Application Note:
PI.0083.0811

Predicting the Percentage of Added Fat in Peanut Butter

Key Words

- Accuracy
- Constituents
- Dielectric
- Fat percentage
- In-process analysis
- Microwave electromagnetic energy
- Peanut butter
- Peanut oil
- Reduce labor costs
- Sensitivity

Objective

The main objectives of this test were:

1. To determine the percentage of added fat to peanut butter with the Thermo Scientific Ɛ scan in-line analyzer,
2. To get a preliminary indication of the accuracy and precision of the Ɛ scan in-line constituent analyzer for this type of measurement.

Thermo Scientific Ɛ scan in-line constituent analyzer

Background

Food manufacturers often use accurate, but costly and labor-consuming primary testing methods to determine the constituents within each batch they produce. The Ɛ scan in-line analyzer has been developed for measuring constituents through the entire matrix of a food product during production. This new unit is helping to reduce labor costs and product waste by measuring the process stream in-line quickly and accurately. The Ɛ scan analyzer uses very low microwave electromagnetic energy to measure the dielectrics within the product. This measurement is capable of simultaneously correlating to multiple constituents that instantly provides valuable information to the production floor.

Summary of Work

Since no primary fat testing method was readily available, a calibration was completed by assuming the starting fat content of the peanut butter used was 50% based on the label declaration. The subsequent lab values were calculated based on the weight of peanut oil added to a known quantity of peanut butter. To aid in the incorporation of the peanut oil into the product, the entire procedure was conducted at a product temperature of +92°F using an environment chamber. The calibration data points were collected to represent a range of 50% to 52.2% total fat, which would be a typical manufacturing range in a processing plant. Upon achieving a successful calibration, a validation was completed by continuing to add peanut oil under the same conditions and evaluating what the Ɛ scan analyzer predicted. (See figures 1 & 2 for the actual data.)

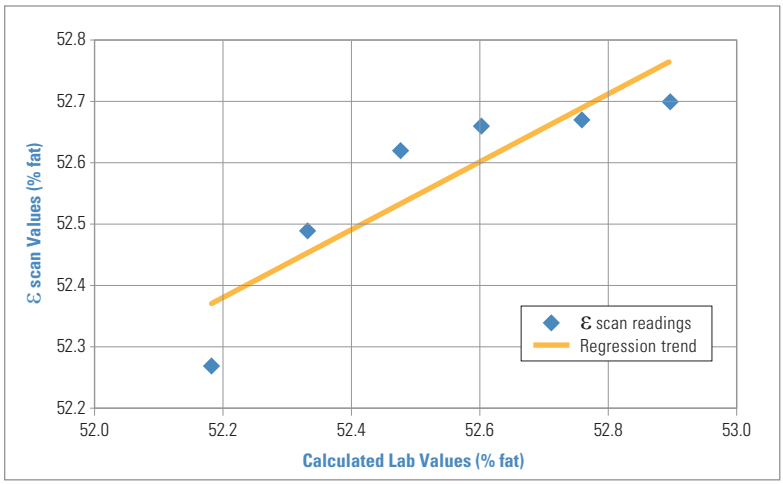

figure 1 – Percentage of fat in peanut butter validation. The graph shows the Ɛ scan readings in relationship to the calculated lab values. The straight line through the data points represents the slope and offset in the linear regression of the calibration.

Instrument/Method Description

The Ɛ scan guided microwave spectrometer is comprised of a) a 4-inch diameter measurement chamber connected to b) a microwave synthesizer via c) two probes and d) a temperature probe attached to the chamber body. The e) HMI is connected to the synthesizer and used for calibration and display of results. There are no moving parts. The chamber body and probes are rated 3A sanitary and IP-69K water/dust ingress, and 500 lbs. pressure (ANSI tested to 750 psig).

Results

Based on the test results, we are confident the installation of our ε scan in-line analyzer for testing fat content in peanut butter would be a great application.

Test highlights include:

1. The ε scan showed sensitivity to changing fat content over a range of 50% to 53% at +92°F,
2. The correlation coefficient and standard error for both the calibration and validation were very favorable for this type of application,
   a. Correlation coefficients (r) of 0.99 and 0.89 respectively. This represents the strength and direction of the linear relationship between two variables. A value of 1 would be a perfect linear fit,
   b. Both standard errors were 0.08. This represents the variance in the data over the tested range.

Benefits of Use

Use of GMS technology to 'see inside the pipe' and measure in real time a non-chemical property such as fat % allows the processor tighter control over a quality measurement critical to their brand and, ultimately, profit.

Conclusion

It was determined that the ε scan in-line analyzer is capable of detecting changes in the fat percentage in peanut butter in this lab procedure. Additional testing at a processing facility would need to be completed to confirm and validate these results against the primary testing method. Our experience is that the results are typically better when the ε scan in-line analyzer is installed in the final process line since the product is constantly moving and the customer has more consistency than what could be achieved in the lab. We are confident the Thermo Scientific ε scan in-line analyzer will provide accurate results and tighter process control for our customers.

Recommendation

Consider use of ε scan with GMS technology when the measurements needed in a nut butter pipestream are critical and optical systems that can become coated with process residue will not work. Typical results in field applications improve by 2X-4X over our lab results using limited sample size.

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Calibration Data		
Sample #	**Lab Value**	**Predicted Value**
1	50.00	49.98
45	50.30	50.40
46	50.45	50.46
47	50.60	50.62
48	50.77	50.72
49	50.94	50.78
50	51.06	51.05
51	51.19	51.19
52	51.33	51.23
53	51.33	51.50
54	51.48	51.40
55	51.62	51.68
56	51.75	51.75
57	51.89	51.92
58	52.06	52.01
59	52.18	52.14
Correlation coefficient (r)		0.99
Standard error		0.08

Validation Data		
Sample #	**Lab Value**	**Predicted Value**
1	52.18	52.27
2	52.33	52.49
3	52.48	52.62
4	52.60	52.66
5	52.76	52.67
6	52.90	52.70
Correlation coefficient (r)		0.89
Standard error		0.08

figure 2 – Percentage of fat in peanut butter—calibration and validation results for ε scan versus lab values

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