

Mid-Infrared Spectroscopic Analysis on Brewed Coffee Characteristics

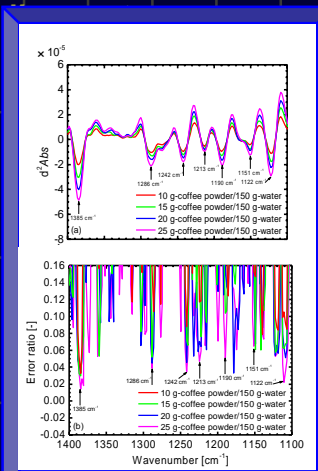
Atsushi Hashimoto¹, Hisanori Mori^{1,2}, Mikihiro Kanou¹, Atsushi Yamanaka¹, Takaharu Kameoka¹¹Department of Sustainable Resource Sciences, Faculty of Bioresources, Mie University, Tsu, Mie, 514-8507

Abstract

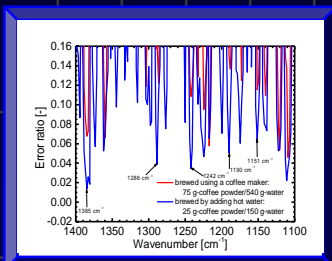
We developed a mid-infrared (MIR) spectroscopic evaluation method of brewed coffee, whose quality and taste highly depend on the properties such as the geographical origin and the roasting, grinding, blending and extraction conditions, using an FT-IR spectrometer equipped with an attenuated total reflectance (ATR) accessory. The objective and stable method to evaluate the brewed coffee characteristics is desirable, since the determination of coffee process conditions and the grasp of the characteristics of coffee varieties are very empirical in coffee manufacturing. Then we studied the influences of the coffee varieties and the roasting degree on the MIR spectral characteristics of brewed coffee and examined to determine the caffeine and chlorogenic acid contents in brewed coffee using the FT-IR/ATR method. Arabica (Colombia, Brazil and Guatemala) and Robusta (Indonesia) coffees roasted to City were prepared as the sample. Indonesian coffees roasted to Full City were also used. All roasted beans were ground to a standard cupping grind and brewed by adding hot water. As the results, the differences between the second derivatives of the ATR spectra of the brewed Arabica and Robusta coffees were observed around the several peaks. In addition, the brewed coffee from the Brazil variety had the different spectral features from those of the other Arabica coffees. Moreover, the roasting conditions of the Indonesian beans reflected the spectral features of the brewed coffee. Furthermore, the caffeine and chlorogenic acid contents in brewed coffee would be determined by the spectroscopic method as well as those in the aqueous solutions.

Experimental Results

Determination of Extraction Conditions for Spectral



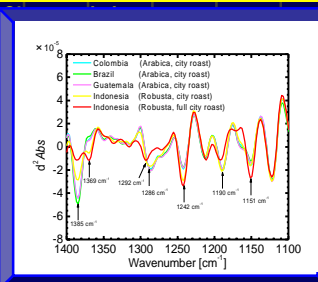
Influences of ratio of amount of coffee (Brazil) powder to water on the stability of MIR spectral characteristics of brewed coffee. (a) second derivative spectra; (b) ratio of standard deviation to average.



Comparison of error ratio for MIR spectra of brewed coffee (Brazil) between the two coffee brewing methods.

For collecting the stable MIR spectral information for the brewed coffee analysis, the brewing method adding hot water under the conditions of the 25 g-coffee powder to 150 g-boiled water was the most useful among all brewing conditions tested in this study.

Mid-Infrared Spectral Identification of Brewed Coffee



Influences of varieties, geographical origins and roasting degree of coffee beans on MIR spectral characteristics of brewed coffee.

It would be possible to identify the varieties and geographical origins of the beans by the MIR spectroscopic analysis of the brewed coffee, and the roasting conditions of the Indonesian beans reflected the spectral features of the brewed coffee.

Conclusion

This study represents as the very important step in developments of the MIR spectroscopic evaluation of the brewed coffee characteristics for determination of coffee process conditions and of the characteristics of the coffee varieties and geographical origins, which are very empirical in coffee manufacturing.

References

- Nakanishi, K. *et al.*: Mid-Infrared Spectroscopic Measurement of Ionic Dissociative Materials in Metabolic Pathway, *Applied Spectroscopy*, **57**(12), 1510-1516 (2003).
- Pan, T. *et al.*: Development of a Quantification System of Ionic Dissociative Metabolites Using an FT-IR/ATR Method, *Bioprocess and Biosystems Engineering*, **26**(2), 133-139 (2003).

Experimental

Coffee Samples

Arabica (Colombia, Brazil and Guatemala): City Roast, Standard Cupping Grind
Robusta (Indonesia) : Full City Roast, Standard Cupping Grind

Reagents

Caffeine and Chlorogenic Acid

Coffee Extraction Methods

1. Method adding hot water

150 mL of boiled water + 10, 15, 20 or 25 g of coffee powders

Agitation for 2 min

Filtration

Keeping at 298 K in a water bath

2. Method using Automatic Coffee Brewer (NC-1103; Matsushita Electric Industrial Co., Ltd.)

1350, 675, 540 or 337.5 mL of distilled water + 75 g of coffee powders

Cooling with iced water for 270 s

Keeping at 298 K in a water bath

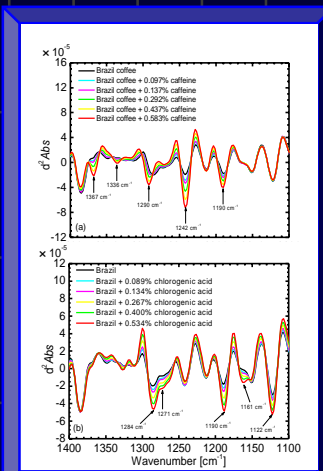
Spectral Measurement

FT-IR system: Magna 750, Nicolet

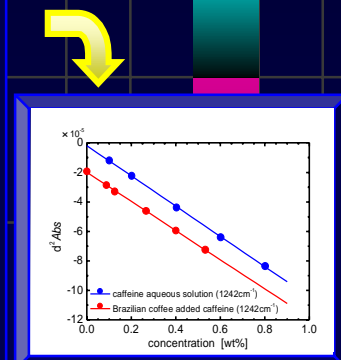
ATR accessory: DuraSampleIR, SensIR Technologies (IRE : diamond on a zinc selenide crystal)

Conditions: 64 scans, 4 cm⁻¹ resolution, 298 K

Quantitative Mid-Infrared Spectral Analysis of Brewed Coffee



Influences of addition of caffeine or chlorogenic acid into brewed coffee (Brazil) on the MIR spectral characteristics. (a) caffeine; (b) chlorogenic acid.



Comparison of error ratio for MIR spectra of brewed coffee (Brazil) between the two coffee brewing methods.

Fitting parameters and correlation coefficients of calibration

reagents	wavenumber [cm ⁻¹]	solvent	slope [wt% ⁻¹]	intercept [wt%]	correlation coefficient [-]
caffeine	1242	brewed coffee	1.003x10 ⁻⁴	1.939x10 ⁻⁵	0.999
	1242	pure water	1.047x10 ⁻⁴	0.066x10 ⁻⁵	0.999
chlorogenic acid	1122	brewed coffee	3.685x10 ⁻⁵	3.014x10 ⁻⁵	0.998
	1120	pure water	4.925x10 ⁻⁵	0.121x10 ⁻⁵	0.998

Using the MIR spectroscopic information, we could quantify the caffeine and chlorogenic acid contents in the brewed coffee as the very complicated system and might analyze the quality as the liquid food.