

Real-Time Monitoring of Thermally Induced *Trans* Fats in Corn Oil Using the FatIR™ Oil Analysis System



Figure 1. The FatIR™.

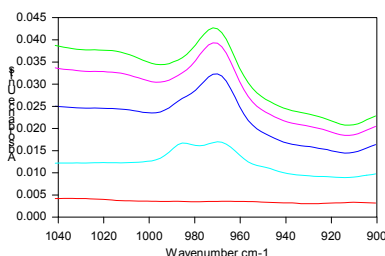


Figure 2. Real-time spectra in the *trans* double bond region of corn oil at 102°C after 5 min (red), 30 min (light blue), 70 min (blue), 115 min (pink), and 155 min (green).

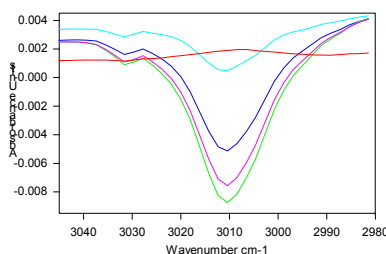


Figure 3. Real-time spectra in the *cis* double bond region of corn oil at 102°C after 5 min (red), 30 min (light blue), 70 min (blue), 115 min (pink), and 155 min (green).

INTRODUCTION

Trans fats (TFA) are unsaturated fatty acids whose carbon chains contain double bonds in the *trans* configuration rather than the more common *cis* configuration. Edible oils have only negligible amounts of TFA¹. However, when exposed to heat the *cis* double bonds in oil may be isomerized to their *trans* configuration. The amount of thermal isomerization is a function of temperature, exposure time and degree of unsaturation of the oil². In this application we monitored in real-time *in situ* the thermal isomerization of corn oil at a moderate temperature (102°C).

EXPERIMENTAL CONDITIONS

The spectra of the heated corn oil were collected *in situ* using the FatIR™ in an infrared spectrometer with a DTGS detector and conditions set for 32 scans at 4 cm⁻¹ resolution. Corn oil was placed on the slightly preheated (30°C) crystal covering the entire sampling surface. The spectrum of corn oil at 30°C was collected. The temperature of the crystal was slowly raised from 30°C to 102°C over a 15 minute period. Spectra of the corn oil at 102°C

were collected after 0, 5, 30, 70, 115 and 155 minutes. The crystal was allowed to cool to 30°C and the spectrum of the cooled corn oil was collected. The spectrum of corn oil at 102°C recorded at $t = 0$ minutes was subtracted from the spectra recorded after $t = 5, 30, 70, 115$ and 155 minutes.

RESULTS

Figure 2 illustrates the changes that take place in the *trans* double bond region (1050-900 cm⁻¹) of the spectrum due to prolonged exposure to moderate heat. There is a marked progressive rise in the 966 cm⁻¹ *trans* band with time. In addition to the rise of the 966 cm⁻¹ peak there is also an initial increase in the 985 cm⁻¹ peak that disappears later on.

The increase of the *trans* band with time is paralleled with a decrease of the band at 3010 cm⁻¹ associated with the CH stretching vibration of *cis* double bonds (Figure 3). By comparing the spectra of corn oil before heating ($T = 30^\circ\text{C}$) and after cooling back to 30°C, in the regions of interest (Figures 4 and 5), we see that there are heat induced changes in the *trans* and *cis* regions. Specifically, there is an increase in the concentration of the *trans* isomers and

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simultaneous decrease in the concentration of the *cis* isomers.

oils and fats, but also enables real-time *in situ* monitoring of the formation of heat induced TFA.

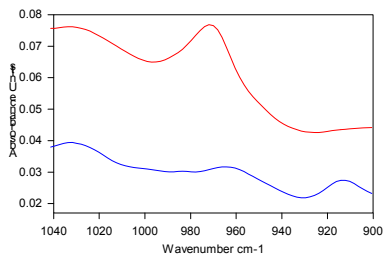


Figure 4. Real-time spectra in the *trans* double bond region of corn oil at 30°C before heating (blue), after cooling (red).

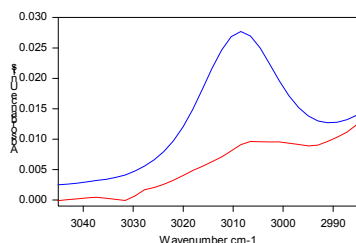


Figure 5. Real-time spectra in the *cis* bond region of corn oil at 30°C before heating (blue), after cooling (red).

¹ Masanari Semma, *Journal of Health Science*, **48(1)**, 7-13 (2002).

² F. R. van de Voort, A. A. Ismail, J. Sedman and G. Emo, *J. Am. Oil Chem. Soc.*, **71**, 243-253 (1994).

CONCLUSION

The new FDA requirement that *trans* fats be included in the Nutrition Facts panel has created a need for the routine determination of the total *trans* fat content of edible oils and fats and for the monitoring of the formation of *trans* isomers during processing of vegetable oils.

Harrick Scientific's FatIR™ Oil Analysis System not only provides a fast and easy way for the routine determination of the total *trans* fat content in edible



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