Carbohydrate Fingerprinting as Applied to Pear Juice and its Authenticity

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Food Authenticity

- Food adulteration is a serious worldwide issue that can have significant negative economic and health effects that impact both consumers and producers
- Due to its high carbohydrate content pear juice is susceptible to adulteration by the addition of less expensive nutritive sweeteners
- Therefore the main goal of this research was to develop a method to detect the debasing of pear juice employing capillary gas chromatography with flame ionization detection (CGC-FID)

Materials & Methods

- 30 pure pear juice concentrates representing five processing regions (Argentina; Chile; China; New Zealand; United States) and three years of production (2012-14) were used to develop a representative database
- A CGC-FID method was developed to detect the fingerprint profiles of pear juice and potential adulterants
  - High fructose corn syrup (HFCS 55 and 90)
  - Hydrolyzed inulin syrup (HIS)
  - Total invert sugar (TIS)

Major Carbohydrates/Sorbitol

Table 1. Major carbohydrate and sorbitol concentrations of the pure pear juice database and the select commercial sweeteners at 12.0 °Brix.

	Fructose (g/100mL)	**Glucose** (g/100mL)	**Sucrose** (g/100mL)	**Sorbitol** (g/100mL)	**F/G Ratio[a]**
Pear Juice: Mean Range	5.85 ± 0.37[b] 5.26 – 6.86	1.79 ± 0.33 1.03 – 2.50	0.59 ± 0.29 0.19 – 1.45	2.51 ± 0.24 1.73 – 2.98	3.5 ± 1.1 2.3 – 6.7
HFCS 55	7.26 ± 0.05	4.07 ± 0.02	ND[c]	ND	1.9
HFCS 90	10.99 ± 0.08	0.81 ± 0.01	ND	ND	13.5
HIS	8.21 ± 0.05	2.54 ± 0.19	ND	ND	3.2
TIS	5.16 ± 0.05	5.58 ± 0.05	1.29 ± 0.01	ND	0.9
PJ + 40% HIS	**6.44**	**2.41**	**0.37**	**1.79**	**2.7**

[a]Fructose to glucose ratio. [b]± Standard deviation. [c]ND: Not detected

High Fructose Corn Syrup (HFCS)

- Oligosaccharides are carbohydrates comprised of 2 to 10 monosaccharide units
- The addition of HFCS to pear juice can be detected by the presence of α- and β-isomaltose
- Detection limits:
  - HFCS 55: 1.0%
  - HFCS 90: 2.0%

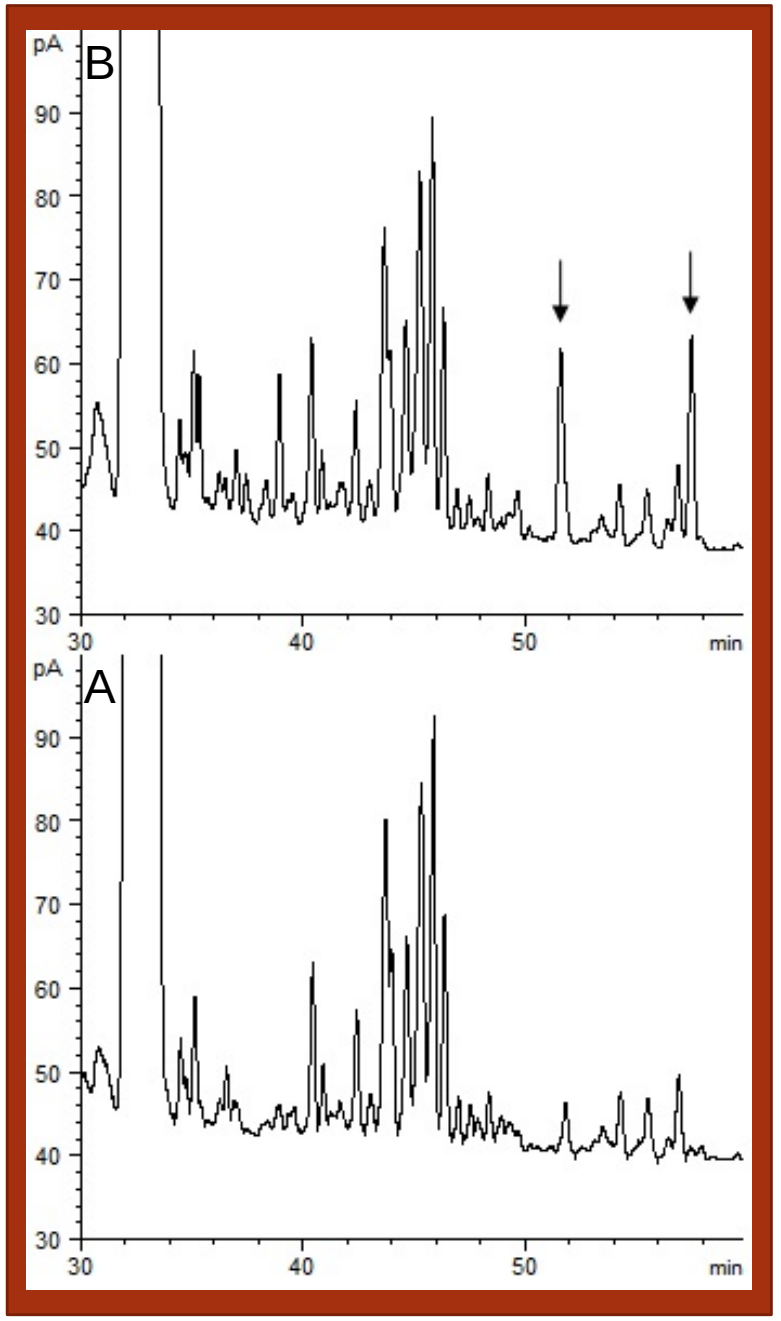

Figure 1. CGC-FID chromatogram of pure pear juice (A) and the same pear juice adulterated with 5.0% (v/v) HFCS 55 (B).

Total Invert Sugar (TIS)

- Invert sugar is produced by the treatment of sucrose with acid or invertase
- Detection limit: 3.0%

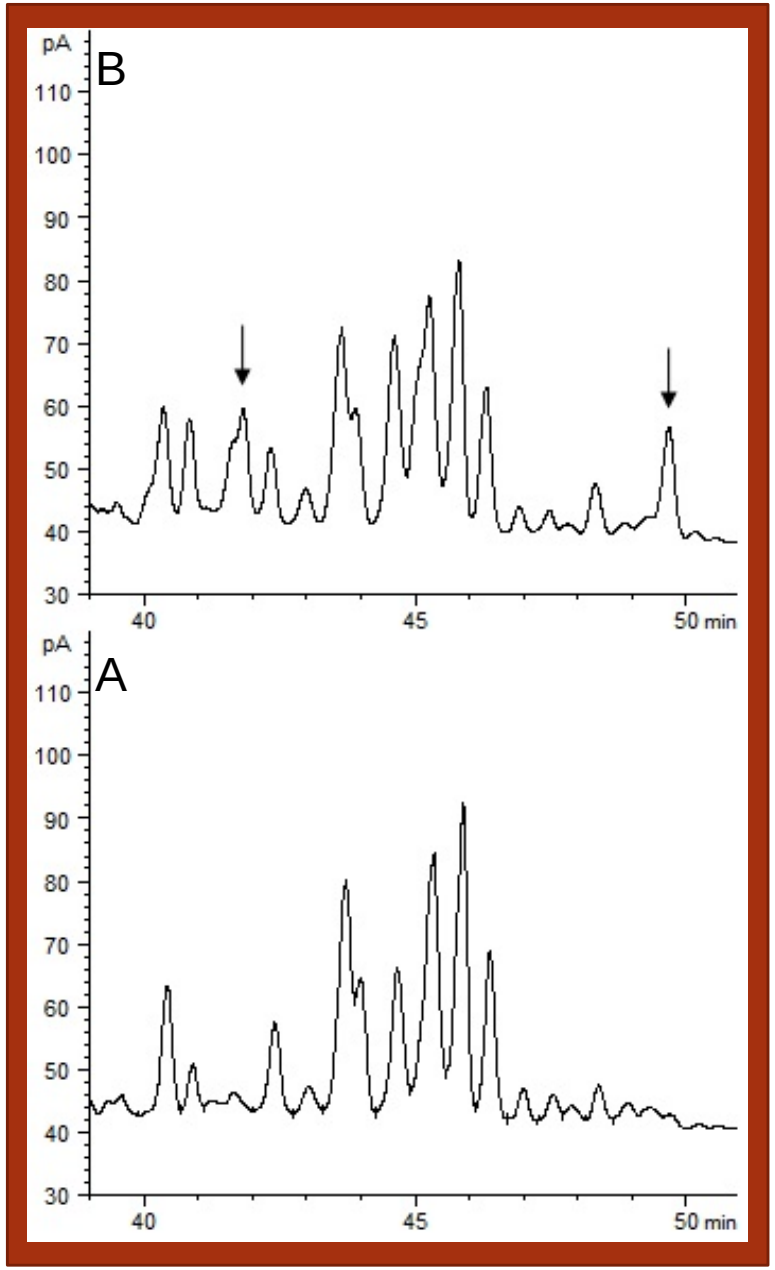

Figure 2. CGC-FID chromatogram of pure pear juice (A) and the same pear juice adulterated with 10.0% (v/v) TIS (B).

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Hydrolyzed Inulin Syrup (HIS)

- Due to its fructose-to-glucose ratio HIS is an ideal adulterant for pear juice
- However HIS contains high concentrations of fingerprint compounds making its detection possible at very low levels
  - Tentatively identified as inulobiose (O-β-D-fructofuranosyl-(2→1)-D-fructose)
- Detection limit: 0.5%

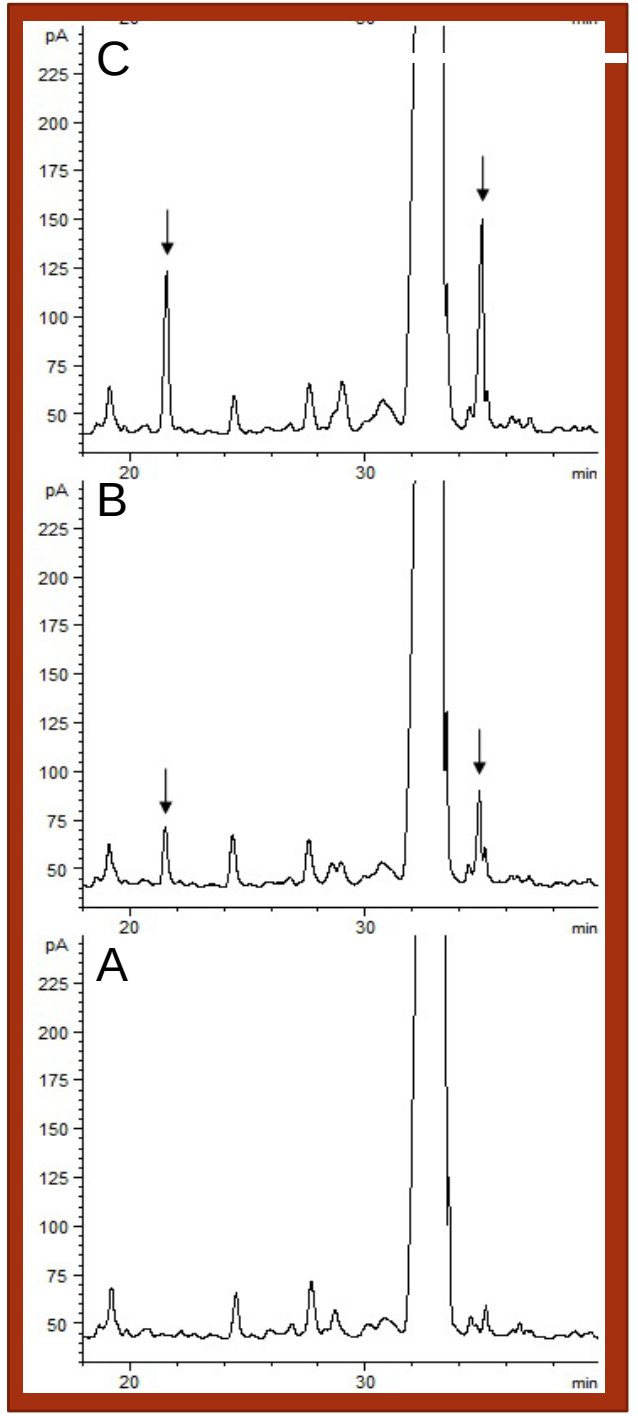
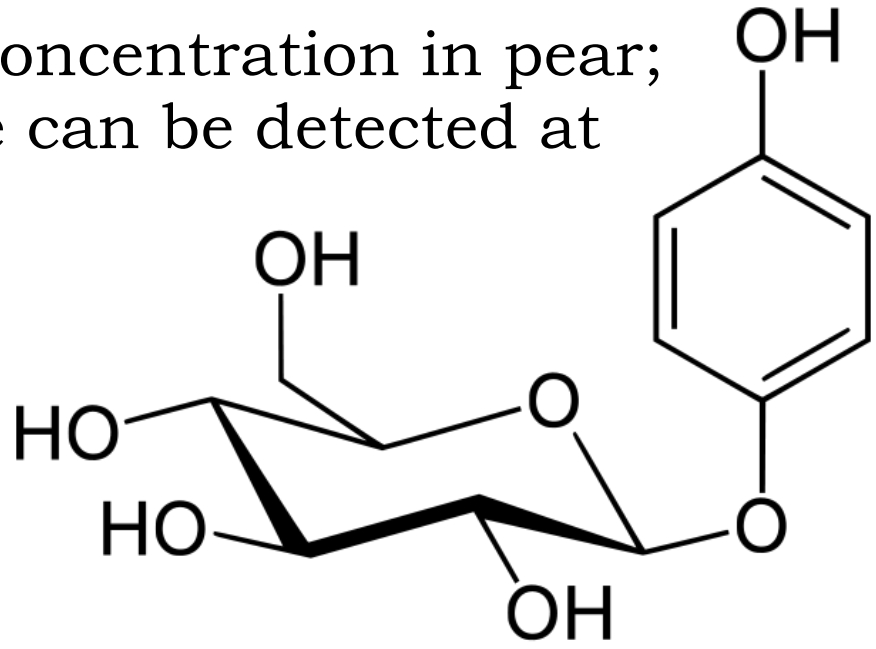


Figure 3. CGC-FID chromatogram of pure pear juice (A) and the same pear juice adulterated with 2.0% (B) and 5.0% (v/v) HIS (C).

Juice-to-Juice Adulteration

- Arbutin (4-hydroxyphenyl-β-D-glucopyranoside) has been identified as a natural constituent of pear juice not found in apple
  - Concentration: 50.6 to 286.9 µL/mL; Average of 79.9 µL/mL
- Based upon the lowest arbutin concentration in pear; pear juice addition to apple juice can be detected at levels down to 3.0% (v/v)



Thavarajah, P.; Low, N. H. *J. Agric. Food Chem.* **2006**, 54, 4861-4867.

Process Adulteration

- Complete liquefaction is a method of juice production which is illegal in North America and the European Union
  - Mash is treated with cellulases and excess pectinases resulting in increased soluble solids and a lower final juice quality
- Cellobiose (O-β-D-glucopyranosyl-(1→4)-D-glucopyranose) has been reported to be present in juices produced by liquefaction

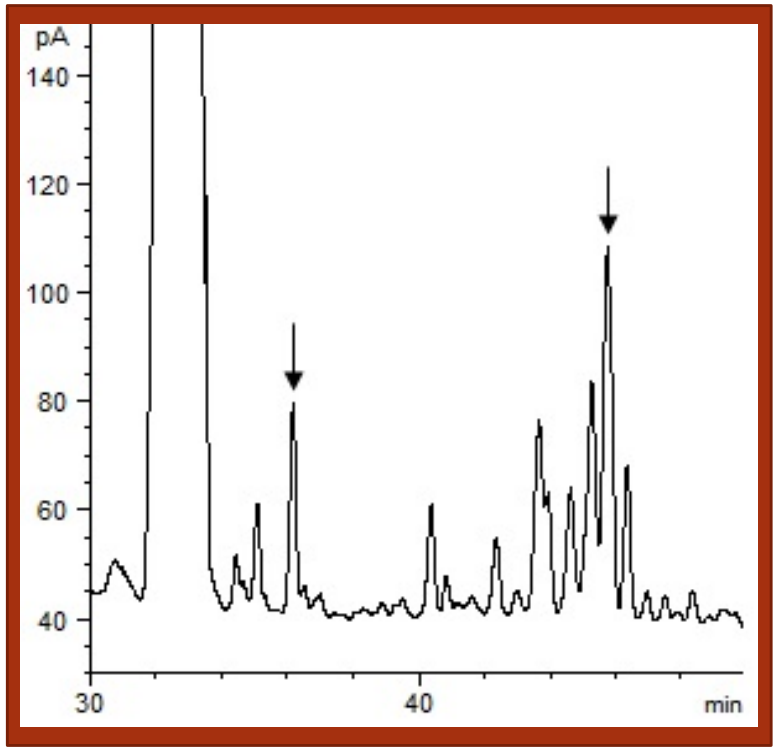


Figure 4. CGC-FID chromatogram of pear juice plus 50.0 ppm cellobiose. The cellobiose peaks are indicated by arrows.

Conclusions

- A method was developed to detect the adulteration of pear juice with less expensive commercial sweeteners employing CGC-FID
  - Detection limits ranged from: 0.5 to 3.0%
- The developed method can also be used to detect the addition of pear to apple juice and to detect if a juice had been produced using complete liquefaction

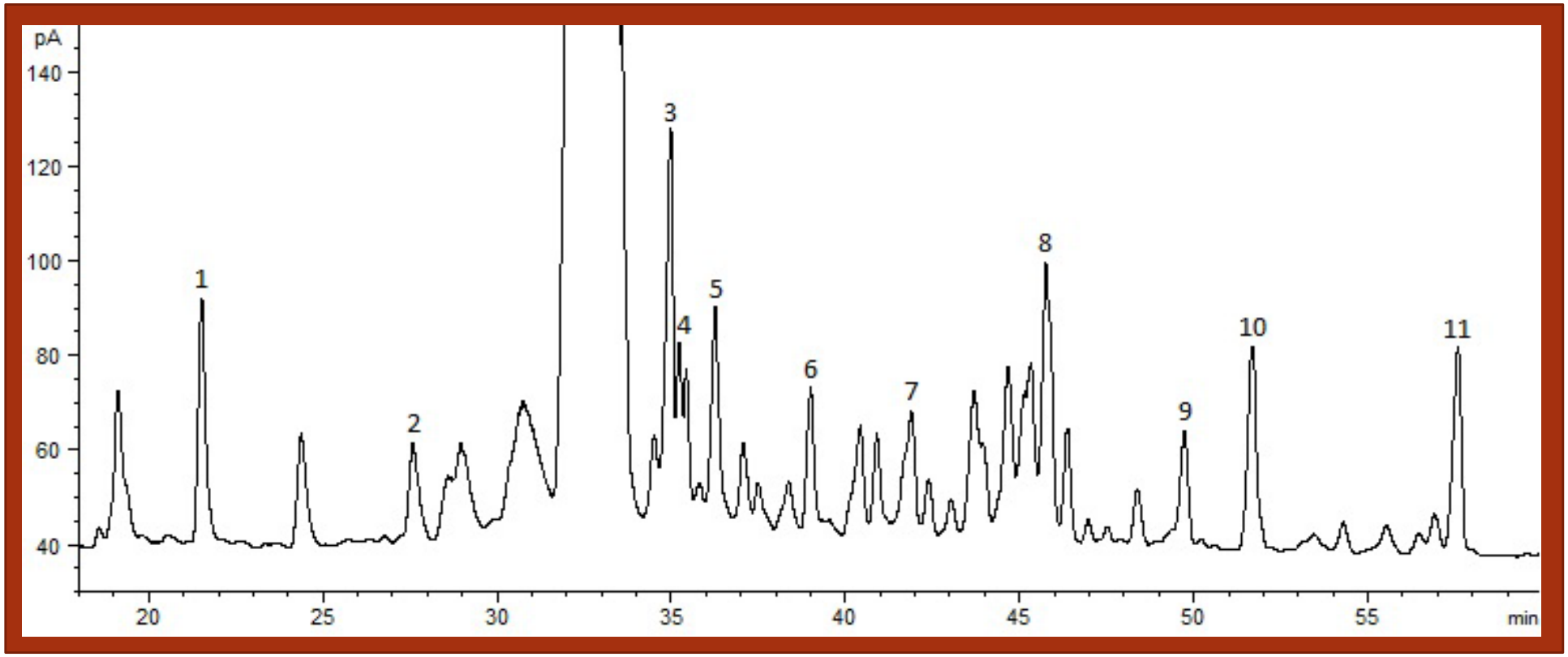


Figure 5. Pear juice plus HFCS 55, HIS, TIS and cellobiose. The marker peaks are as follows: 1 = HIS marker; 2 = Abrutin; 3 = HIS marker; 4 = α-maltose; 5 = α-cellobiose; 6 = β-maltose; 7 = TIS marker; 8 = β-cellobiose; 9 = TIS marker; 10 = α-isomaltose; 11 = β-isomaltose.

Thank You