QA/QC of sugars using the Agilent Cary 630 ATR-FTIR analyzer

Application note

Food testing and agriculture

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Introduction

Various manufacturers especially in the chemical, pharmaceutical and food industries employ sugars in their products. Sugars can be extracted from plant or microbial sources or they can be chemically synthesized. The majority of sugars are purchased as crystalline white powders and the most common examples are glucose, sucrose, lactose, fructose, maltose and xylitol. Protein-based sweeteners such as thaumatin, curculin and monellin are also used. Substituting artificial sweeteners such as aspartame, saccharin and sucralose can significantly reduce or virtually eliminate the calories associated with sugar content in food and beverages.

Due to the similarity in their color, odor, texture and general appearance (Figure 1) it is very difficult for processors to authenticate the sugar identity prior to its addition to a formulation.

Currently, most pharmaceutical and food manufacturers rely on chromatographic techniques, which are tedious, time-consuming and require the use of solvents, to distinguish between the sugars. Occasionally, for quality assurance/quality control (QA/QC) purposes it is necessary to use internal or external chemical laboratory support for testing. As in all food commodity or food-grade pharmaceutical excipients, the manufacturer usually requires an advance sample from the supplier to verify that it meets their requirements. The sample is analyzed to compare it with other lots previously received. Then, when the bulk shipment arrives it must be tested to ensure that it has the same chemical and crystalline composition as the advance sample and that it is homogenous in composition. This can be accomplished by acquiring multiple samples from different containers. Sometimes, material from the regular supplier is not available and a new vendor must be found and the new sugar chemical composition must be compared to that supplied by the previous vendor.

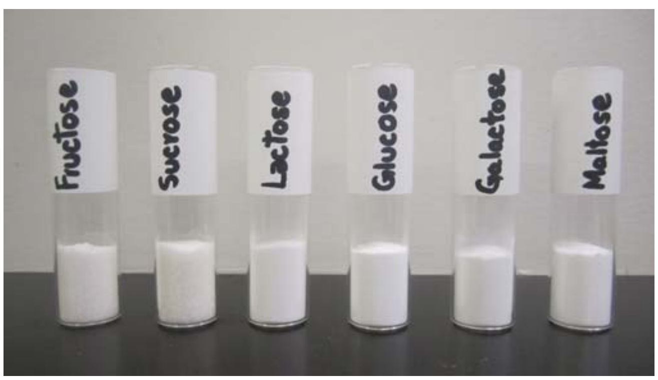

Figure 1. Various sugars

Manufacturers who use sugars in their products need a ready-to-deliver, robust technology, free from system calibrations, that can test and accept or reject the sugar powder on the spot, ideally immediately on receiving the sample.

Experimental

Small amounts of sugar samples were placed without weighing onto the sampling surface of the Agilent Cary 630 ATR-FTIR analyzer (Figure 2). The samples were pressed against the diamond crystal using the attached pressure clamp. A slip clutch on the clamp prevents overtightening.

Spectra were acquired in about 30 seconds by co-adding 64 spectra with a resolution of 4 cm^{-1}. Each resulting spectrum was displayed on the computer screen along with its closest spectral analogue chosen from a spectral library database of sugar standards acquired using the Cary 630 ATR-FTIR analyzer and its MicroLab FTIR software.

Figure 2. Agilent Cary 630 ATR-FTIR analyzer

Results and discussion

All carbohydrate-based sugars possess strong and characteristic infrared absorptions between 1200 and 600 cm^{-1} attributed to C-O-H and C-O-C bonds (Figure 3, top). Protein-based sweeteners like thaumatin show unique absorption bands between 1700 and 1500 cm^{-1} (Figure 3, bottom), which can be attributed to the amide I and amide II absorption bands belonging to the proteins. Artificial sweeteners also possess unique absorptions depending on their chemical structure. Accordingly, the spectrum of a sugar can be easily assigned to a particular sugar class (carbohydrate, protein-based or artificial sweetener) and in most cases assigned with a high degree of accuracy to a specific sugar. Hence, when a new or unknown sweetener is received, its spectrum can be compared to those stored in the database of previously recorded sweeteners, and its identity can be correctly established by the MicroLab FTIR software (Figure 4).

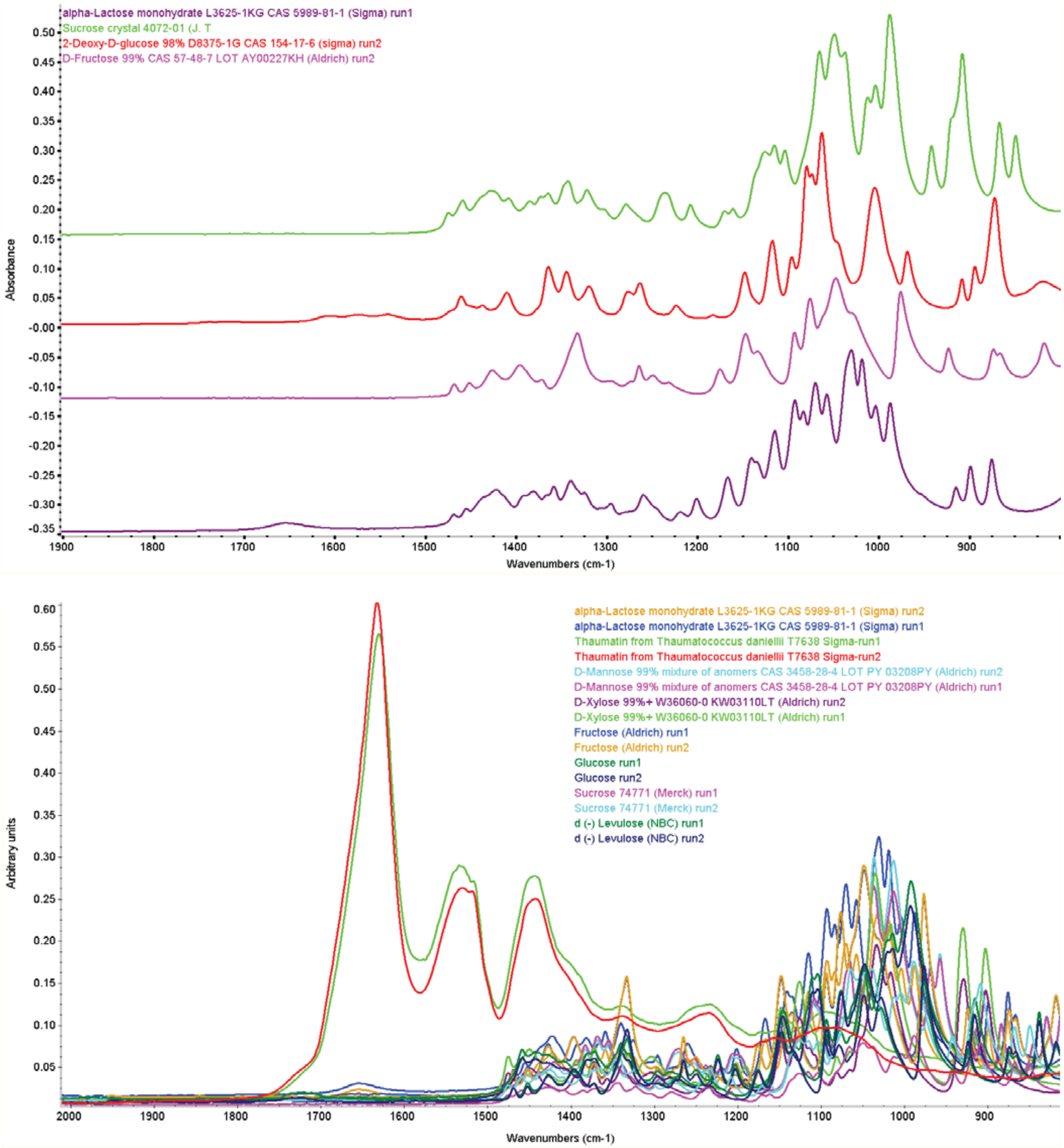

Figure 3. Infrared sugar spectra recorded on the Cary 630 ATR-FTIR analyzer. Spectra in the upper image have been offset. The strong infrared absorption band in the lower image located between 1700 and 1600 cm^{-1} is attributed to the amide I band of protein sweeteners.

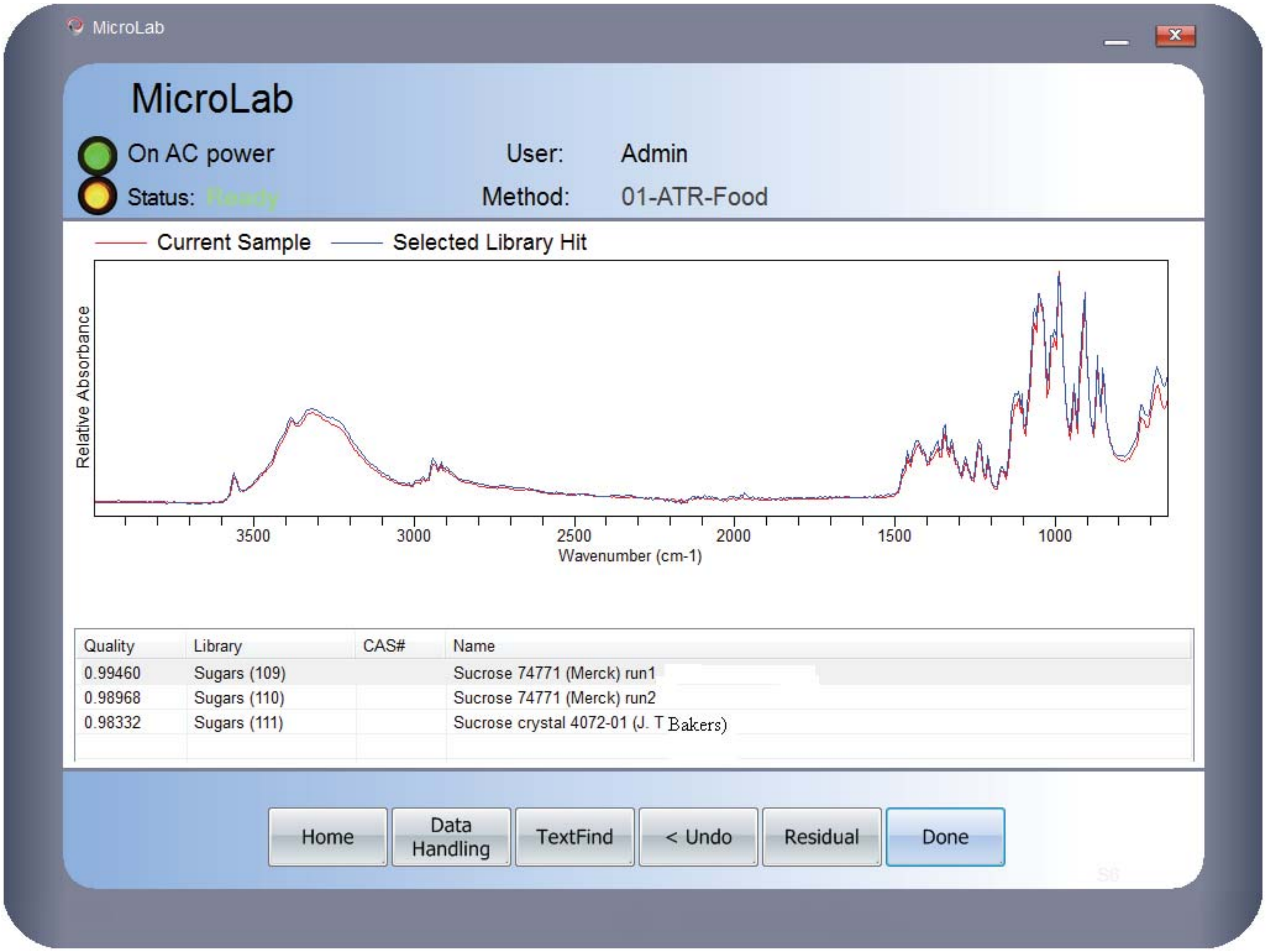

Figure 4. Correct identification of an unknown sugar sample by the MicroLab FTIR software

Conclusion

The Agilent Cary 630 ATR-FTIR is a robust, light-weight and compact (12 in long, 6 in wide, 9 in high and ~7 lb) analyzer that rapidly provides high quality spectra. It comes with very intuitive MicroLab FTIR analysis software for authenticating sugar samples by comparison to known spectra of reference standards. This makes the Cary 630 ATR-FTIR analyzer ideal for use at the receiving dock, on the production floor or it can be taken to the ingredient supplier depot for on-site verification.

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Published November 28, 2012
Publication number: 5991-0786EN

Agilent Technologies