INTERNATIONAL JOURNAL OF CURRENT RESEARCH IN CHEMISTRY AND PHARMACEUTICAL SCIENCES
(p-ISSN: 2348-5213: e-ISSN: 2348-5221)
www.ijcrcps.com
DOI:10.22192/ijcrcps Coden: IJCROO(USA) Volume 3, Issue 11 - 2016

Research Article

DOI: http://dx.doi.org/10.22192/ijcrcps.2016.03.11.002

Study on detection methods for sorbitol

Liyun Yuan, Xiaodong Dong*

College of Medicine, Hebei University, Baoding 071000, China

*Corresponding Author: xddong@hbu.edu.cn

Abstract

Sorbitol has been applied as sweetener in “sugar free” food products intended for diabetics for many years. It is also applied as starting material for Vitamin C synthesis. Furthermore, sorbitol is one of polyols commonly used in the treatment of patients with oliguric renal failure. However, more accumulation of sorbitol in tissues has been suspected as one of the causative factors of diabetic complications. Thus, the establishment of a simple and rapid method for the determination of sorbitol with high selectivity and sensitivity is of great significance to efficient quality control of foods and pharmaceuticals and people’s health. In this article the studies of detection methods for sorbitol in recent years are reviewed.

Keywords: sorbitol; determination; detection; sensor.

1. Introduction

Sorbitol is a six carbon sugar alcohol formed from the reduction of glucose. It can be formed naturally in a variety of fruits such as apples, peaches, pears, and plums, and also be produced synthetically from corn syrup. It is a nutritive sweetener frequently used to replace sucrose, which is widely used in the confectionery industry in sugar-free chewing gum and tablets, fruit preserves, baked goods, and frozen desserts [1-3]. Nowadays, despite the major contribution of synthetic sweeteners such as aspartame, sorbitol is still frequently applied in all kinds of food products. Furthermore, sorbitol is also one of polyols commonly used in the treatment of patients with oliguric renal failure. Administered as a hypertonic infusion solution, it enhances distal tubule delivery of Na^+ and water, and results in increased urine formation, which exhibits diuretic effect [4-6]. However, more accumulation of sorbitol in tissues has been suspected as one of the causative factors of diabetic complications [7-9]. In order to assure quality and safety of food and pharmaceutical applications, and maintain the health of the mankind, the simple, rapid and sensitive determination of sorbitol is of great importance. In this paper, the attributes of different analytical technique for the determination of sorbitol in recent years are reviewed.

2. Analytical Methods

2.1. HPLC method. High-performance liquid chromatography (HPLC) is a powerful tool that enables the separation of complex mixtures into individual components, and is a highly sensitive and reproducible analytical technique. In recent years, HPLC has been combined with many sensitive detection techniques and has experienced continuous improvement of stationary phases, which have improved its sensitivity and specificity. HPLC is currently widely used for the analysis of drugs and dosage forms with respect to quality control, quantitative determination of active ingredients and impurities, monitoring drug blood concentration in patients, and bioequivalence assessment [10-12].

Filip *et al.* [13] developed and validated a HPLC method with refractive index detection for simultaneous determination of glucose, fructose, sucrose and sorbitol in leaf and/or apple peel samples from nine apple

cultivars and rootstocks, originating from a germplasm collection. They applied Box–Behnken design of response surface methodology for the method optimization. The Carbosep Coregel 87H3 column was used, and the mobile phase was 0.005 mol L^{-1} H_2SO_4 solution with flow rate of 0.3 mL min^{-1} and column temperature of 35℃. The limits of detection were 2.67–4.83 μg mL^{-1} and the recovery was 93.94–103.06%.

Grembecka *et al.* [14] reported a simple, sensitive and accurate method for simultaneous determination of glucose, fructose, sucrose, maltose, erythritol, mannitol, maltitol, sorbitol and xylitol by HPLC coupled to corona charged aerosol detector for the first time. The method was elaborated using a Shodex Asahipak, NH2P-50 4E, column packed with 5 μm shell particles and acetonitrile–water gradient mobile phase at 25 °C. The method showed wide concentration range and good accuracy. Limits of detection for nine analytes were in the range of 0.12–0.44 μg ml^{-1}, respectively. The results obtained for real samples illustrated the ability of the proposed method to quantify a range of sugars and sugar alcohols in a single analysis, making it appropriate for food analysis.

2.2. Capillary electrophoresis method. In recent decades, capillary electrophoresis (CE) has been developed for trace analysis because of its small sample size of only nanoliters to femtoliters, short analysis time, and biocompatible environments. In addition, rapid separations are feasible with CE because high voltages can be applied to short capillaries and separation efficiency is not dependent on column length. To identify biological and pharmaceutical analysis, CE is coupled to a variety of detectors, including fluorescence, mass spectrometry, and electrochemical detection [15,16].

Pospisilova *et al.* [17] applied capillary zone electrophoresis with indirect UV detection at 215 nm for the separation and determination of mannitol, sorbitol and xylitol in the form of anionic borate–polyol complexes. The separation was carried out in a fused silica capillary at 25 kV. The optimized background electrolyte was 200 mM borate buffer containing 10 mM 3-nitrobenzoate as the chromogenic co-ion. The rectilinear calibration range was 0.2–2 mg mL^{-1} for mannitol and sorbitol when using xylitol as the internal standard, and the limit of detection was 30μg mL^{-1} for either analyte. The method was used for the assay of mannitol or sorbitol in pharmaceutical infusion solutions. The results were in good agreement with those of pharmacopoeial iodimetric titration.

Bai *et al.* [18] developed a miniaturized CE with electrochemical detection system for the separation and determination of xylitol and sorbitol in three commercial sugar-free gums. They examined and optimized the factors influencing the separation and detection processes. These two analytes have been separated within 10 min at a separation voltage of 4 kV in 70 mmol/L NaOH running buffer. Linear response was obtained at the range of 5.0×10^{-5} – 1.0×10^{-2} mol/L and 5.0×10^{-5} – 5.0×10^{-2} mol/L with the detection limits of 5.0×10^{-6} mol/L and 2.5×10^{-6} mol/L for xylitol and sorbitol, respectively. The proposed method was successfully applied to determine the gum samples with the RSD and average recoveries of 3.7%, 4.5% and 98.1%, 91.1% for xylitol and sorbitol, respectively.

2.3. Other methods. In addition to these main approaches mentioned above for sorbitol detection, still a few special techniques with high sensitivity have been applied. Butler *et al.* [19] developed an analytical protocol for the sensitive determination of mannitol, sorbitol and glucose containing powders in pharmaceutical workplaces by ion chromatography using a pulsed amperometric detector. De Castro *et al.* [20] proposed the direct determination of sorbitol and sodium glutamate by attenuated total reflectance Fourier transform infrared spectroscopy in the thermostabilizer employed in the production of yellow-fever vaccine. Liang *et al.* [21] developed a rapid method for the quantitative determination of endogenous sorbitol and fructose in human erythrocytes by atmospheric-pressure chemical ionization LC tandem mass spectrometry.

3. Conclusions

Sorbitol is commonly used in various matrices including food, biological samples and pharmaceuticals. Especially, the accumulation of sorbitol in the tissue is known to cause microvascular diabetic complications. To accurately assess the effectiveness of various formulations containing sorbitol and ensure the health of the body, the quantitative determination of sorbitol is essential. [22,23]. This review has highlighted the significant developments in rapid and alternative techniques for the detection of sorbitol in recent years. We believe the development of sorbitol sensors with better sensitivity and specificity, lower cost, simplicity, along with in vivo analytical technique is still the future effort.

Acknowledgments

The work was supported by the Hebei Provincial Natural Science Foundation of China (No. B2015201161), Medical Engineering Cross Foundation of Hebei University (No. BM201108) and Training Programs of Innovation and Entrepreneurship for Undergraduates of Hebei University (No. 2016061).

References

[1] Ma CM, Sun Z, Chen CB, Zhang LL, Zhu SH. Simultaneous separation and determination of fructose, sorbitol, glucose and sucrose in fruits by HPLC-ELSD, Food Chem 2014; 145:784–788.

[2] Sim HJ, Jeong JS, Kwon HJ, Kang TH, Park HM, Lee YM *et al*. HPLC with pulsed amperometric detection for sorbitol as a biomarker for diabetic neuropathy, J Chromatogr B 2009; 877(14-15):1607-1611.

[3] Gessei T, Arakawa T, Kudo H, Mitsubayashi K. A fiber-optic sorbitol biosensor based on NADH fluorescence detection toward rapid diagnosis of diabetic complications, Analyst 2015; 140(18):6335-6342.

[4] Umeda M, Otsuka Y, Ii T, Matsuura T, Shibati H, Ota H *et al*. Determination of D-sorbitol in human erythrocytes by an enzymatic fluorometric method with an improved deproteinization procedure, Ann Clin Biochem 2001; 38: 701-707.

[5] Feng L, Liu Y, Tan Y, Hu J. Biosensor for the determination of sorbitol based on molecularly imprinted electro synthesized polymers, Biosens Bioelectron 2004; 19(11):1513-1519.

[6] DeJong AE, Hartel RW. Determination of sorbitol crystal content and crystallization rate using TD-NMR, J Food Eng 2016; 178:117-123.

[7] Balint T, Viola H, Jozsef B, Ferenc O, Andras S. Determination of sorbitol in the presence of high amount of mannitol from biological samples, Period Polytech-Chem Eng 2014; 58(1):1-6.

[8] Liang HR, Takagaki T, Foltz RL, Bennett P. Quantitative determination of endogenous sorbitol and fructose in human nerve tissues by atmospheric-pressure chemical ionization liquid chromatography/tandem mass spectrometry, Rapid Commun Mass Spectrom 2005; 19(16):2284-2294.

[9] Hu B, Wang S, Xie FW, Liu HM. Application of high performance liquid chromatography evaporative light scattering detection in determination of water-soluble sugars and sorbitol in tobacco flavourings and casings, Chin J Chromatogr 2012; 30(3):298-303.

[10] Ye NS, Gao T, Li J. Hollow fiber-supported graphene oxide molecularly imprinted polymers for the determination of dopamine using HPLC-PDA, Anal Methods 2014; 6(18):7518–7524.

[11] Capone DL, Ristic R, Pardon KH, Jeffery DW. Simple quantitative determination of potent thiols at ultratrace levels in wine by derivatization and high-performance liquid chromatography−tandem mass spectrometry (HPLC-MS/MS) analysis, Anal Chem 2015; 87(2):1226–1231.

[12] Simonzadeh N, Ronsen B. An isocratic HPLC method for the determination of sorbitol and glycerol in pharmaceutical formulations, J Chromatogr Sci 2012; 50(7):644-647.

[13] Filip M, Vlassa M, Coman V, Halmagyi A. Simultaneous determination of glucose, fructose, sucrose and sorbitol in the leaf and fruit peel of different apple cultivars by the HPLC-RI optimized method, Food Chem 2016; 199:653-659.

[14] Grembecka M, Lebiedzinska A, Szefer P. Simultaneous separation and determination of erythritol, xylitol, sorbitol, mannitol, maltitol, fructose, glucose, sucrose and maltose in food products by high performance liquid chromatography coupled to charged aerosol detector, Microchem J 2014; 117:77-82.

[15] Suntornsuk L. Recent advances of capillary electrophoresis in pharmaceutical analysis, Anal Bioanal Chem 2010; 398(1):29-52.

[16] Chen G, Chu QC, Zhang LY, Ye JN. Separation of six purine bases by capillary electrophoresis with electrochemical detection, Anal Chim Acta 2002; 457:225-233.

[17] Pospisilova M, Polasek M, Safra J, Petriska I. Determination of mannitol and sorbitol in infusion solutions by capillary zone electrophoresis using on-column complexation with borate and indirect spectrophotometric detection, J Chromatogr A 2007; 1143(1-2):258-263.

[18] Bai JG, Song LH, Zhou WH. Determination of xylitol and sorbitol in sugar-free chewing gums by miniaturized capillary electrophoresis system with amperometric detection, Chin J Anal Chem 2007; 35(11):1661-1664.

[19] Butler O, Forder J, Saunders J. Analytical protocol for the sensitive determination of mannitol, sorbitol and glucose containing powders in pharmaceutical workplaces by ion chromatography using a pulsed amperometric detector, J Pharm Biomed Anal 2015; 106:204-209.

[20] de Castro EDG, Cassella RJ. Direct determination of sorbitol and sodium glutamate by attenuated total reflectance Fourier transform infrared spectroscopy (ATR-FTIR) in the thermostabilizer employed in the production of yellow-fever vaccine, Talanta 2016; 152:33-38.

[21] Liang HR, Takagaki T, Foltz RL, Bennett P. Quantitative determination of endogenous sorbitol and fructose in human erythrocytes by atmospheric-pressure chemical ionization LC tandem mass spectrometry, J Chromatogr B 2005; 824(1-2):36-44.

[22] Wei Y, Ding MY, Zhang WQ. Simultaneous analysis of aspartic acid and sorbitol in potassium magnesium aspartate and sorbitol injection by ion-exclusion chromatography with evaporative light-scattering detection, Chin J Chromatogr 2002; 20(4):356-358.
[23] Tang GY, Guo SX, Wu HJ, Pan DM. The determination sorbitol and carbohydrates in nane fruit by high performance liquid chromatography, Chin J Chromatogr 2000; 18(5):459-461.

Access this Article in Online	
	**Website:** www.ijcrcps.com
Quick Response Code	**Subject:** Pharmaceutical Sciences
DOI: 10.22192/ijcrcps.2016.03.11.002	

How to cite this article:
Liyun Yuan, Xiaodong Dong. (2016). Study on detection methods for sorbitol. Int. J. Curr. Res. Chem. Pharm. Sci. 3(11): 6-9.
DOI: http://dx.doi.org/10.22192/ijcrcps.2016.03.11.002