FTIR microspectroscopy imaging promising tool to study biomacromolecular distribution in biological samples

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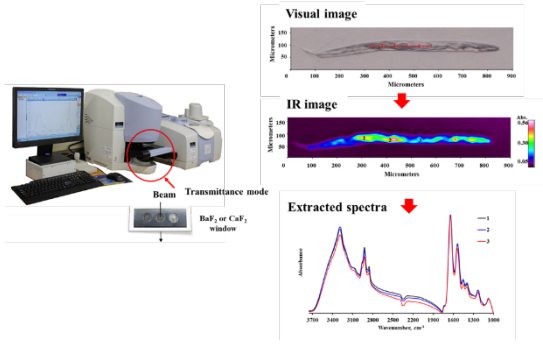
Abstract

Fourier Transform Infrared (FTIR) microspectroscopy is a non-destructive technique for the study of various materials including biological samples. It provides information on the presence of chemical species as well as their distribution within a sample. The IR spectrum of a material is made of absorption peaks, which represent frequencies of vibrations between bonds of the molecules making up the material. Because different materials have a unique combination of molecules, they exhibit different IR signatures. Thus, the IR spectra provide a unique chemical fingerprint of the samples. In this study, we used FTIR imaging to study the biochemical profile in white adipose (WAT), brown adipose (BAT), liver tissues, and intact *C. elegans* worms. First, we developed a detailed protocol for cryo-sectioning tissues with a high-fat content, which are considered the most difficult-to-cryosection tissues. We found that adjusting the temperature of the cutting blade and the sample is the key to cryosection tissues rich in fat. In the second study, we used FTIR imaging to investigate biochemical changes in WAT and BAT that are associated with the development of obesity. We identified several infrared bands, infrared peak ratios, and data analysis techniques to monitor vital changes in BAT and WAT. In the third study, we used FTIR imaging to investigate biochemical changes associated with developing non-alcoholic fatty liver disease. We identified fatty liver-associated changes in fat distribution in mouse liver tissues and structural changes in fatty acid molecules. In the fourth study, we used FTIR imaging to study diet, genotype, and age-dependent biochemical changes in wild-type (N2) and mutant (Tub-1 and Fat-3) *C. elegans* strains. These studies paved the way for understanding the biochemical changes in intact nematodes in response to induced changes (e.g., drug, diet, and pathogenesis of diseases).



Recent Publications

1. Liyanage, S., & Abidi, N. (2019). Fourier transform infrared applications to investigate induced biochemical changes in liver. *Applied Spectroscopy Reviews*, 0(0), 1–33.
2. Bouyanfif, A., Liyanage, S., Hequet, E., Moustaid-Moussa, N., & Abidi, N. (2019). FTIR microspectroscopy reveals fatty acid-induced biochemical changes in C. elegans. *Vibrational Spectroscopy*, 102, 8–15.
3. Liyanage, S., Bouyanfif, A., Ramalingam, L., Moustaid-Moussa, N., & Abidi, N. (2018). Application of FTIR imaging to detect dietary-induced biochemical changes in brown and white adipocytes. *Vibrational Spectroscopy*, 97(May), 91–101.
4. Bouyanfif, A., Liyanage, S., Hewitt, J., Vanapalli, S. A., Moustaid-Moussa, N., Hequet, E., & Abidi, N. (2017). FTIR imaging detects diet and genotype-dependent chemical composition changes in wild-type and mutant C. elegans strains. *Analyst*, 142, 4727–4736.
5. Liyanage, S., Dassanayake, R. S., Bouyanfif, A., Rajakaruna, E., Ramalingam, L., Moustaid-Moussa, N., & Abidi, N. (2017). Optimization and validation of cryostat temperature conditions for trans-reflectance mode FTIR microspectroscopic imaging of biological tissues. *MethodsX.*, 4, 118–127.

Biography

Dr. Noureddine Abidi is Professor of Biopolymers and Bioproducts and Director of the Fiber and Biopolymer Research Institute at Texas Tech University. His focus is on the chemistry of biopolymers, particularly cellulose, and their transformation to advanced materials. He holds a "Habilitation à Diriger les Recherches" from the University of Haute Alsace in France and a Ph.D. from the University of Montpellier II in France. Dr. Abidi has generated 147 refereed journal publications and book chapters, 3 books, more than 182 presentations, 9 patents/provisional patents. Abidi has served as PI or co-PI on funded research grants totaling more than $17M. He received several awards such as Texas Tech University Chancellor's Council Distinguished Research Award, Texas Tech University Outstanding Research Award, Texas Tech University President's Mid-Career Award, Fulbright US Scholar Award, Texas Tech University Integrated Scholar Award, American Chemical Society Cellulose and Renewable Materials Division Fellow.