Application Note

No. 050-AT-0215

Quantitative Analysis of Trans-fats in Food Products Using an FT/IR-ATR Method

Introduction

Trans-fats can be formed when liquid oils are solidified and used in various food products. The excessive ingestion of trans-fats increases LDL (bad) cholesterol in blood and decreases HDL (good) cholesterol. Consequently, the ingestion of trans-fat products can increase the incidence of ischemic cardiac disease and thus, the trans-fat content in food is of great concern. According to reports by a joint specialists conference of the Food and Agriculture Organization (FAO) and the World Health Organization (WHO) of the United Nations, it is proposed that the intake of trans-fats should be less than 1% of the overall caloric intake. As a result of these findings, many foreign countries are mandating the disclosure of trans-fat content in foods; some of the EU countries control the content in food and some other countries such as U.S., Canada and Korea are obligated to supply the trans-fat content on all food labels. In Japan, the Consumer Affairs Agency recently announced that food producers will be obligated to state the trans-fats content of food products as well.

For these reasons, it is becoming more important to measure the content of trans-fats in food. A quantitative analysis is generally performed according to the official method designated by public institutions, and gas chromatography (GC) or infrared spectroscopy are currently used for the official method for the content measurement of trans-fats. The GC method widely used requires some complicated procedures such as separation extraction of the sample and esterification, and thus requires considerable time and cost. The American Organization of Analytical Chemists (AOAC) formulate method AOAC 2000.10 by using infrared spectroscopy and ATR to evaluate the trans-fat content.

In this application, we demonstrated the quantitative analysis of trans-fats in several kinds of oil with a calibration made according to the official AOAC ATR method.

Experimental

Method AOAC 2000.10 requires a quantitative calibration be developed and the quantitative analysis of the unknown samples performed by measuring the samples with an ATR crystal heated to 65°C to melt the oils completely. The cis- and trans-fats contained in natural fats have their own IR peaks in the range from 1000 cm^{-1} to 600 cm^{-1}, which is used for the quantitative analysis (Figure 1). In the official method, cis-triolein and trans-trielaidin are used as the standard samples. The spectrum of cis-triolein in orange and the spectrum of trans-trielaidin in green are overlaid as displayed in Figure 1. Both spectra have similar absorptions in the mid-infrared spectral range except for specific peaks associated with the two different forms as displayed from 1000 cm^{-1} to 600 cm^{-1}.

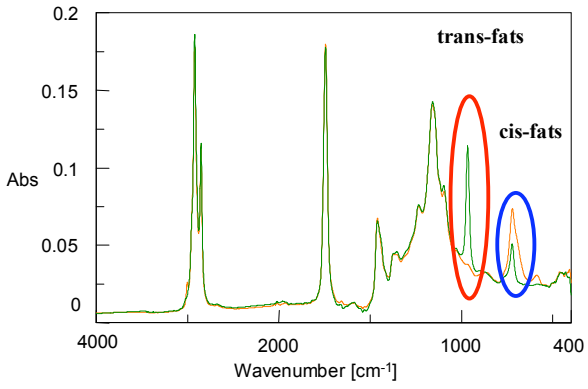

Figure 1: Mid-IR spectra of cis-fats and trans-fats (demonstrating the significant peaks in the highlighted areas)

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<Measurement Conditions>

Instruments: FT/IR-6100 and a thermostatted single reflection ATR accessory
Detector: DLATGS
Resolution: 4 cm^{-1}
Integration time: 64 scans
Temperature: 65 +/- 2°C
Apodization: Triangle
Method: ATR method (Crystal: Diamond)
Standard samples: Triolein and Trielaidin (Combination ratio of trielaidin: 0.5, 1, 5, 10, 20, 30, 40, 50 %)
Measurement samples: Shown in Table 1 (Sample volume: 50µL or less)

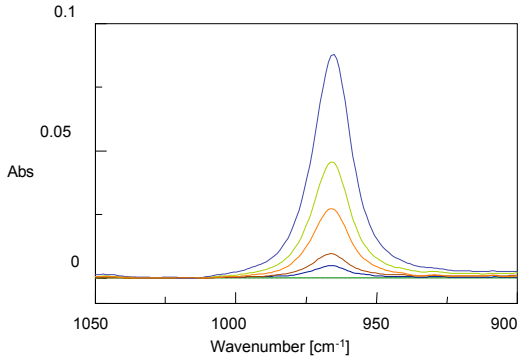

Figure 2: Peaks of trans-fats at 966 cm^{-1}

Results and Discussion

The trans-fat has a vibrational absorption peak due to the C-H bending mode near 966 cm^{-1} and the peak area around the peak is used for the quantitation in the official method. The overlaid spectrum for each concentration at 966 cm^{-1} are shown in Figure 2. Figure 3 is a screen shot of the Quantitative Calibration Program. The calibration curve calculated with the program is displayed in Figure 4. Table 1 outlines the result of the quantitative analysis of several commercial food oils. In general, margarine contains a trans-fat content of 1 to 10 %, and olive oil and sesame oil contain almost no trans-fat. This shows that the system as outlined is effective for the quantitative analysis of trans-fats.

By using the ATR methods, the quantity of trans-fats in various kinds of oil for food can be determined simply and quickly without complicated procedures.

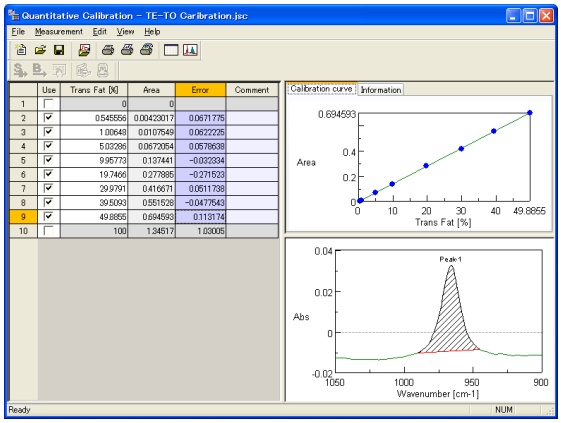

Figure 3: Quantitative Calibration Program

Table 1: Trans-fat content of food oils

Sample	Content rate of trans-fat [%]
Margarine	3.1
Cooking oil	1.9
Sesame oil	0.7
Olive oil	0.8
Chili oil	1.2

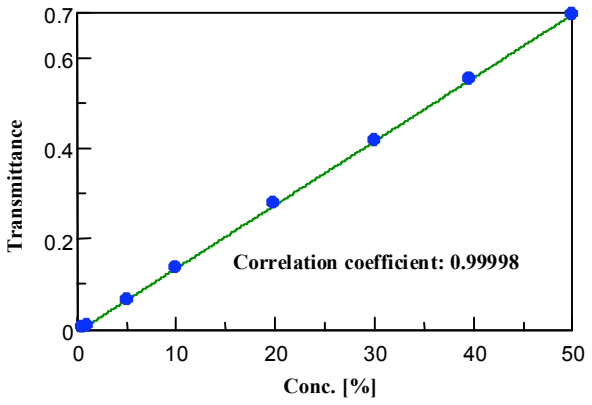

Figure 4: Calibration curve for trans-fat content