PRODUCT SPECIFICATION 73347

Dionex CarboPac PA1 columns for Dual EGC mode

Improved reproducibility and accuracy for general carbohydrate analysis

Benefits

- Predictable, high-resolution, separation of monosaccharides and disaccharides using electrolytically generated potassium methanesulfonate and potassium hydroxide
- Rugged all-purpose column to determine monosaccharides and disaccharides in a variety of matrices
- Column chemistry approved for use in a variety of official methods for the analysis of foods (AOAC Methods 995.13, 996.04, 997.08, 2000.11, 2000.17, and 2001.02)

The Thermo Scientific™ Dionex™ CarboPac™ PA1 column is a specialized anion-exchange column designed to be used with high performance anion exchange chromatography with pulsed amperometric detection (HPAE-PAD) to deliver high resolution separations of monosaccharides, disaccharides, and some oligosaccharides. The resin consist of 10 µm diameter nonporous beads covered with a fine latex of functionalized Thermo Scientific™ Dionex™ MicroBead™ resin. This pellicular resin structure permits excellent mass transfer, resulting in high resolution chromatography and rapid re-equilibration. The Dionex CarboPac PA1 1 mm column is recommended for Dual Eluent Generation Cartridge (Dual EGC) mode applications using a Thermo Scientific™ Dionex™ ICS-6000 HPIC™ System.

Predictable, high-resolution, isocratic and gradient separation of carbohydrates

The Dionex CarboPac PA1 columns are designed primarily for isocratic determinations of monosaccharides, disaccharides, and short chain linear polysaccharides. Using the Dual EGC mode allows for predictable, high-resolution separations of monosaccharides, disaccharides and some oligosaccharides using electrolytically generated potassium methanesulfonate and potassium hydroxide with a combined concentration of up to 200 mM.

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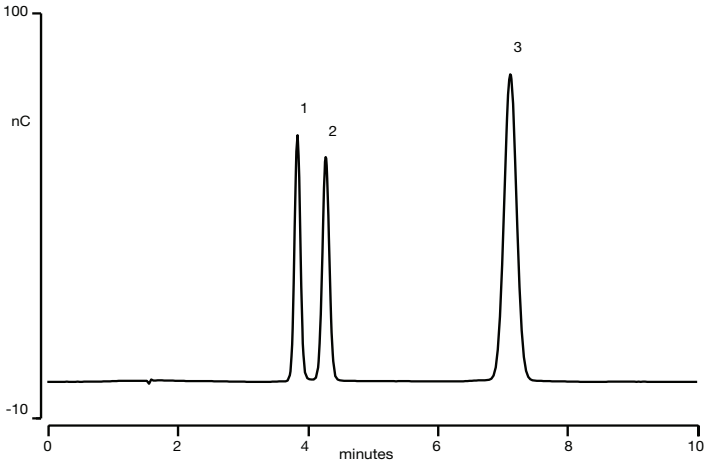
Monosaccharide analysis

The Dionex CarboPac PA1 1 mm column can be used to separate and quantify mono-saccharides in various matrices. Figure 1 shows the separation of glucose, fructose and sucrose. The method uses no MSA but a higher concentration of potassium hydroxide. Dual EGC mode allows for the use of electrolytically generated potassium methane sulfonate and potassium hydroxide gradients with a combined concentration up to 200 mM. Regular EG allows for a maximum eluent concentration of 100 mM. The capability to run higher eluent concentrations can be of a significant benefit for the separation of groups of analytes that require a step or gradient elutions. Retention of carbohydrates can be varied with eluent concentration, in some cases changing the elution order as the eluent concentration increases.

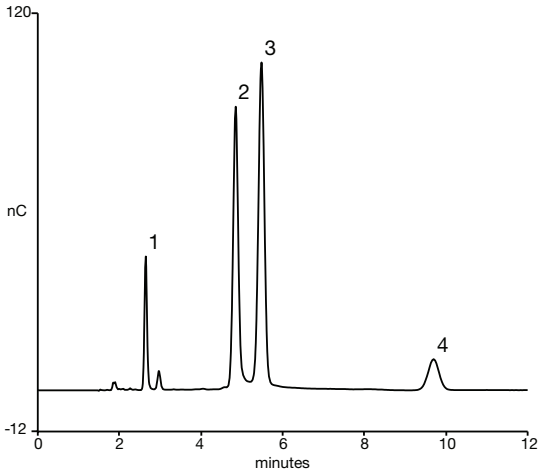


Column:	Dionex CarboPac PA1 1 mm analytical/guard column
Eluent:	200 mM KOH/0 mM MSA
Eluent source:	Dionex EGC 400 KOH cartridges
Flow rate:	0.063 mL/min
Inj. volume:	0.4 µL
Gasket:	1 mil
Temperature:	30 ˚C
Detection:	Integrated amperometry, quadruple pulse waveform
Working electrode:	PTFE gold, disposable electrode
Reference electrode:	Ag/AgCl

Peaks:	nmoles/mL
1. Glucose	55
2. Fructose	83
3. Sucrose	146

Separation of monosaccharides standards using the Dionex CarboPac PA1 1 mm column

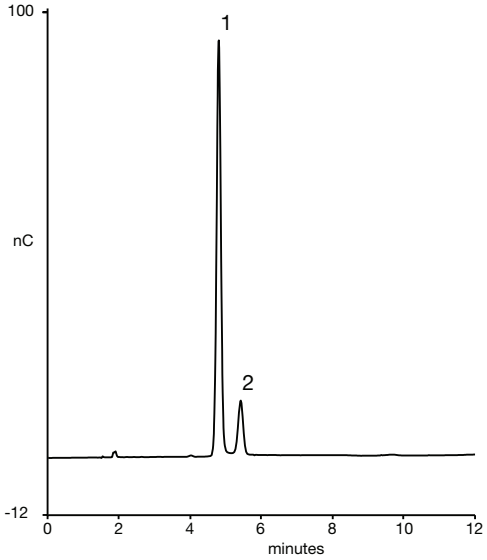
A.



Column:	Dionex CarboPac PA1 1 mm analytical/guard column
Eluent:	150 mM KOH/0 mM MSA
Eluent source:	Dionex EGC 400 KOH cartridge
Flow rate:	0.063 mL/min
Inj. volume:	0.4 µL
Gasket:	1 mil
Temperature:	30 ˚C
Detection:	Integrated amperometry, quadruple pulse waveform
Working electrode:	PTFE gold, disposable electrode
Reference electrode:	Ag/AgCl
Sample:	Juice sample 1:1000 dilution in DI water 0.45 µm filtered

Peaks:	nmoles
1. Sorbitol	0.14
2. Glucose	0.56
3. Fructose	1.07
4. Sucrose	0.12

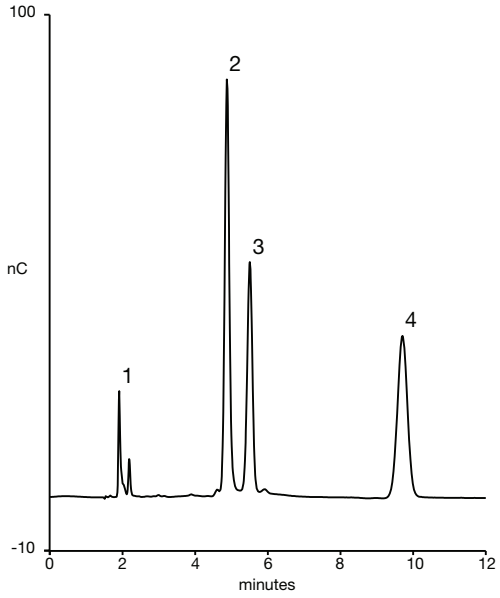
B.



Column:	Dionex CarboPac PA1 1 mm analytical/guard column
Eluent:	150 mM KOH/0 mM MSA
Eluent source:	Dionex EGC 400 KOH cartridge
Flow rate:	0.063 mL/min
Inj. volume:	0.4 µL
Gasket:	1 mil
Temperature:	30 ˚C
Detection:	Integrated amperometry, quadruple pulse waveform
Working electrode:	PTFE gold, disposable electrode
Reference electrode:	Ag/AgCl
Sample:	Juice sample 1:1000 dilution in DI water 0.45 µm filtered

Peaks:	nmoles
1. Glucose	0.68
2. Fructose	0.15

C.



Column:	Dionex CarboPac PA1 1 mm analytical/guard column
Eluent:	150 mM KOH/0 mM MSA
Eluent source:	Dionex EGC 400 KOH cartridge
Flow rate:	0.063 mL/min
Inj. volume:	0.4 µL
Gasket:	1 mil
Temperature:	30 ˚C
Detection:	Integrated amperometry, quadruple pulse waveform
Working electrode:	PTFE gold, disposable electrode
Reference electrode:	Ag/AgCl
Sample:	Juice sample 1:1000 dilution in DI water 0.45 µm filtered

Peaks:	nmoles
1. Glycerol	0.12
2. Glucose	0.53
3. Fructose	0.46
4. Sucrose	0.43

Figure 2. Separation of sugars in fruit juices (A) apple juice, (B) cranberry juice, and (C) orange juice using the Dionex CarboPac PA1 1 mm column

Analysis of common sugars from fruit juices

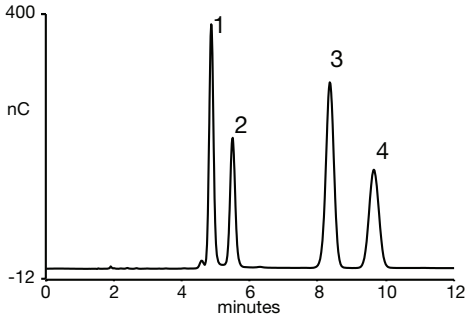
The Dionex CarboPac PA1, 1mm column does an excellent job for the determination of common sugars in various fruit juice samples as demonstrated in Figures 2A, B, and C using PAD. Note that each juice sample was diluted a thousand-fold with deionized water to avoid overloading the column and/or the detector.

Like in Figure 1, all the separations in Figure 2 and Figure 3 use no MSA, but 150 mM potassium hydroxide. Dual EGC mode allows for the use of electrolytically generated potassium methane sulfonate and potassium hydroxide gradients with a combined concentration up to 200 mM, regular EG allows for a maximum eluent concentration on 100 mM.

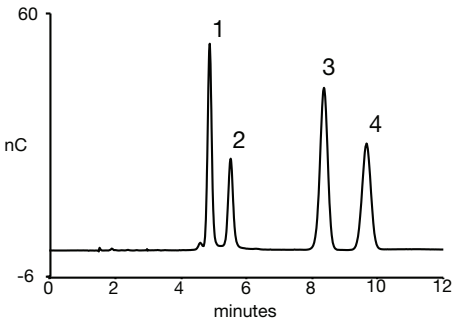
Official methods using the Dionex CarboPac PA1 column

The Dionex CarboPac PA1 column has been approved for use in a number of official methods, including ISO/DIS 11292 for coffee authenticity, International Committee of Uniform Methods of Sugar Analysis (ICUMSA) for sugars in molasses, and AOAC Methods 996.04 and 2000.11. Figure 3 shows an example of an isocratic method to determine sugars in molasses using a Dionex CarboPac PA1 1 mm column with a Dual EGC mode system.

A.



B.



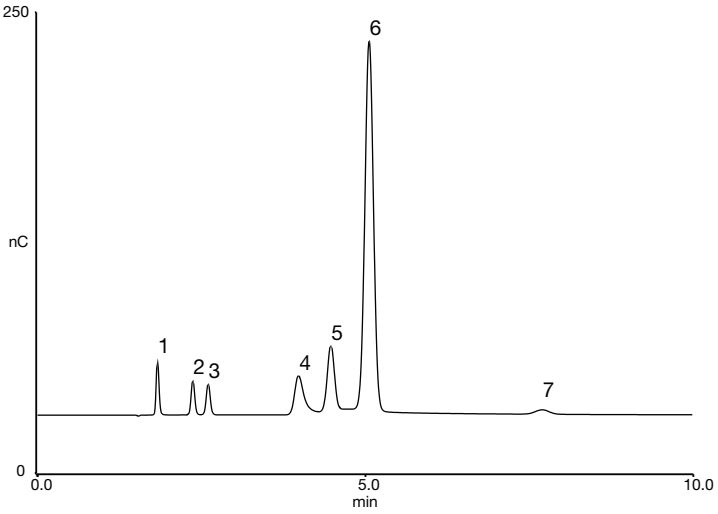
Column:	Dionex CarboPac PA1 1 mm analytical/guard column
Eluent:	150 mM KOH/0 mM MSA
Eluent source:	Dionex EGC 400 KOH cartridge
Flow rate:	0.063 mL/min
Inj. volume:	0.4 µL
Gasket:	1 mil
Temperature:	30 ˚C
Detection:	Integrated amperometry, quadruple pulse waveform
Working electrode:	PTFE gold, disposable electrode
Reference electrode:	Ag/AgCl
Sample:	Molasses sample A: 1:1000 dilution in DI water B: 1:10,000 dilution in DI water

Peaks:	nmoles injected*	
	1:1000	1:10,000
1. Glucose	2.37	0.31
2. Fructose	2.10	0.23
3. Lactose**	2.97	0.42
4. Sucrose	2.06	0.33

- 1:1000 dil not as accurate due to overloading of column
- 1:10,000 dil most accurate

*Internal standard

Figure 3. Separation of sugars in molasses using the Dionex CarboPac PA1 1 mm column



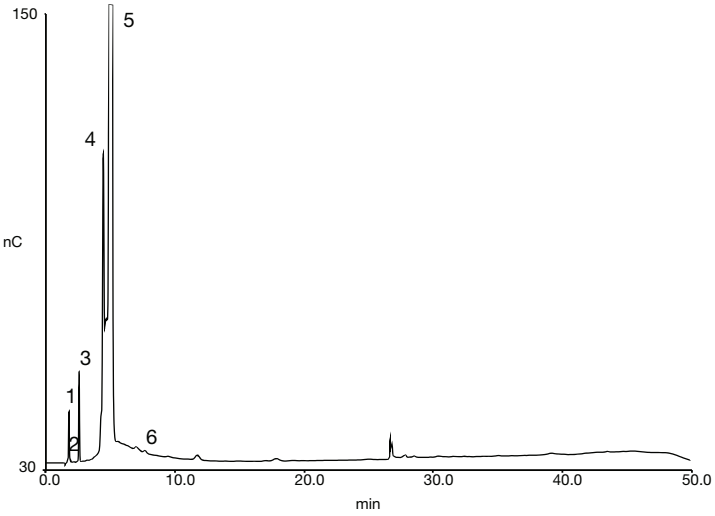
Column:	Dionex CarboPac PA1 1mm analytical/guard column
Eluent:	150 mM KOH/0 mM MSA
Eluent source:	Dionex EGC 400 KOH cartridge
Flow rate:	0.063 mL/min
Inj. volume:	0.4 µL
Gasket:	1 mil
Temperature:	30 °C
Detection:	Integrated amperometry, quadruple pulse waveform
Working electrode:	PTFE gold, disposable electrode
Reference electrode:	Ag/AgCl
Sample:	Agave syrup standard

Peaks:	mg/L
1. Inositol	2.5
2. Sorbitol	2.5
3. Mannitol	2.5
4. HMF*	10.0
5. Glucose	10.0
6. Fructose	100.0
7. Sucrose	2.5

*Hydroxymethylfurfural

Gradient: 0-6 min: 3 mM MSA/102 mM KOH
6-12 min: 14 mM MSA/108 mM KOH

Figure 4. Separation of sugars in an agave syrup standard using a Dionex CarboPac PA1 1 mm column with Dual EGC mode



Column:	Dionex CarboPac PA1 1 mm analytical/guard column
Eluent source:	Dionex Dual EGC 400 MSA/400 KOH cartridge
Flow rate:	0.063 mL/min
Inj. volume:	0.4 µL
Gasket:	1 mil
Temperature:	30 °C
Detection:	Integrated amperometry, quadruple pulse waveform
Working electrode:	PTFE gold, disposable electrode
Reference electrode:	Ag/AgCl
Sample:	Agave syrup sample 1:1000 dilution in DI water 0.45 µm filtered

Peaks:	g/100g
1. Inositol	0.107
2. Sorbitol	0.002
3. Mannitol	0.244
4. HMF	ND
5. Glucose	1.26
6. Fructose	ND

Gradient: 0-6 min: 3.00 mM MSA/102.00 mM KOH
6-12 min: 14.00 mM MSA/108.00 mM KOH
12-30 min: 70.00 mM MSA/130 mM KOH
30-40 min: 100 mM MSA/100 mM KOH
40.1 min: 3.00 mM MSA/102.00 mM KOH
40.1-70 min: 3.00 mM MSA/102.00 mM KOH

Figure 5. Separation of sugars in agave syrup using a Dionex CarboPac PA1 1 mm column with Dual EGC mode

Figures 4 and 5 show the separation of sugars in agave syrup. Agave syrup is a recent food product from Mexico, produced from the sap of the agave plant. This product has gained popularity as an alternative to traditional sweeteners, such as table sugar and honey, partially due to its low glycemic index. Excellent reproducibility was obtained using the Dionex CarboPac PA1 1 mm column for this analysis.

Exceptional performance

The Dionex CarboPac PA1 column is a specialized anion-exchange column designed to be used with PAD to deliver high resolution separations of mono-, di- and many oligosaccharides. The resin consist of 10 µm diameter nonporous beads covered with a fine latex of functionalized Thermo Scientific™ Dionex™ MicroBead™ resin. This pellicular resin structure permits excellent mass transfer, resulting in high resolution chromatography and rapid re-equilibration. The resulting polymer has a pH tolerance range from 0-14, and is compatible with <2% common organic solvents.

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Specifications	
Resin composition	10 µm diameter substrate (polystyrene 2% crosslinked with divinylbenzene) agglomerated with 500-nm MicroBead quaternary ammonium functionalized latex (5% crosslinked)
Anion exchange capacity	1 x 250 mm: 6.25 µeq per column 1 x 50 mm:1.25 µeq per column
pH range	0–14
Temperature limits	4–60 °C
Organic solvent limits	<2% compatible
Typical eluents	Potassium hydroxide, potassium methanesulfonate
Recommended flow rate	0.063 mL/min
Maximum pressure	5000 psi

Ordering information

Description	Part Number
Dionex CarboPac PA1 1 mm Analytical Column (1 x 250 mm)	303272
Dionex CarboPac PA1 1 mm Guard Column (1 x 50 mm)	303273
Thermo Scientific™ Dionex™ EGC 400 KOH Eluent Generator Cartridge	302766
Thermo Scientific™ Dionex™ EGC 400 MSA Eluent Generator	302767
Thermo Scientific™ Dionex™ Gold on PTFE Disposable Electrode for 1 mm and Capillary Applications (6 pack)	303397

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