

FTIR-ATR Characterization of Commercial Honey Samples and Their Adulteration with Sugar Syrups Using Chemometric Analysis

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Abstract

Honey is a valuable food commodity that gains a lot of attention due to its potential health benefits and usage to sweeten foods and beverages. To save on manufacturing costs, honey is susceptible to deliberate adulteration with sugar syrups such as corn syrup. Honey adulteration does not pose significant health problems, but it negatively influences market growth and consumer confidence. Fourier transform infrared spectroscopy (FTIR) with

attenuated total reflectance (ATR) was used to collect absorption spectra of various commercial honey samples. Partial-least squares (PLS) was used to process FTIR spectra to determine the potential adulteration of honey samples. The techniques presented in this work provide an alternative to determine the purity and authenticity of foods, such as honey, and other natural products.

Introduction

- Pure Honey contains multiple types of sugars primarily composed of Fructose, Glucose, and Sucrose
- Reported Ratio of Fructose:Glucose for Pure Honey is 1.2:1
- Elevations in Glucose Levels may suggest the presence of added sugars such as Corn Syrup, commonly referred to "Glucose Syrup"
- Relative percentages of each sugar
 - Fructose: (33-43%)
 - Glucose: (25-35%)
 - Sucrose: (0-2%)
- It is expected that Honey Adulterated with cheaper alternatives such as Corn Syrup will Show Elevated Levels of Glucose

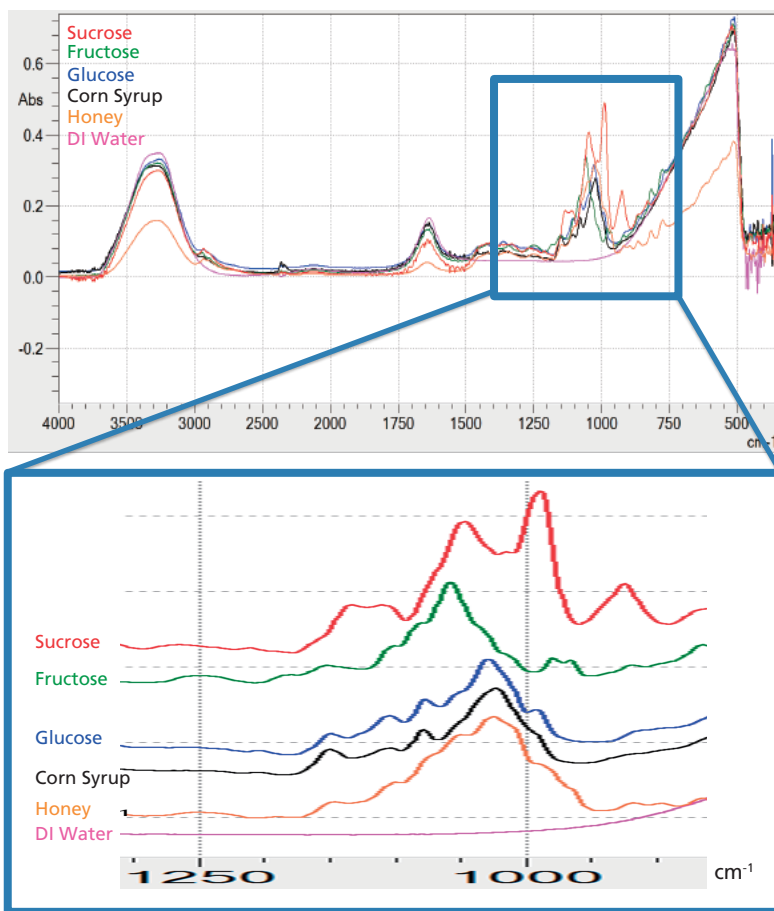
Method

- Nine separate commercial honey samples obtained and diluted 10% W/W in deionized water
- Absorbance spectra collected on the Shimadzu IRTracer-100 with ZnSe Quest ATR from Specac
- Using Chemometric Analysis sugar content was estimated for Fructose, Glucose, and Sucrose for each of the samples

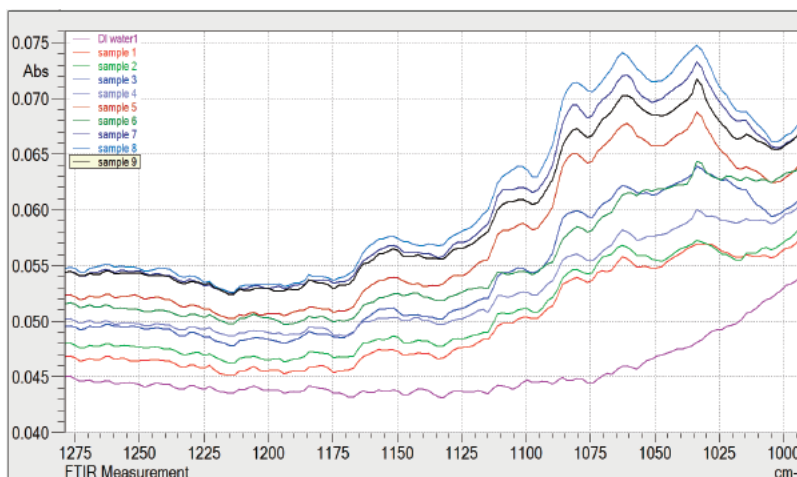


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FTIR Spectra of 50% Aqueous Sucrose, Fructose, Glucose, Corn Syrup, and Honey



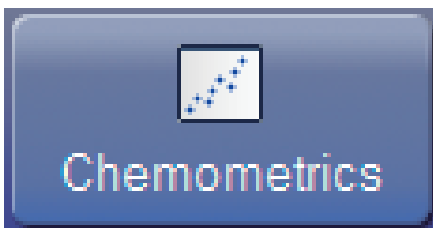
FTIR Spectra of 10%W/W Honey Samples diluted in DI Water



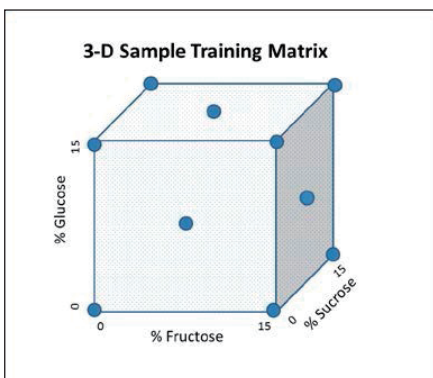
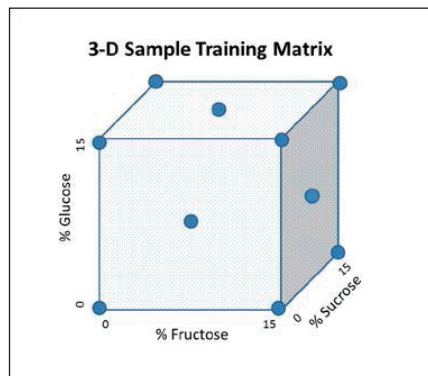
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Chemometric Analysis

- Chemometric factor-space analysis was utilized to establish simultaneous calibration curves for the three sugar aqueous mixtures. Partial Least Squares (PLS) was selected as the factor-space routine of choice.
- Amounts of Fructose, Glucose, and Sucrose were estimated.



- A training set of samples was prepared to cover full 3-dimensional quantitative space required for analysis of the Honey Samples.



Sugar Concentration (Mass Percent)			
Sample	Fructose	Glucose	Sucrose
1	0.00	0.00	0.00
2	5.08	0.00	0.00
3	10.06	0.00	0.00
4	0.00	5.00	0.00
5	0.00	10.22	0.00
6	0.00	0.00	4.37
7	0.00	0.00	3.34
8	4.32	4.91	0.00
9	0.00	5.10	4.95
10	4.95	0.00	4.91
11	10.10	10.55	0.00
12	0.00	9.83	9.88
13	10.21	0.00	10.03
14	5.10	5.06	5.04
15	10.11	9.84	9.94
16	3.84	7.83	2.68
17	7.94	5.03	1.75
18	1.83	4.67	0.73
19	0.48	2.94	3.07
20	4.95	6.39	1.47
21	3.99	2.66	7.21
22	3.56	3.53	9.63
23	4.97	4.96	9.95
24	10.13	5.05	5.05
25	4.92	9.84	4.94
26	14.95	0.00	0.00
27	0.00	14.99	0.00
28	0.00	0.00	14.72
29	15.14	15.26	0.00
30	15.31	0.00	15.24
31	0.00	15.15	15.16
32	14.97	14.98	7.59
33	14.89	7.45	14.97
34	7.53	15.14	15.21

PLS Calibration Report

Algorithm:	PLS I		
Number of components:	3		
Number of references:	25		
Range[1]:	963.00 - 1486.00		
Preprocess:			
Scale:	None		
Component:	Fructose	Glucose	Sucrose
Number of factors:	5	5	5
Correlation coeff.:	0.9990	0.9987	0.9986
Square of correlation coeff.:	0.9980	0.9973	0.9973
MSEP:	0.0019	0.0026	0.0026
SEP:	0.0441	0.0506	0.0513
X Leverage warnings:	3	3	3
Y Residual warnings:	1	0	2

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Calibration Results for 9 Separate Honey Samples

Sample	Claim	Fructose	Glucose	Sucrose	Fructose:Glucose
1	100% Pure Honey	0.081	0.242	0.00	0.33
2	100% Pure Honey	0.119	0.180	0.00	0.66
3	100% Pure Honey	0.186	0.367	0.00	0.51
4	Pure Clover Honey	0.031	0.236	0.00	0.13
5	100% Pure Honey	0.279	0.404	0.00	0.69
6	Made with 7% Honey	0.00	0.299	0.089	0.00
7	N/A	0.462	0.428	0.00	1.08
8	N/A	0.536	0.464	0.00	1.16
9	Grade A	0.379	0.363	0.000	1.04

Conclusions

- Based on the obtained results, the honey samples which claim to be 100% pure honey (Samples 1-5) actually show elevated levels of Glucose.
- This may suggest that these samples potentially could contain other adulterants such as Corn Syrup, which is commonly known as "Glucose Syrup".
- Sample #6, labeled to contain 7% real honey, exhibited a large concentration of sucrose. This may suggest the use of sugar water in the preparation of that product.
- FTIR-ATR analysis is an ideal technique for the quick screening of honey samples for adulteration.

References

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