

Application Note AN-NIR-139

Quality control of ice cream mix with near-infrared spectroscopy

Rapid determination of fat, total solids, protein, lactose, sucrose, and calories

Ice cream is a complex emulsion of water, dairy products, fat, proteins, sugars, and air. Each component of this frozen dessert plays a crucial role in creating its smooth and creamy texture. During ice cream manufacturing, quality testing ensures batch-to-batch consistency to meet consumer expectations. Quality analysis of ice cream involves analyzing fat content, protein percentage, and total solids as well as lactose, sucrose content, and calories. These factors influence the texture and flavor, shelf life, and consumer satisfaction. Standard laboratory analysis of ice cream is time consuming and requires sample preparation. Near-infrared spectroscopy (NIRS) is a simpler alternative chemical-free technique that measures all these parameters simultaneously in a few seconds.

EXPERIMENTAL EQUIPMENT

Forty different ice cream samples were analyzed on a Metrohm NIR Analyzer. All measurements were performed in reflection mode (1000–2250 nm) using the small cup accessory and single-point measurement.

Reference values were obtained by official methods, e.g., AOAC 941.08 (total solids), AOAC 930.33 (protein), and AOAC 932.06 (fat). Lactose and sucrose reference values were measured by HPLC (high-performance liquid chromatography), and a bomb calorimeter measured caloric content.

Metrohm software was used for all data acquisition and prediction model development.

RESULT

The obtained NIR spectra (Figure 1) were used to create prediction models for the different reference parameters mentioned in the previous section. A leave one out validation procedure was applied.

Correlation diagrams which display the relation between the NIR prediction and the reference values are shown in Figures 2–7 together with the respective figures of merit (FOM).

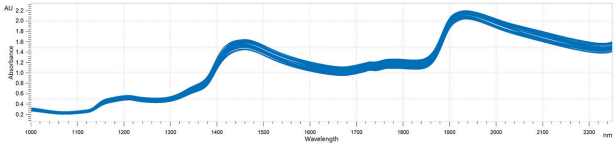


Figure 1. NIR spectra of several ice cream samples

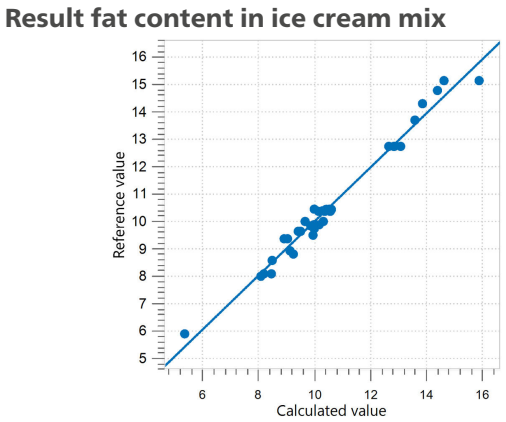


Figure 2. Correlation diagram and the respective figures of merit for the prediction of fat in ice cream mix. Reference values were obtained according to AOAC 932.06.

R^2	SEC (%)	SECV (%)

0.979	0.24	0.30

Result total solids content in ice cream mix

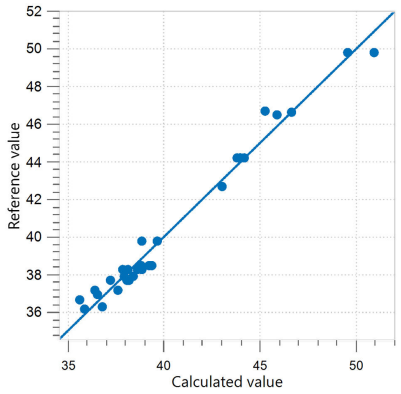


Figure 3. Correlation diagram and the respective figures of merit for the prediction of total solids in ice cream mix. Reference values were obtained according to AOAC 941.08.

R^2	SEC (%)	SECV (%)
0.979	0.52	0.58

Result lactose content in ice cream mix

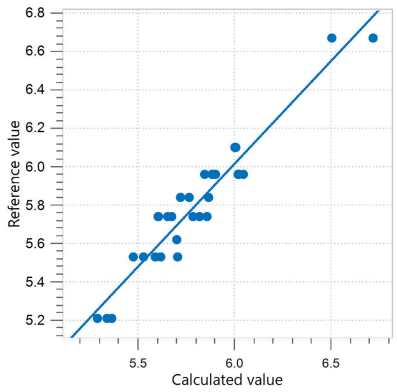


Figure 4. Correlation diagram and the respective FOMs for the prediction of lactose in ice cream mix. Reference values were obtained with high-performance liquid chromatography (HPLC).

R^2	SEC (%)	SECV (%)
0.921	0.06	0.10

Result sucrose content in ice cream mix

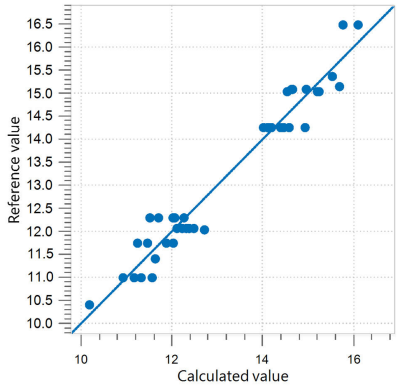


Figure 5. Correlation diagram and the respective FOMs for the prediction of sucrose in ice cream mix. Reference values were obtained with high-performance liquid chromatography (HPLC).

R^2	SEC (%)	SECV (%)
0.952	0.33	0.37

Result protein in ice cream mix

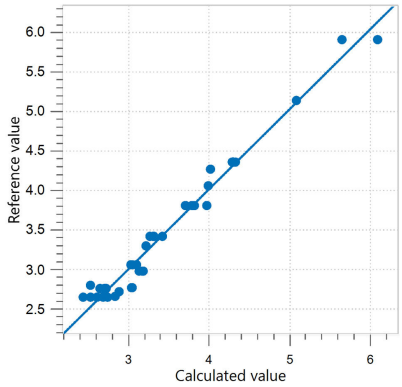


Figure 6. Correlation diagram and the respective FOMs for the prediction of protein content in ice cream mix. Reference values were obtained according to AOAC 930.33.

R^2	SEC (%)	SECV (%)
0.974	0.11	0.14

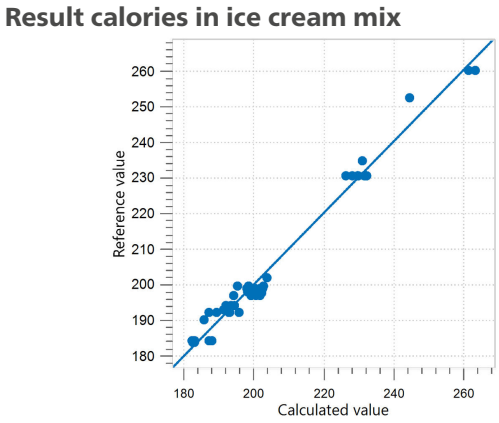


Figure 7. Correlation diagram and the respective FOMs for the prediction of calories in ice cream. Reference values were obtained by using a bomb calorimeter.

R^2	SEC (%)	SECV (%)
0.981	2.83	2.89

CONCLUSION

Among other parameters, total solids and fat determination in ice cream are crucial for quality control purposes. This Application Note shows the feasibility of using NIR spectroscopy for the analysis of calories, fat, total solids, lactose, sucrose, and protein content in ice cream. These parameters are determined simultaneously with NIRS. The analysis is easy and can be conducted in just seconds without any chemicals. The NIRS solution can be used for quality assurance in ice cream production, such as during the production process and for quality control of the final product.

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