

Nondestructive fermentation monitoring of fermented soy food "Tempeh" using NIR Spectroscopy

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Abstract

The NIR study on fermentative quality analysis of Tempeh, soybeans fermented food, has been performed. The obtained NIR spectra in the region of 500–1000 nm are useful for classification of fermentation state, while the spectra in the region of 800–2500 nm altered due to the proteins and lipids substances liberated during fermentation process. This work is to demonstrate the possibility of near infrared spectroscopy for the determination of degree of fermentation and quality evaluation of Tempeh.

Keywords: Tempeh, soybean, fermentation

Introduction

The fermented soy food “tempeh”, which is a traditional cuisine and ingredient in Indonesia, has recently been drawn attention as healthy food and good source of protein even in the other countries. Although the complicated fermentation conditions are very important for both substantial quality and taste, the present method is depending on experience and intuition. Therefore, we applied NIR spectroscopic study on fermentation process of Tempeh to analyze the quality of the healthful food.

Materials and methods

Sample

An 150 g of soybean (Yuzuru, produce of Hokkaido, Japan) was boiled and peeled before inoculation of Ragi Tempeh (purchased from Raprima, produce of Indonesia). The inoculated soybeans were incubated in sanplatec P-BOX for 24 hours in 32 degree C.

Spectral acquisition and Data analysis

The Fruits-Selector K-BA100R (Kubota) and the NIR spectrophotometer VECTOR22/N equipped with integrating sphere (Bruker) were used for NIR spectral acquisition of the regions 500–1000 nm and 800–2500 nm, respectively.

Data analysis was performed with Unscrambler X software. The PCA and hierarchical cluster analysis by single linkage method were applied to the obtained data.

Results and discussion

Figure 1 shows the obtained NIR spectra by using the Fruits-Selector K-BA100R under the fermentation process in incubation of 13–23 hours. The intensity of absorption for 500–700 nm is decreasing with respect to the increasing of fermentation time, while the feature near 830 nm is changed by proceed of ferment.

The score plot of the PCA analysis for NIR spectra in the region of 550–950 nm on the fermentation process of tempeh is shown in Figure 2, while the cross-section textures of well and partially fermented tempeh are shown in Figure 3. Comparison of the PCA results by nondestructive NIR measurements and texture cut by cross section of the incubated tempeh, the fully fermented tempeh are able to classify to No. 2 region while the insufficient one are assignable to No. 3 region in the calculated score plot. This results indicates that the degree of fermentation and quality evaluation of Tempeh are able to be determined by NIR spectra and chemometrics analyses.

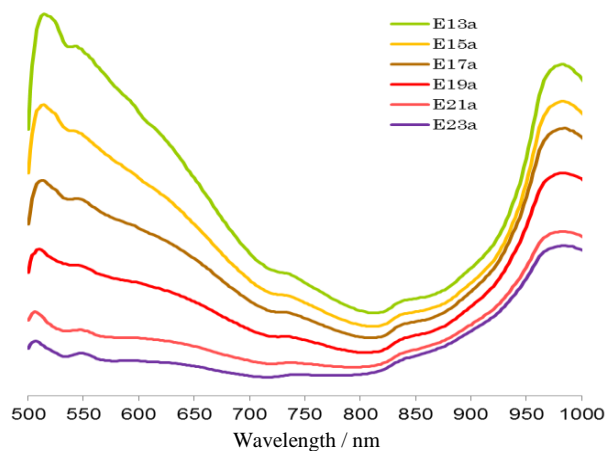


Figure 1. NIR spectra of tempeh

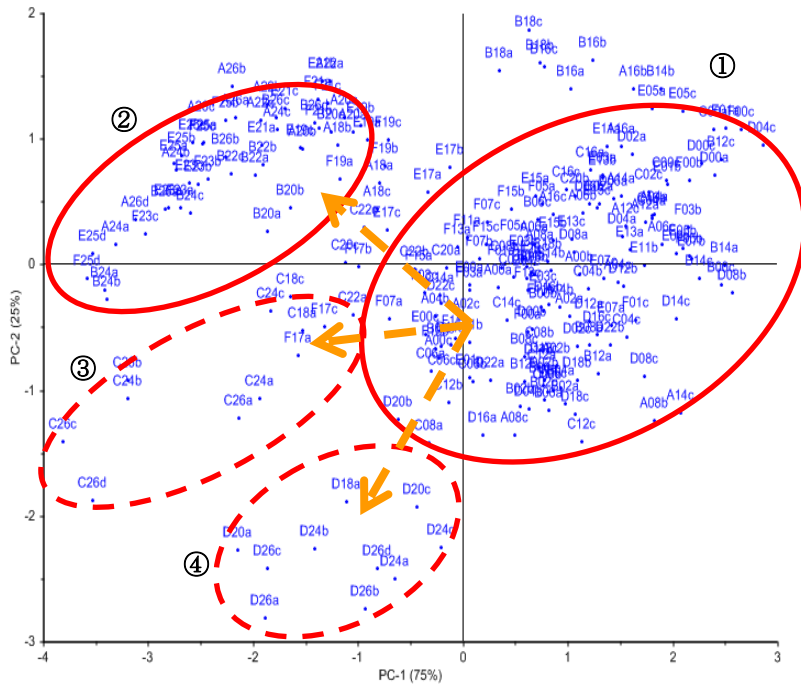


Figure 2. Score Plot of NIR spectra region 550–950nm



Figure 3. Texture of cross-section of classified in No.2 and No.3

In Figure 4 the NIR spectra for the region of 800–2500 nm during fermentation process of tempeh are compared. The spectral changes of the feature near 1650 nm and cluster analyses of the NIR spectra suggest that the proteins and lipids have been degraded to amino acid and fatty acid, respectively, during fermentation process.

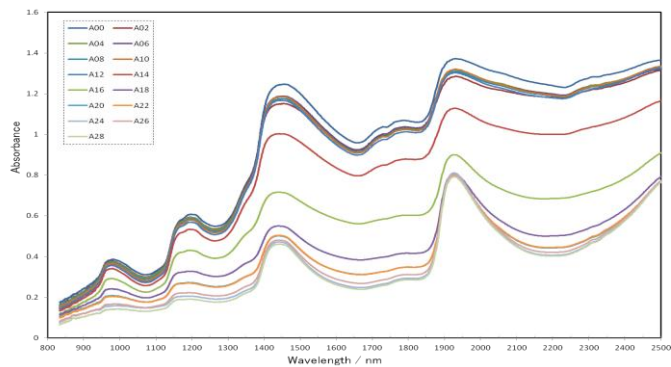


Figure 4. NIR spectra of tempeh for the region of 800–2500 nm

Conclusion

This study demonstrates that the identification and classification of fermentative molecular structural changes of proteins and lipids in food. Thus, the NIR spectroscopy had high potential for the determination of degree of fermentation and quality evaluation of fermented soy food Tempeh.

Acknowledgement

The authors express our sincere thanks to Professor Y. Ozaki at Kwansei Gakuin University for the NIR measurements by using integrating sphere and fruitful discussions.

Type of presentation: Poster Presentation