FT-NIR Analysis of Coffee

Introduction

Coffee is a brewed drink prepared from ground roasted coffee beans, which are the seeds of berries from the coffea plant. Over 2.25 billion cups of coffee are consumed daily and it is one of the world's most popular beverages.

Among different varieties of genus coffea plants, Arabica and Robusta are the two most economically and commercially important ones. Arabica beans contain lower caffeine content than Robusta beans and Arabica coffee is more flavorful than Robusta coffee. Robusta tends to be bitter and have less flavor, but better body, than Arabica. For these reasons, 75–80% of the coffee produced worldwide is Arabica and around 20% is Robusta. Once ripe, coffee berries are picked, processed, and dried. The dried coffee beans are roasted to varying degrees and blended to obtain different flavors. Roasted beans are ground and brewed with near boiling water to produce coffee as a beverage.

Each year, over 8.8 million tons of coffee is produced worldwide. It is one of the most traded agricultural commodities, and ranks second only to petroleum in terms of dollars traded.

In this highly competitive industry quality control is a very important factor. From harvesting through processing, quality control tests are required for every stage of coffee production, for example to check the moisture content of green beans, monitor degree of roasting, and test for chemical constituents such as caffeine, chlorogenic acids, trigonelline, fat, sucrose and dry matter of the roasted beans, since these determine the quality of coffee as a beverage. Quality analysis and testing provide the assurance for the best final product.

Compared to traditional analytical methods, near-infrared (NIR) spectroscopy has the advantages of being nondestructive, rapid, cost effective, and it allows for simultaneous measurements of multiple components. Furthermore, with a calibrated instrument, the end user needs no special skill or spectroscopy knowledge to run the analysis.

FT-NIR Spectroscopy for the Coffee Industry

Coffee beans and ground coffee powders can be analyzed by Fourier transform near infrared (FT-NIR) spectroscopy, using a diffuse reflectance measurement.

Experimental

Moisture Content in Green Beans

Moisture content is an important parameter to monitor in green beans because high moisture content can result in microbial growth, mycotoxin formation, and final product sensorial change. Reh et al.[1] compared the specificity and accuracy of different reference methods for the determination of water content in green coffee. In their study, NIR spectroscopy was used to analyze different drying methods. Morgano et al.[2] used NIR spectroscopy to determine moisture in raw coffee.

Chemical Composition of Ground Coffee

Zhang et al.[3] analyzed caffeine content in roasted Arabica coffee using NIR. Huck et al.[4] compared NIR spectroscopy to HPLC-MS for the analysis of caffeine, theobromine, and theophylline in coffee. Pizarro et al.[5] evaluated the influence of data pre-processing on the quantitative determination of the ash content and lipids in roasted coffee by NIR spectroscopy. In these studies, it was determined that FT-NIR spectroscopy provides a rapid and accurate assessment for coffee properties. Furthermore, FT-NIR spectroscopy can be used for the simultaneous analysis of compounds such as caffeine, theobromine, theophylline, chlorogenic acids, moisture, ash, and fat content, thus saving time and expense.

Degree of Roasting

Roasting degree is an important factor in determining the taste of coffee. It can be predicted through variables such as weight loss, density, and moisture content of roasted coffee samples. Alternatively, FT-NIR PLS calibrations can be developed to predict these parameters. For example, Esteban-Díez et al.[6] did a feasibility study using NIR to predict roasting color and other quality parameters of roasted coffee samples. Also, Alessandrini et al.[7] used NIR spectroscopy as an analytical tool to predict coffee roasting degree. These studies show that FT-NIR calibrations can be developed for quality assurance parameters including total acidity, caffeine content, chlorogenic acids, and roasted bean color.

Adulteration & Discrimination

Because coffee is a high price commodity, it is susceptible to adulteration that will lower the quality; such substitutes include chicory, malts, starch, glucose, and coffee husk. FT-NIR spectroscopy can be used as a quick screening tool that can rapidly and simultaneously analyze compound parameters, thus exposing the adulterants. For example, Ebrahimi-Najafabadi et al.[9] used NIR spectroscopy to detect addition of barley to coffee.

FT-NIR spectroscopy is also a discrimination tool that can differentiate between varieties of coffee, such as Arabica and Robusta. Pizarro et al.[8] used NIR spectroscopy to measure the percentage of robusta variety present in a mixture in order to detect adulteration in roasted coffee.

Conclusion

FT-NIR spectroscopy provides a rapid, nondestructive method for analyzing coffee. Near instantaneous results that are comparable to traditional lab methods can be obtained across a wide range of parameters.

Designed with a large 23mm sampling area and additional off-centered mounted spinner accessory, the reflectance capabilities of the QuasIR™ 3000 are ideally suited to coffee analysis.

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