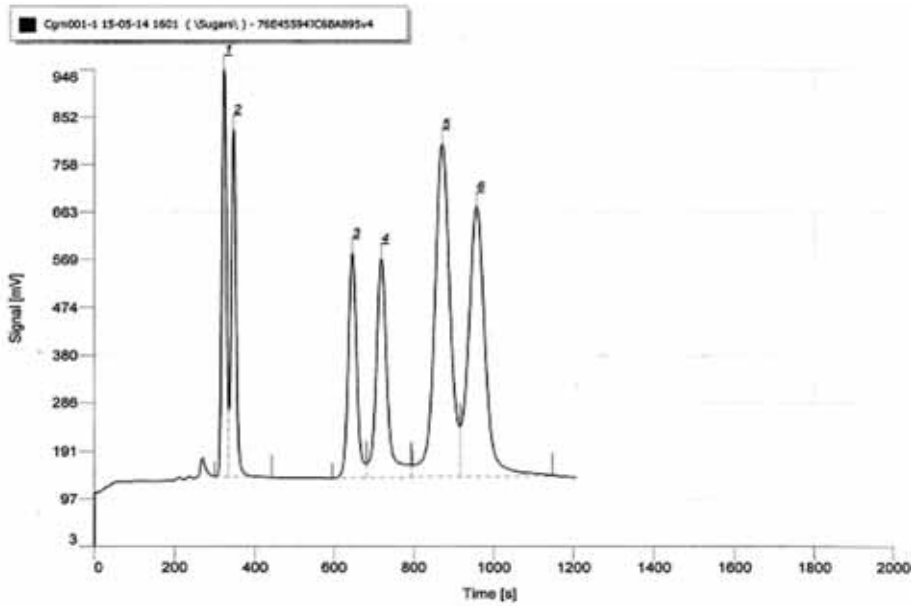
The resulting chromatograms of standards showed fairly good separation of each analyte, which may be further improved with some method development work.

Hence we demonstrate the suitability of a commercial HPLC system for the analysis of 100 ppb concentrations of sugars and sugar alcohols. Depending on the types of sample pre-treatment concentrations, even higher degrees of sensitivity may be achieved.

The authors

Ade Kujore and Terence Duley
Cecil Instruments Limited
Milton Technical Centre,
Cambridge CB24 6AZ
UK

Email: info@cecilinstruments.com
Tel. +44 (0) 1223 420821
www.cecilinstruments.com



No.	Peak Name	Ret. Time [s]	Start Time [s]	End Time [s]	Area [mVs]	Height [mV]
001	D-Sorbitol	322.2	298.2	334.0	10323.3	805.3
002	D-Mannitol	345.2	334.0	441.0	9658.5	686.6
003	D-Glucose	645.2	594.8	679.8	10881.6	443.8
004	D-Fructose	718.0	679.8	793.0	13883.9	432.5
005	D-Sucrose	871.0	796.6	914.8	29515.3	658.7
006	D-Lactose	957.0	914.8	1147.8	25777.8	533.0

Chromatogram, of a 100 ppb standard solution of some sugars and sugar alcohols.

Calendar of events

October 13-16, 2015
Euro Food Chem XVIII
Madrid, Spain
www.ictan.csic.es/en/eurofoodchem2015

October 27-29, 2015
Gulfood Manufacturing
Dubai World Trade Centre (DWTC)
www.gulfoodmanufacturing.com

November 2-4, 2015
MENOPE 2015
Dubai, UAE
www.naturalproductme.com

November 3-6, 2015
RAFA (7th Int'l symp on recent advances in food analysis)
Prague, Czech Republic
www.rafa2015.eu

November 10-12, 2015
BrauBeviale
Nuremberg, Germany
www.braubeviale.de/en

November 17-19, 2015
Food Matters Live
London, UK
www.foodmatterslive.com

December 1-3, 2015
Fi Europe & Ni 2015
Paris, France
www.figlobal.com/fieurope

Jan 31-Feb 3, 2016
ISM 2016 & Pro sweets
Cologne, Germany
www.ism-cologne.com
www.prosweets-cologne.com

March 6-10, 2016
Pittcon
Atlanta, GA, USA
www.pittcon.org

April 26-28, 2016
Seafood Expo Global & Seafood Processing Global
Brussels, Belgium
www.seafoodexpo.com/global

May 10-12, 2016
Vitafoods Europe
Geneva, Switzerland
www.vitafoods.eu.com

July 16-19, 2016
IFT
Chicago, IL, USA
www.ift.org

For more events see www.fei-online.com/events/

Dates and descriptions of future events have been obtained from usually reliable official industrial sources. FEI can not be held responsible for errors, changes or cancellations.