SHIMADZU
Excellence in Science

Application News

No. A628

Fourier Transform Infrared Spectrophotometer (FTIR)

Qualitative Analysis and Quantitative Analysis of Sugars in Maple Syrup by FTIR

Maple syrup is a natural sweetener which is made by boiling down the sap of the sugar maple tree (*Acer saccharum*). Many virgin sugar maple forests, which provide the raw material for maple syrup, grow in southeast Canada and the northeast United States, and the products produced in those regions account for the larger part of distribution.

Food stores handle an abundant range of maple syrups with different colors and tastes to respond to the diverse needs of customers, including products made by mixing corn syrup with maple syrup, as well as low-priced syrup products made by adding the flavor and smell of maple syrup to corn syrup. Corn syrup is a liquid which is produced by using enzymes or acid to decompose corn starch to sugar, and is frequently added to syrup products in the manufacturing process [(1)].

Pure maple syrup consists of various phenols, flavor components, and sugars. Sucrose makes up 90 % or more of the sugars, and the contents of fructose and glucose are less than 2 %. In contrast, glucose is the main component of corn syrup.

In this article, we conducted a qualitative analysis and quantitative analysis of the sugars in maple syrup.

J. Head, J. Kinyanjui, M. Talbott, R. Clifford, R. Fuji

Analysis Method

The Shimadzu IRTracer™-100 Fourier transform infrared spectrophotometer (FTIR) shown in Fig. 1 was used. Measurements were carried out by the 10-bounce attenuated total reflectance (ATR) method using a horizontal ATR accessory (HATR). Table 1 shows the measurement conditions. The maple syrup samples were diluted to 10 % w/w with water and dripped on the ATR prism (ZnSe) for measurement.

Fig. 1 IRTracer™-100

Table 1 Measurement Conditions

Instruments	: IRTracer-100 HATR-10
Resolution	: 4 cm^{-1}
Accumulation	: 32 times
Wavenumber range	: 4000 - 600 cm^{-1}
Apodization function	: Happ-Genzel
Detector	: DLATGS

Qualitative Analysis of Sugars

Fig. 2 shows the infrared (IR) spectra of commercial maple syrup products (pure maple syrup, low-priced maple syrup), corn syrup, and various types of sugars. The IR spectrum of the commercial pure maple syrup, in which sucrose accounts for 98 % of the total content, shows good agreement with the IR spectrum of sucrose, whereas the IR spectrum of the low-priced commercial syrup is consistent with corn syrup. Thus, the quality of maple syrups can be judged quickly by comparison with the IR spectra of corn syrup and various types of sugars.

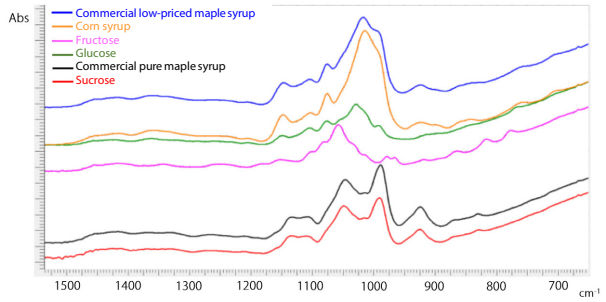

Fig. 2 Infrared Spectra of Commercial Maple Syrups (Pure, Low-Priced), Corn Syrup, and Various Sugars

Quantitative Analysis of Sugars

The concentrations (% w/w) of fructose, glucose, and sucrose in various maple syrups were calculated by chemometrics by the PLS (partial-least squares) method. This analytical method makes it possible to obtain the amounts of target substances in multicomponent mixtures.

Table 2 shows the results of a quantitative analysis of fructose, glucose, and sucrose in various types of maple syrup products. In the commercial pure maple syrups, sucrose accounts for 90 % or more of the total, whereas the concentration of glucose is clearly higher in the commercial low-priced maple syrups. This suggests that the commercial low-priced maple syrups are essentially corn syrup of which glucose is the main component. Moreover, differences in the concentration of fructose can also be seen, depending on the sample.

Table 2 Quantitative Analysis Results of Concentrations of Fructose, Glucose, and Sucrose in Various Maple Syrup Products

Type of Maple syrup/sample ID	Sample name	Fructose % (w/w)	Glucose % (w/w)	Sucrose % (w/w)
Vermont Sampling Kit				
1	Vermont Fancy	3.30 %	0 %	96.70 %
2	Grade A Medium Amber	2.90 %	0 %	97.10 %
3	Grade A Dark Amber	3.70 %	0 %	96.30 %
4	Grade B	6.90 %	0 %	93.10 %
Commercial pure maple syrup				
5	U.S. Grade A Light Amber	0 %	0 %	100 %
6	Grade A Medium Amber	0 %	0 %	100 %
7	U.S. Grade A Dark Amber	3.20 %	0 %	96.80 %
8	U.S. Grade A Dark Amber	5.80 %	0 %	94.20 %
9	U.S. Grade A Dark Amber	8.90 %	0 %	91.10 %
10	Grade A Dark Amber	5.40 %	0 %	95.50 %
11	U.S. Grade A Dark Amber	6.10 %	0 %	93.90 %
12	U.S. Grade A Dark Amber	6.40 %	0 %	93.60 %
13	U.S. Grade A Dark Amber	0 %	0 %	100 %
14	U.S. Grade B	4.50 %	0 %	95.50 %
Commercial low-priced maple syrup				
15	Sample 1	0 %	68.10 %	31.90 %
16	Sample 2	2.80 %	94.40 %	2.80 %
17	Sample 3	8.10 %	87.70 %	4.20 %
18	Sample 4	15.20 %	79.50 %	5.30 %
19	Sample 5	23.40 %	58.90 %	17.70 %

Conclusion

In this article, a qualitative analysis and quantitative analysis of the various types of sugars in maple syrup were conducted by FTIR measurement and chemometric analysis. As results, in comparison with commercial pure maple syrup, the concentration of glucose in commercial low-priced maple syrups was remarkably higher, suggesting that the low-priced products contain corn syrup.

Chemometric analysis enables quantitative analysis of multiple components contained in maple syrup and other food products, and FTIR measurement by the ATR method is extremely simple. Thus, a combination of these techniques is the ideal solution for quality control when qualitative analysis and quantitative analysis of the components of foods is necessary.

<Reference>

(1) Nollet, L.M.L. "Handbook of Food Analysis, Methods and Instruments in Applied Food Analysis". 2nd Edition, Revised and Expanded. Marcel Dekker, Inc. 2004.

*Note: Grading of maple syrups
In 2017, the former standard of 5 grades was revised to a new standard consisting of 4 grades (Golden, Amber, Dark, and Very Dark). The quality of all four ranks is classified as Canadian grade A.

Source:
https://www.maplesource.com/pure-maple-syrup-grades-explained/

IRTracer is a trademark of Shimadzu Corporation in Japan and/or other countries.

The content of this Application News was published by Shimadzu Scientific Instruments in September 2014.

First Edition: Aug. 2020

Shimadzu Corporation
www.shimadzu.com/an/

For Research Use Only. Not for use in diagnostic procedure.
This publication may contain references to products that are not available in your country. Please contact us to check the availability of these products in your country.

The content of this publication shall not be reproduced, altered or sold for any commercial purpose without the written approval of Shimadzu. Shimadzu disclaims any proprietary interest in trademarks and trade names used in this publication other than its own. See http://www.shimadzu.com/about/trademarks/index.html for details.

The information contained herein is provided to you "as is" without warranty of any kind including without limitation warranties as to its accuracy or completeness. Shimadzu does not assume any responsibility or liability for any damage, whether direct or indirect, relating to the use of this publication. This publication is based upon the information available to Shimadzu on or before the date of publication, and subject to change without notice.

© Shimadzu Corporation, 2020