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

Application note

Food testing and agriculture

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Introduction

Tea is the most widely consumed beverage after water. Teas are generally divided into categories based on processing techniques. The most commonly applied processes are oxidation and fermentation. There are many different tea varieties (Figure 1) including white, yellow, green, oolong, black and post-fermented. Some teas can be modified further by the addition of additives or by blending different varieties to improve taste. Almost all teas sold in bags and other types of teas (leaves) in the world are blends.

Tea leaves contain more than 700 compounds including, flavanoids, amino acids, vitamins (C, E and K), caffeine, polysaccharides, flavanols, tannin, polyphenols and catechins. Catechins can make up to 30% of the dry weight of teas and their concentration is greatest in white and green teas, while black teas contain substantially fewer catechins.

The levels of antioxidants in green and black teas do not greatly differ. In addition, teas contain neurologically-active compounds such as theanine, theophylline, theobromine and caffeine. The complexity of the chemical composition of teas makes it very difficult to establish an authentication process and quality control/quality assurance (QA/QC) procedures. Indeed, most companies will focus simply on a two-component analysis consisting of caffeine and the total polyphenol content. A complete component analysis would be highly desirable if it could be performed quickly and with minimal analysis cost per sample. Furthermore, companies that blend the teas would also benefit substantially if the authentication and quality verification of the arriving teas could be established prior to blending, to ensure the consistent production of high-quality products.

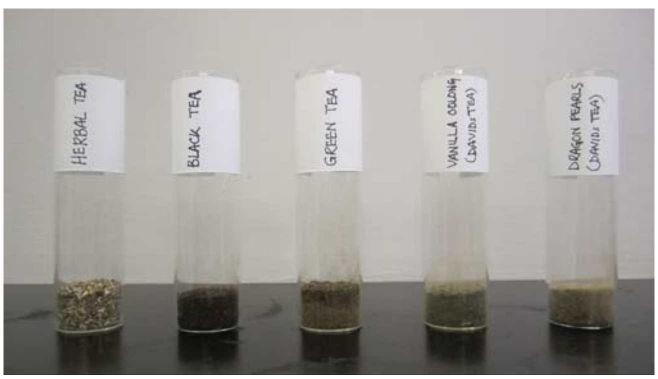

Figure 1. Various teas

Among available techniques, Fourier transform infrared (FTIR) spectroscopy used in combination with a diamond crystal attenuated total reflectance (ATR) accessory can provide important information about all the organic compounds present in teas, and this spectral information can be utilized in a number of ways to aid tea manufacturers in optimizing their products and to ensure product consistency. The Agilent Cary 630 ATR-FTIR analyzer can reduce operational costs, is lightweight (~7 lb or ~3 kg) and robust, and can thus be easily carried and used as a portable analyzer. The Agilent MicroLab FTIR software is easy-to-use and requires minimal training so that different tea varieties can be differentiated within minutes.

Experimental

1. Several different commercial tea brands were purchased from grocery stores and were ground to produce uniformly-sized powders.

2. A small amount of each ground-tea powder was placed on the diamond ATR crystal of the Cary 630 ATR-FTIR analyzer (Figure 2).

3. The samples were pressed against the diamond crystal using the attached pressure clamp. A slip clutch on the clamp prevents overtightening.

Figure 2. Agilent Cary 630 ATR-FTIR analyzer

4. FTIR spectra were acquired (64 scans at 4 cm^{-1} resolution) in less than 30 seconds.

5. The recorded spectra were automatically stored in a spectral database for comparison to previously pre-recorded reference spectra already in the spectral database or for the determination of a percentage (%) similarity comparison by the MicroLab FTIR software.

Results and discussion

All the ground-tea samples were scanned using the Cary 630 ATR-FTIR analyzer. The acquired spectra (Figure 3) were automatically stored in a spectral database using the MicroLab FTIR software. The spectral information between 3800 and 2600 cm^{-1} and 2000 and 600 cm^{-1} provides the means for differentiating between the different tea varieties. These spectral regions contain absorption bands for all the major and minor organic components found in teas and therefore, all the spectral information within these regions plays an important role in distinguishing amongst teas with varying chemical compositions.

Each sample was run in duplicate sets (on different days) wherein one set was stored in a spectral database and the second set was used for validation purposes. In all cases, the duplicate samples were correctly identified and matched by the MicroLab FTIR software. Therefore, when a new sample is acquired, it can easily be compared to the previously recorded spectra, and its identity established within seconds of spectral acquisition by the MicroLab FTIR software (Figure 4). The results can be expressed in the form of a % similarity or pass/fail based on an operator's pre-established % similarity limits.

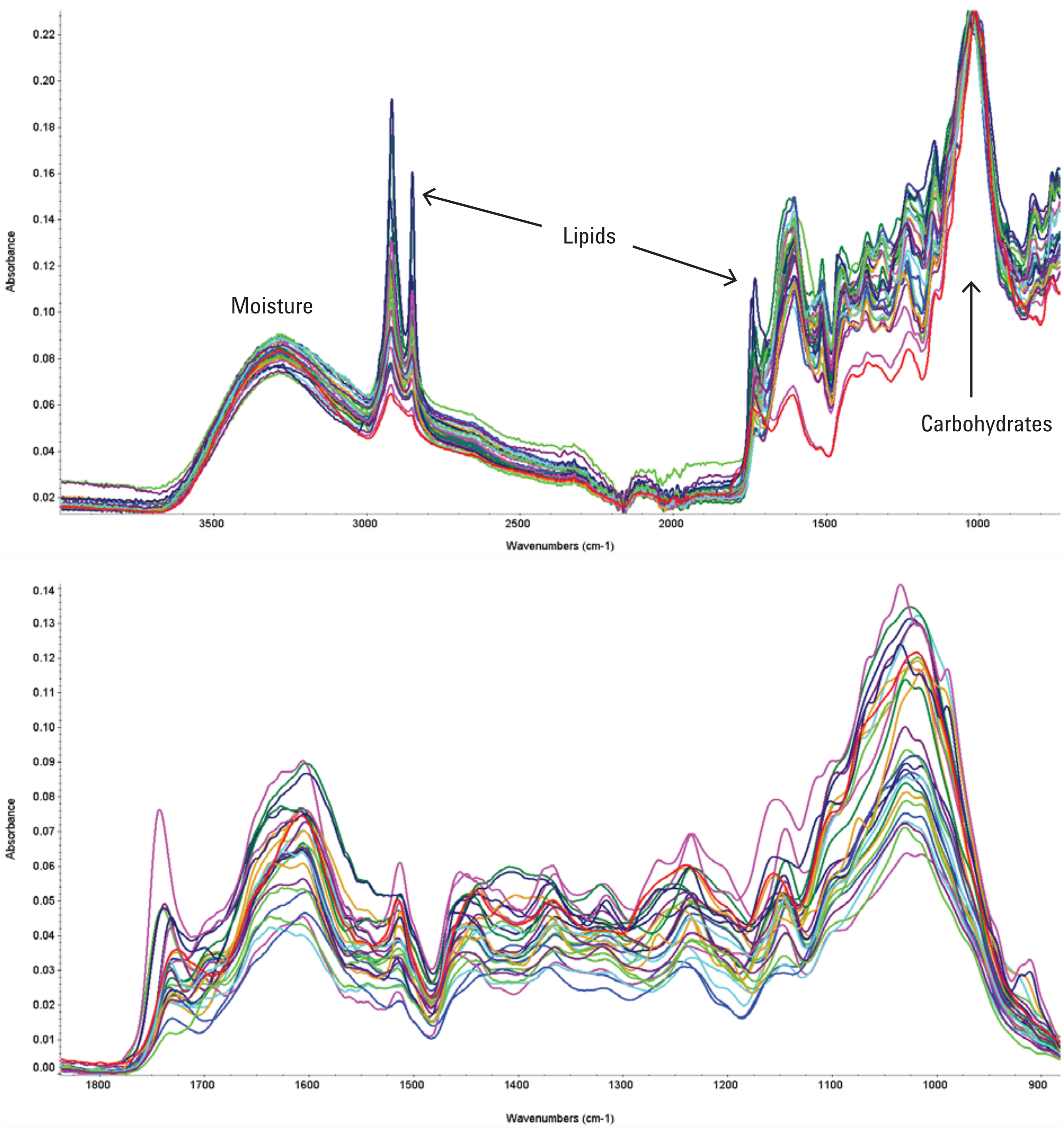

Figure 3. Agilent Cary 630 ATR-FTIR spectra of selected teas

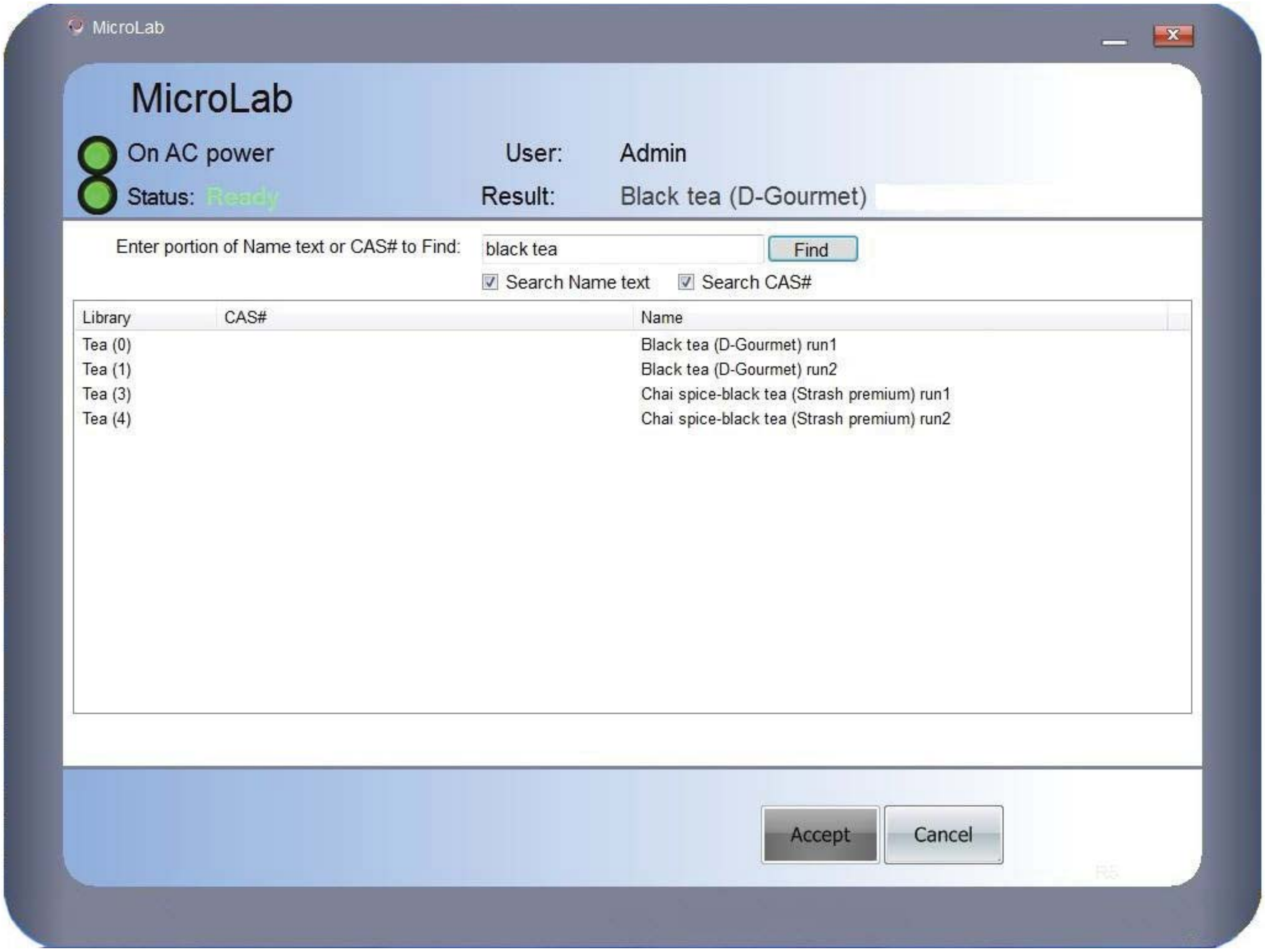

Figure 4. Example of the Agilent Cary MicroLab FTIR software for the correct identification of a new black tea sample

Conclusion

The Agilent Cary 630 ATR-FTIR analyzer can meet the challenge of providing a molecular fingerprint for all the organic components in teas. It is an extremely rapid, portable method that can provide analytical results within seconds without the use of solvents or any prior sample preparation. It can be employed at the receiving dock, in the production line, in the QC lab or it can be easily moved from one location to another. The resourceful MicroLab FTIR software allows the operator to carry out the analysis with minimal training. Since the operator receives real-time results he or she can either accept or reject a new tea shipment, verify the quality of materials held in storage, or ensure product consistency after blending.

Suggested references

1. Rodriguez-Saona, L. E. & Allendorf, M. E. (2011). Use of FTIR for rapid authentication and detection of adulteration of food. *Annu. Rev. Food Sci. Technol. 2*, 467–483.

2. Budínová, G. Vláčil, D., Mestek, O. & Volka, K. (1998). Application of infrared spectroscopy to the assessment of authenticity of tea. *Talanta, 47*, 255–260.

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