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APPLICATION NOTE

No. AN52259

Quality control of potato crisps flavoring using near-infrared spectroscopy

Keywords
Antaris, flavoring, near infrared (NIR), potato crisps, quality control (QA/QC), food

Introduction

The quality of potato crisps as judged by the consumer is often based on the level and quality of the flavoring. The consistency of flavoring is a critical quality parameter for companies in the snack food industry. For potato crisps manufacturer Seabrook Crisps in Bradford, West Yorkshire, the quality of their products is their number one priority. Founded in 1945 by Mr. C. Brook, Seabrook Crisps has been producing the high quality potato crisps for over 60 years. Proud to be a family-owned business to this day, Seabrook offers a large range in flavors made from selected quality ingredients.

Figure 1: View of flavor dosing process

Figure 2: Antaris II MDS FT-NIR with Sample Cup Spinner Accessory

Seabrook was in search of a better way for monitoring the consistency of flavoring on their crisps. Seabrook turned to near infrared technology for their quality control testing due to the short analysis time and ease of implementation for use by their production operators. The key to a consistent flavored crisp is a smooth and even dosage of the flavor onto the product. Previously, flavor determination as done by taste testing to determine that the dosage levels from the flavor machine (Figure 1) were correct. Seabrook has implemented quality control testing using the Thermo Scientific™ Antaris™ II FT-NIR analyzer with RESULT software as a way of ensuring consistent flavoring on the crisps to increase the quality of the product. The Antaris II FT-NIR is a rugged, fit-for-use analyzer designed for operation in food production environments. The RESULT software that drives the Antaris II was designed for routine QC analysis by production operators. Single push button analysis using dedicated, automated workflows in RESULT, minimizes operator training time and protects against operator errors in the results.

Near-Infrared (NIR) spectroscopy has been used successfully for decades to analyze key components, such as moisture, protein, fat and carbohydrates, in agricultural and food products. NIR spectroscopy finds use as both an at-line or laboratory quality control tool as well as an in-line process analysis tool for real-time monitoring and control of production processes. The technique has many distinct advantages that make it an ideal choice for QC testing across industries. It is a fast, accurate technique that requires minimal or no sample preparation, and has no expensive reagents or disposable costs. NIR directly replaces time-consuming and error prone multi-step analytical techniques such as titrations, loss on drying, HPLC and solvent extractions.

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Experiment

The NIR analyses were performed on an Antaris II Method Development Sampling (MDS) system equipped with a Sample Cup Spinner accessory (Figure 2). The integrating sphere module, in combination with the Sample Cup Spinner, was used to perform the diffuse reflectance measurement on the crisps. The integrating sphere module is a high performance sampling system designed for optimum collection efficiency of reflected light. The high efficiency of the integrating sphere module allows method development with few samples and development of applications requiring high signal to noise. The integrating sphere on the Antaris II MDS uses an automated, internal gold background standard to guard against contamination of the background standard. It also guarantees a proper background is taken even with samples in the analysis position.

In preparation for analysis on the Antaris II MDS, crisps were lightly crushed with a pestle and mortar to a few millimeters particle size and placed in a 5 cm diameter sample cup (Figure 3). The cup was rotated during analysis to give an average spectrum that was most representative of the sample. Spectra were collected over the entire NIR region from 10,000–4,000 cm^{-1} at a resolution of 8 cm^{-1} with 32 co-averaged scans per spectrum resulting in an average analysis time of 30 seconds per sample.

To develop a method for predicting the percentage of flavoring on crisps, standard spectra were collected from samples with known concentrations of flavoring. Potato crisp standards were generated by weighing different quantities of flavor into a bag containing 100 g of unflavored crisps and shaking the bag to evenly distribute the flavoring on the crisps. Potato crisps with beefy flavor % from 1 to 13% were used as standard samples for calibration model development. The standard samples were used to develop a partial least squares (PLS) calibration model using the Thermo Scientific TQ Analyst chemometric software package. Standard spectra were collected over time, using this procedure, to incorporate potato variation into the PLS model for improved robustness of the model.

To aid in spectral region selection during calibration model development, a spectrum of the pure beefy flavor was collected. A comparison of the pure beefy flavor spectrum (red) to spectra of samples varying in percentage flavoring (Figure 4) was performed to determine which region(s) of the spectrum was related to change in flavoring concentrations.

Figure 3: Potato crisps are ground by a mortar and pestle (inset) then loaded into the Sample Cup Spinner accessory of the Antaris II MDS system

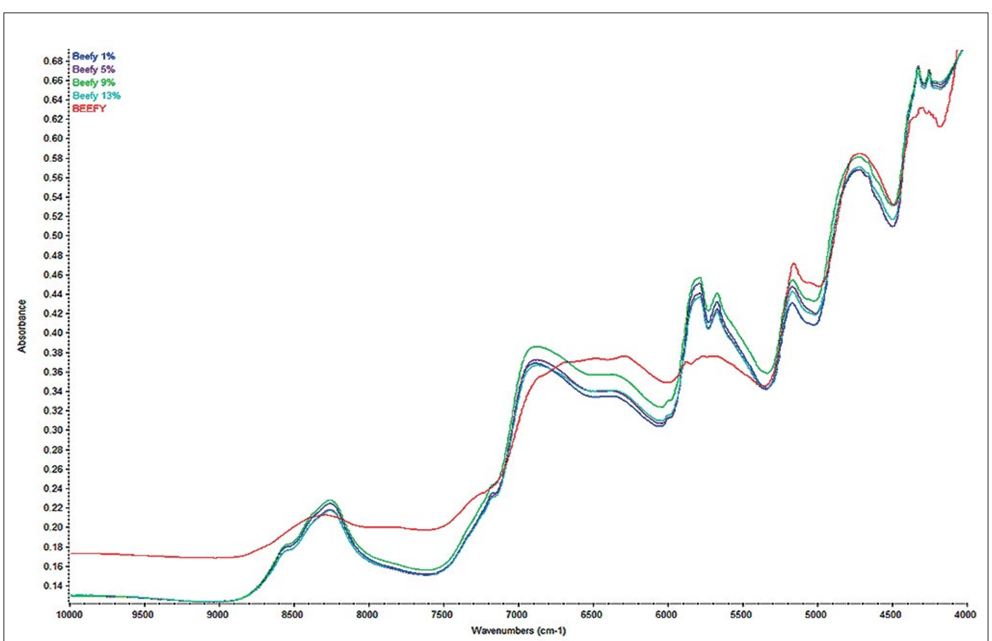

Figure 4: NIR spectra of pure beefy flavor (red) and crisps with 1 to 13% flavoring

There was no obvious visual change in spectral shape or absorbance correlated to the percentage of flavoring in the raw spectra. However, baseline shifts were observed in the standard spectra as is typical for solids samples analyzed in the near-infrared.

This shift is due to the light scattering effects caused by the difference in particle size in the sample matrix. To help normalize the baseline and to improve the peak shape prior to calibration, a second derivative was applied to the calibration spectra. (Figure 5).

It was apparent from the spectra that there was no single region where the flavor could be measured without influence from the crisps. Hence the entire NIR region from 4104–6876 cm^{-1} was used for the partial least squares (PLS) regression due to strong absorbance and spectral variation among the standards in that region.

Results and discussion

The calibration plot and results shown in Figure 6 demonstrate good correlation between the known flavoring percentage and the NIR predicted results. An excellent correlation coefficient of 0.98 was achieved for the calibration with a root mean square error of calibration (RMSEC) of 0.572. The independent validation samples showed the same excellent correlation and a root mean square error of prediction (RMSEP) of 0.632. The close agreement between the calibration error (RMSEC) and the validation error (RMSEP) demonstrates the accuracy and suitability needed for implementation of the NIR method for analyzing flavor concentration in production samples.

The NIR method was put into service for QC testing of beefy flavor crisps by taking samples from the production line and analyzing them on the Antaris II FT-NIR. The NIR calibration model was implemented into a RESULT workflow, so operators could use the instrument for routine analysis. To analyze a sample, the operator simply loads the sample, presses the 'Go' button in RESULT and enters the sample details. The RESULT software provides the concentration of the flavoring on the crisp sample in an on-screen report that can also be printed or archived to disk. To give a regular indication of the flavor application on the finished crisp, the NIR flavor analysis was conducted throughout the 12 hour production shift and whenever there was a flavor change over. When the Antaris NIR generated flavoring concentration results outside of the specification limits, alterations were made to the flavor machine settings to optimize the application rate. Further calibration development for other flavors will allow Seabrook Crisps to monitor and control the level of flavoring concentration for other product lines.

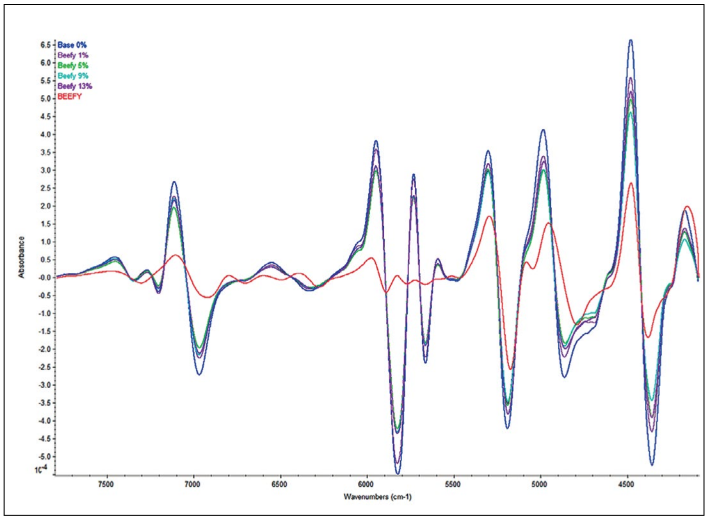

Figure 5: Second derivative spectra of crisps with 1 to 13% flavoring and pure beefy flavor (red)

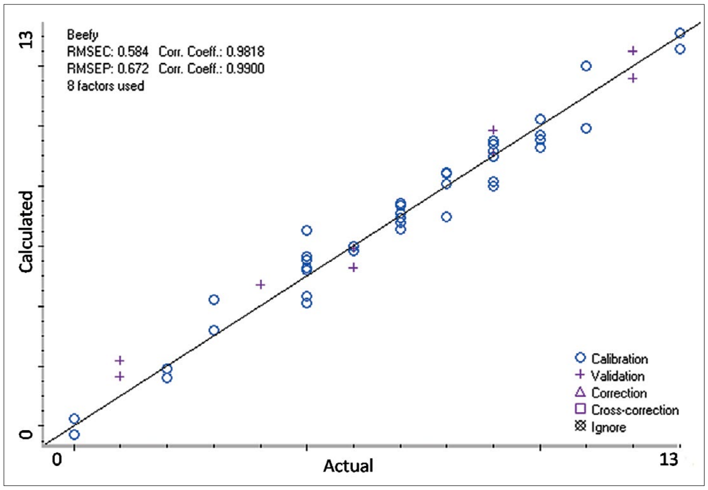

Figure 6: NIR predicted vs. flavor weight % values

Conclusion

It is important to potato crisp manufacturers, such as Seabrook Crisps, to maintain a consistent level of flavoring on their products since this has a huge effect on quality. Since Seabrook Crisps has put the Antaris II FT-NIR analyzer into operation for fast and accurate flavor determination, the number of customer complaints and on-line flavoring issues has been greatly reduced. By replacing time-consuming and subjective taste testing techniques with NIR, a company can greatly reduce the financial loss due to out-of-specification product. The fact that NIR analysis can be performed with minimal or no sample preparation, and requires no expensive reagents or disposable labware, makes it an ideal analytical technique for routine QC testing. Also, the push button analysis via automated workflows in RESULT software minimizes the implementation and training time so companies can focus on optimizing their production process. At Seabrook, the Antaris II helps to ensure the flavor quality of the Seabrook Crisps brand and the company's reputation. The accurate determination of flavor concentration enables a tighter control of the flavoring process and assists in timely changes to the flavor application rates to guarantee a smooth and consistent level of flavoring on the crisp.

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