Discrimination of fishmeal and meat and bone meal by temperature-dependent two-dimensional correlation near-infrared spectroscopy

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1. Introduction

Fishmeal (FM) oil and meat and bone meal (MBM) fat differ in composition, length, and unsaturated degree of the fatty acids. Temperature-sensitive oil and fat may have changes during heating,[1-2] and subsequently result in minor spectral changes. The objective of this paper is to propose a FM and MBM identification method by temperature-dependent two-dimensional (2D) correlation near-infrared (NIR) spectroscopy technique, which has the advantage to capture small spectral changes by spreading peaks over the second dimension.[3-4]

2. Materials and Methods

2.1 Sample Preparation

42 samples (21 FM and 21 MBM) were collected. All samples were examined under optical microscopy to confirm their authenticity and purity.

2.2 Spectral Collection

PerkinElmer Spectrum400 FT-NIR spectrometer, Julabo F12-ED refrigerated/heating circulator, and Data Taker DT85 data logger were used to collect temperature-dependent NIR spectra.

One FM and one MBM (calibration) were scanned at temperature from 20℃ (room temperature) to 60℃ with an interval of 10℃ to determine the effective perturbation temperature levels. The remaining samples (independent validation) were scanned at the determined temperature levels. Each spectrum was acquired in the range of 6000-5400 cm^{-1} with a 4 cm^{-1} resolution.

2.3 Data Processing Procedure

All calculations were performed in Matlab v. 2009(The MathWorks, Inc., USA) with PLS Toolbox 5.5 (Eigenvector Research, Inc., USA). Wavelet transform , baseline correction, and mean-centering were consecutively applied to the spectra. 2D correlation maps were calculated[3] with 2 temperature-dependent spectra, one of which is always obtained at the room temperature.

3. Results and Discussions

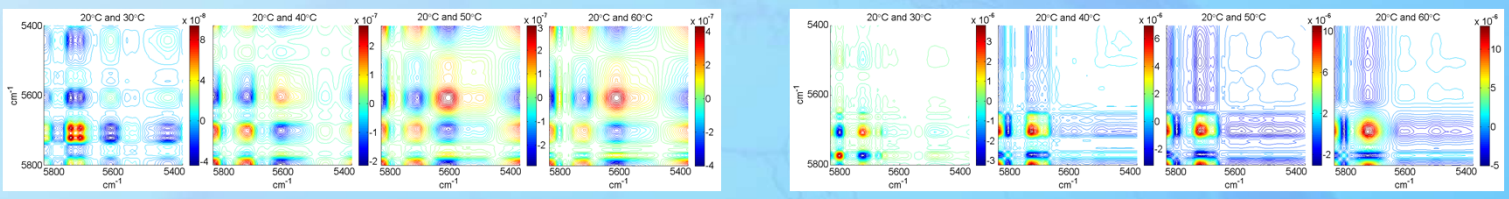

Fig.1. Calibration (Left) FM and (Right) MBM synchronous between 2 temperature levels of 20 ℃ and 30 ℃- 60 ℃

3. 1 Determination of Effective Perturbation Temperature Levels

At higher temperature, the 2D correlation maps exhibit higher synchronous intensity and stronger peaks (Fig. 1). Synchronous at 50 ℃ and 60 ℃ present more stable characteristics than those at 30 ℃ or 40 ℃. Thus, 20 ℃ and 50 ℃ are suggested as the effective perturbation temperature levels for validation.

3.2 2D Correlation NIR Feature of FM and MBM

Four regular positive peaks with approximately square and dense contour line are located at 5650-5400 cm^{-1} of calibration FM map (Fig. 1-FM-20℃ and 50 ℃). A central autopeak and 4 surrounding negative cross peaks are observed around 5787 cm^{-1} of calibration MBM map (Fig. 1-MBM- 20℃ and 50 ℃). These temperature-dependent 2D intuitive characteristics could be used to identify FM and MBM. The independent validation set of 20 FM and 20 MBM samples gives similar 2D correlation NIR features as those in the calibration set(Fig. 2).

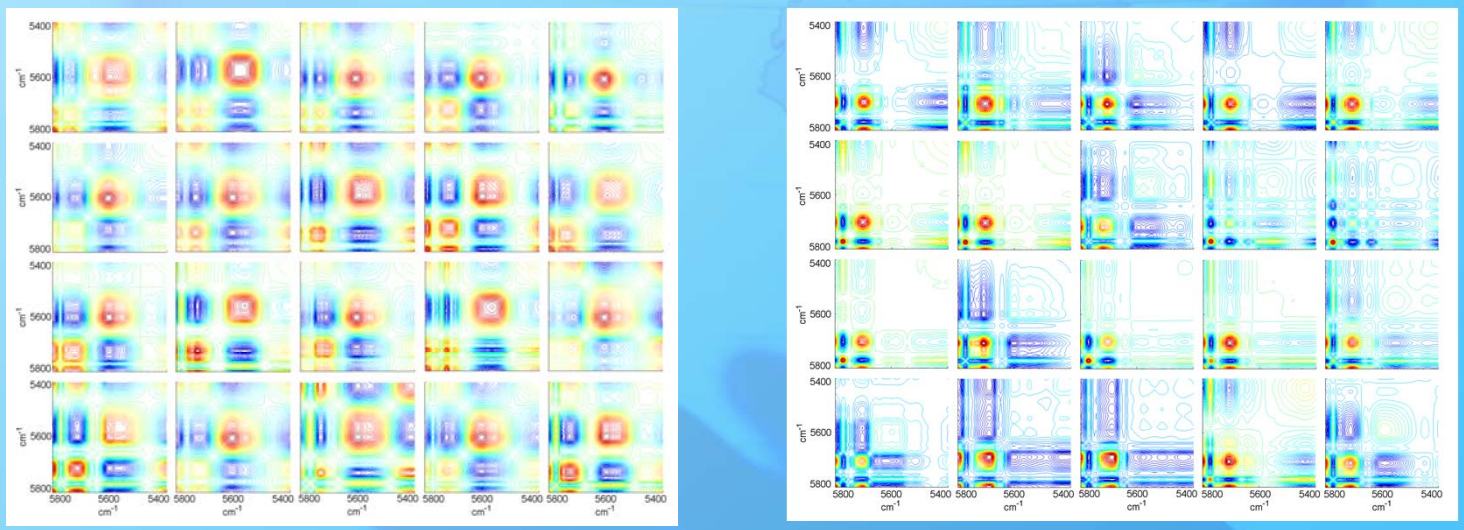

Fig.2. Validation (Left) FM and (Right) MBM synchronous with 20 ℃ and 50 ℃ dynamic spectra

4. Conclusions

By collecting dynamic NIR spectra at 20 ℃ and 50 ℃ in the spectral range of 6000-5400 cm^{-1}, FM and MBM can be successfully differentiated using 2D correlation synchronous.

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