

Determination of Characteristic Differences of Honey Samples by Using THz-TDS and FTIR Spectroscopy For Quality Standardization



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ABSTRACT

In this study, characteristic differences of honey samples will be determined with respect to local conditions, types and crystallizations by using terahertz time domain and Fourier transformation infrared spectroscopies. The differences and qualities of the samples will be determined via spectrum analysis with help of a multivariate analysis method; principal component analysis.

INTRODUCTION

Honey is a highly consumed natural product. Numerous parameters such as local conditions, product processing, kind, color and scent may be related to the quality of honey. These parameters should be considered when mentioning about the quality. Anything sold as honey has to be produced by bees from the secretions of plants, and also should not contain any additives and contaminants. Yet, selling adulterated or simulated honey has become very common. Authentication of honey gains great importance at this point.¹

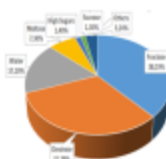


Figure 1. Chemical Composition of Honey



Figure 2. Terahertz Frequency Interval

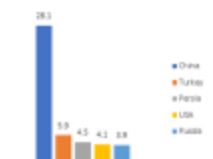


Figure 3. Important Countries in Honey Production, %

METHOD & ANALYSIS

Attenuated Total Reflection (ATR)
Principal Component Analysis (PCA)



Figure 4. The Thermo Scientific Nicolet iS10 FT-IR Spectrometer



Figure 5. Thermo Nicolet 6700 FTIR spectrometer

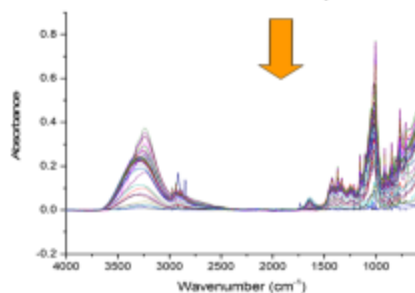


Figure 6. ATR-FTIR Spectrum of All Samples

PCA

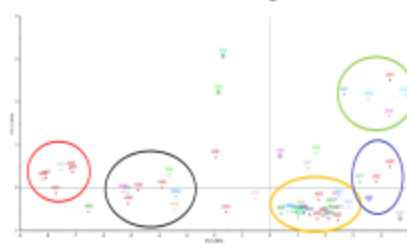


Figure 7. PC1 vs. PC2 Scores Plot of ATR-FTIR Data of All Regions

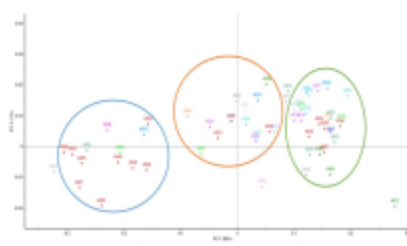


Figure 8. PC1 vs. PC3 Scores Plot of Region 3

- Sharp peaks
- Intensity differences
- Water peaks
- Region 1: 3000-2800 cm⁻¹
C-H Stretching (carbohydrates)
O-H Stretching (carboxylic acids)
NH₃ Stretching (free amino acids)

- Region 2: 1700-1600 cm⁻¹
O-H Stretching/Bending (water)
C=O Stretching (mainly carbohydrates)
N-H Bending of amide (mainly proteins)

- Region 3: 1540-1175 cm⁻¹
O-H Stretching/Bending
C=O Stretching (carbohydrates)
C-H Stretching (carbohydrates)
C=O Stretching of ketones

- Region 4: 1175-940 cm⁻¹
C-O & C-C Stretching (carbohydrates)
Ring Vibrations (mainly from carbohydrates)

Principal Component Analysis (PCA)

- Dimension-reduction tool
- Reduce a large set of variables to a small set
- Still contains most of the information in the large set

Time Domain Terahertz Spectroscopy (THz-TDS)
Principal Component Analysis (PCA)

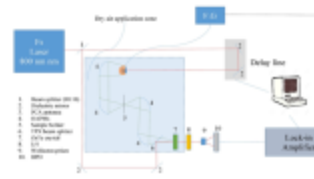


Figure 9. The Block Diagram of THz-TDS



Figure 10. THz-TDS Spectrum and FFT Applied Spectrum of Sample A001

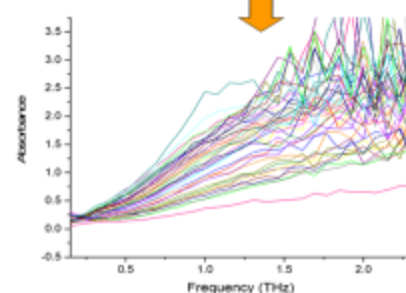


Figure 11. Absorbance vs. Frequency Plot of 45 Samples

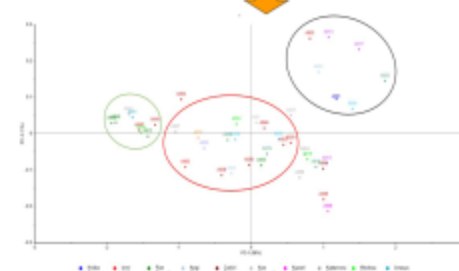


Figure 11. PC1 vs. PC2 Scores Plot of THz-TDS Measurements

ACKNOWLEDGEMENT

We acknowledge Turkish Beekeepers Association for providing us the most of the honey samples

REFERENCES

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- 2.Aytekin, Y.S., Time Domain Terahertz Spectroscopy: Construction of The Setup and Application in Analysis of Active Pharmaceutical Ingredients (Yüksek lisans tezi, ODTÜ, Türkiye), 2016

CONCLUSION

ATR-FTIR and THz-TDS spectra of honey samples were collected and their PCA analysis were performed. The PCA results were analyzed with only known information about the samples, the geographical regions and honey types.