

Thermal Decomposition of Iso-Alpha Acids

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Abstract

Hops, a flower added to beer in attempt to balance its sweet flavors, contain alpha acids that isomerize throughout the brewing process into iso-alpha acids. Iso-alpha acids are largely responsible for the complementary bitter taste and are measured in IBU (International Bitterness Units). Iso-alpha acids degrade over time due to temperature and light exposure, which ultimately changes the flavor profile of beer. As a result, our research consists of determining the rates of degradation of standard samples of iso-alpha acids at different temperatures in order to determine rate constants and an activation energy for the decomposition. This is accomplished using high-performance liquid chromatography (HPLC) and the method of internal standard. This research will benefit both beer enthusiasts and breweries by obtaining a better understanding of beer shelf life and the ever-changing chemical composition of a bottled beer.

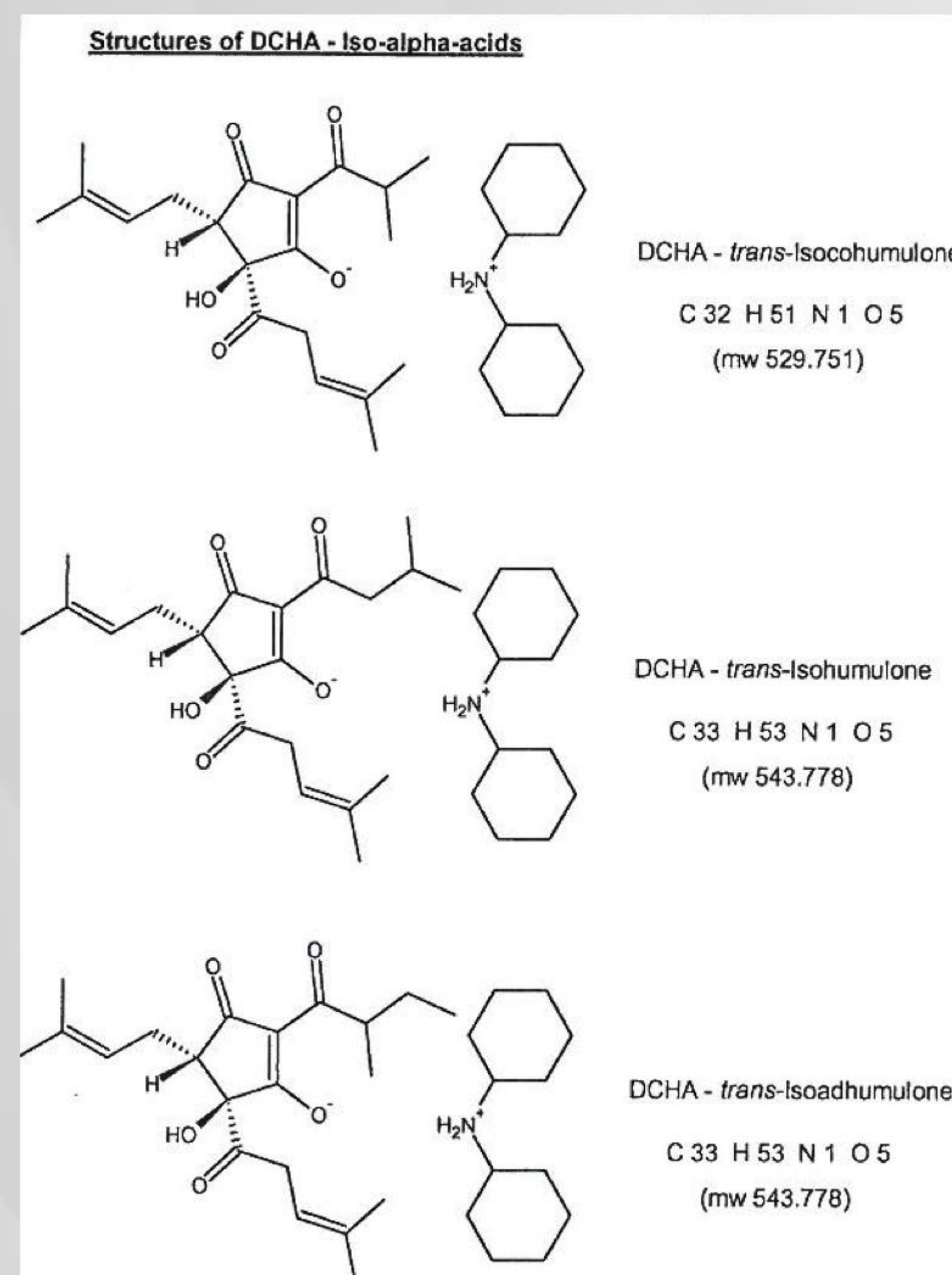
Goals

- Quantify iso-alpha acids in standard samples using HPLC
- Determine rates of degradation of iso-alpha acids at different temperatures
- Determine an activation energy of thermal decomposition

Experimental

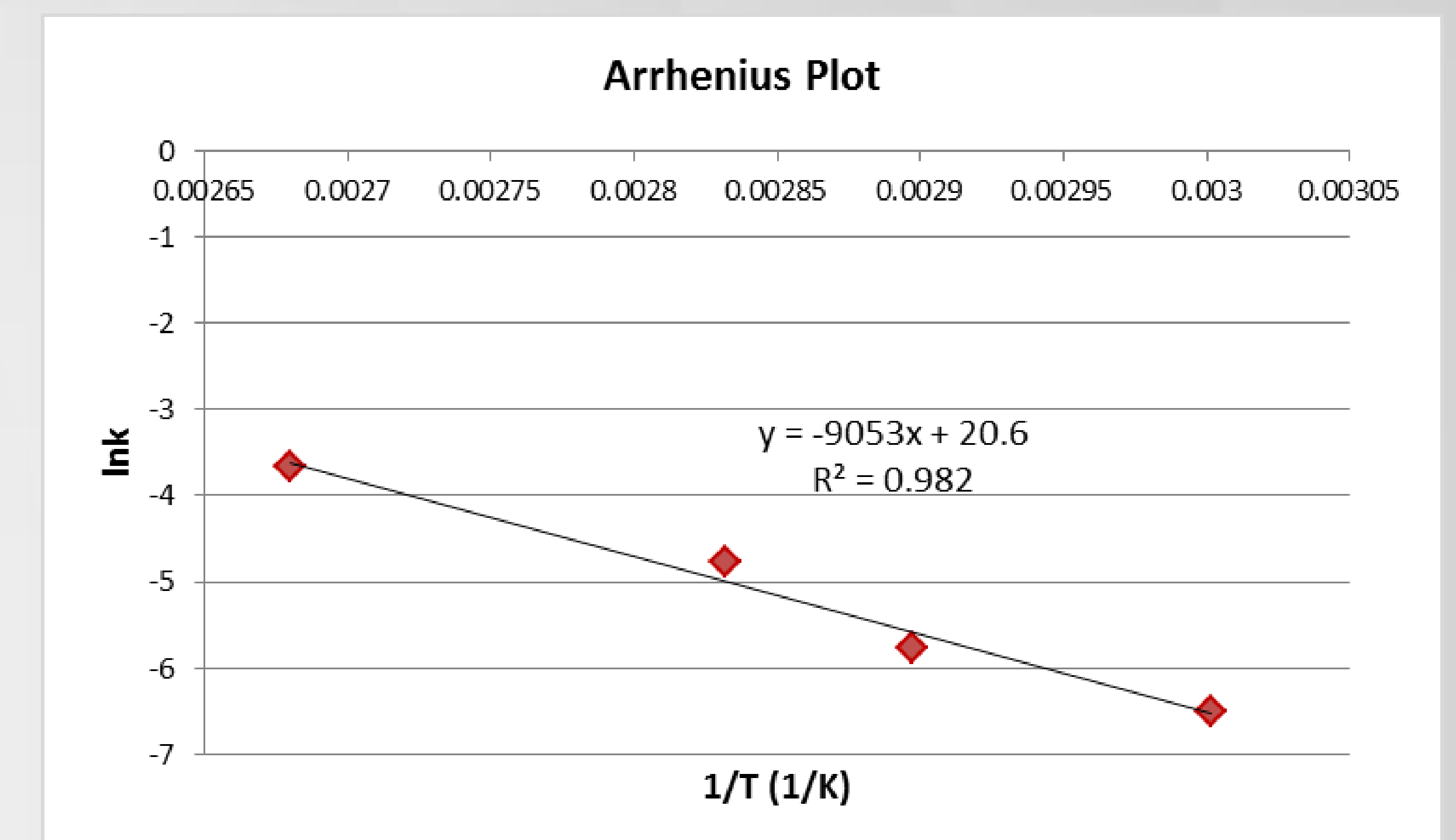
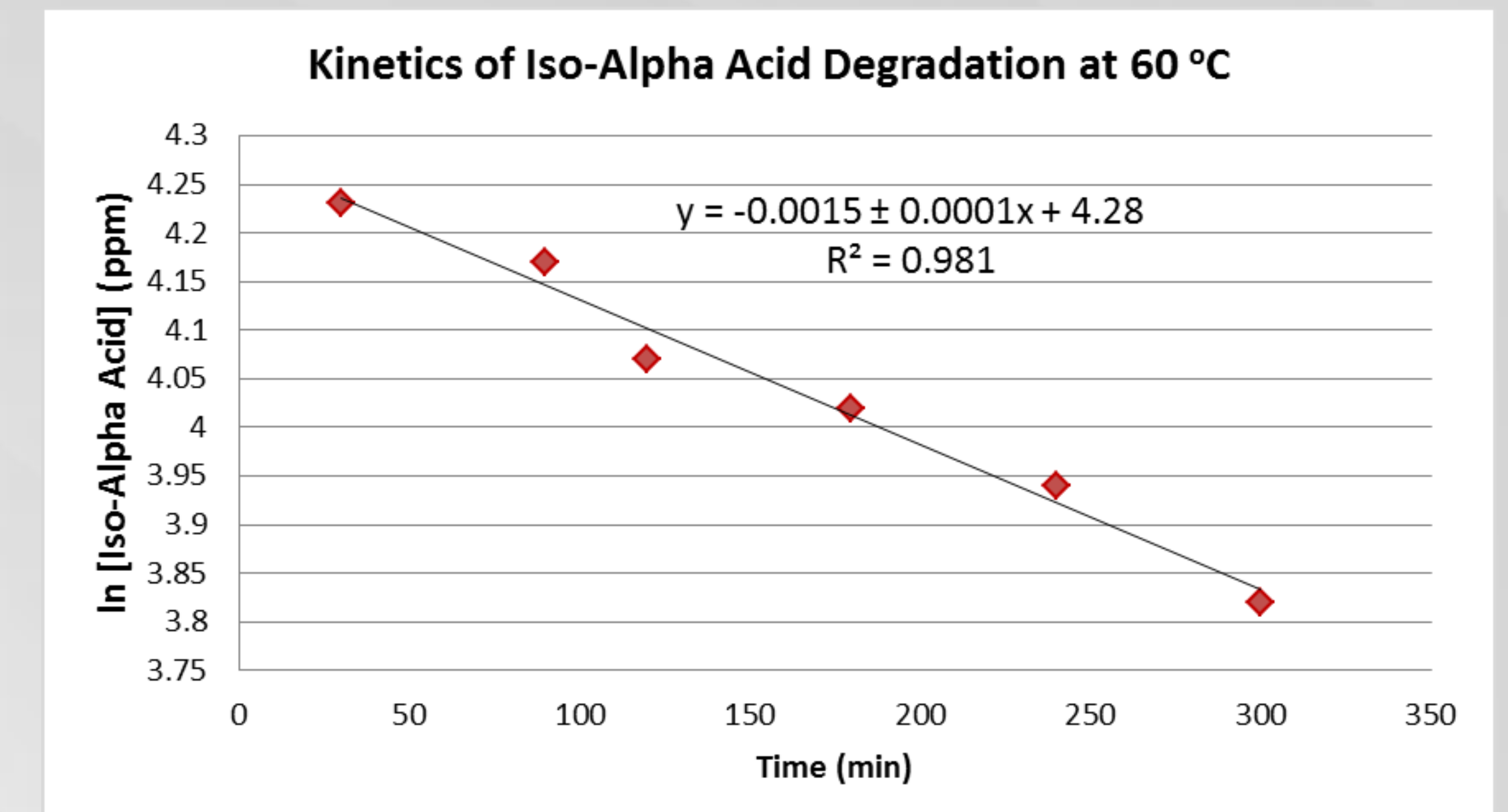
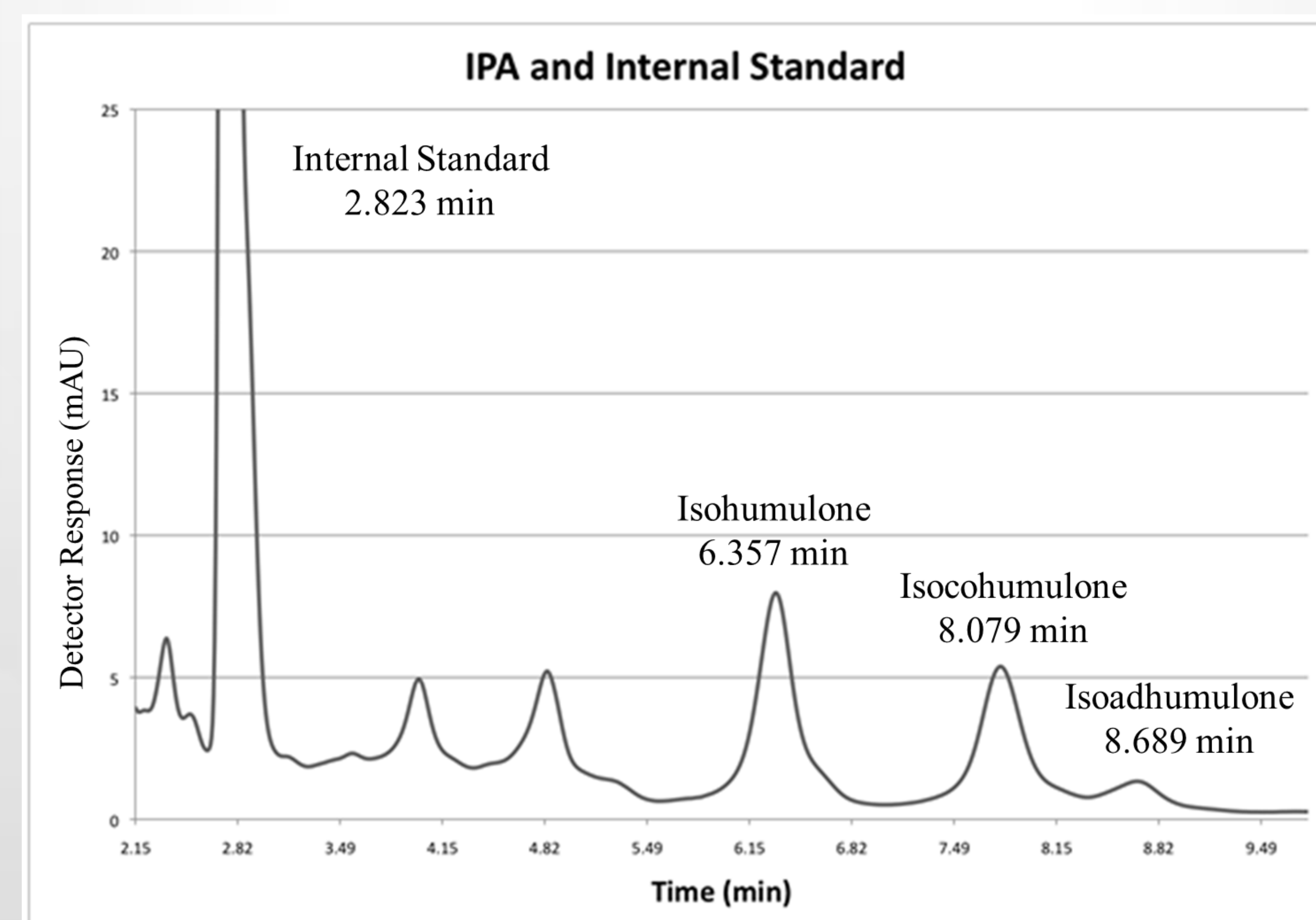
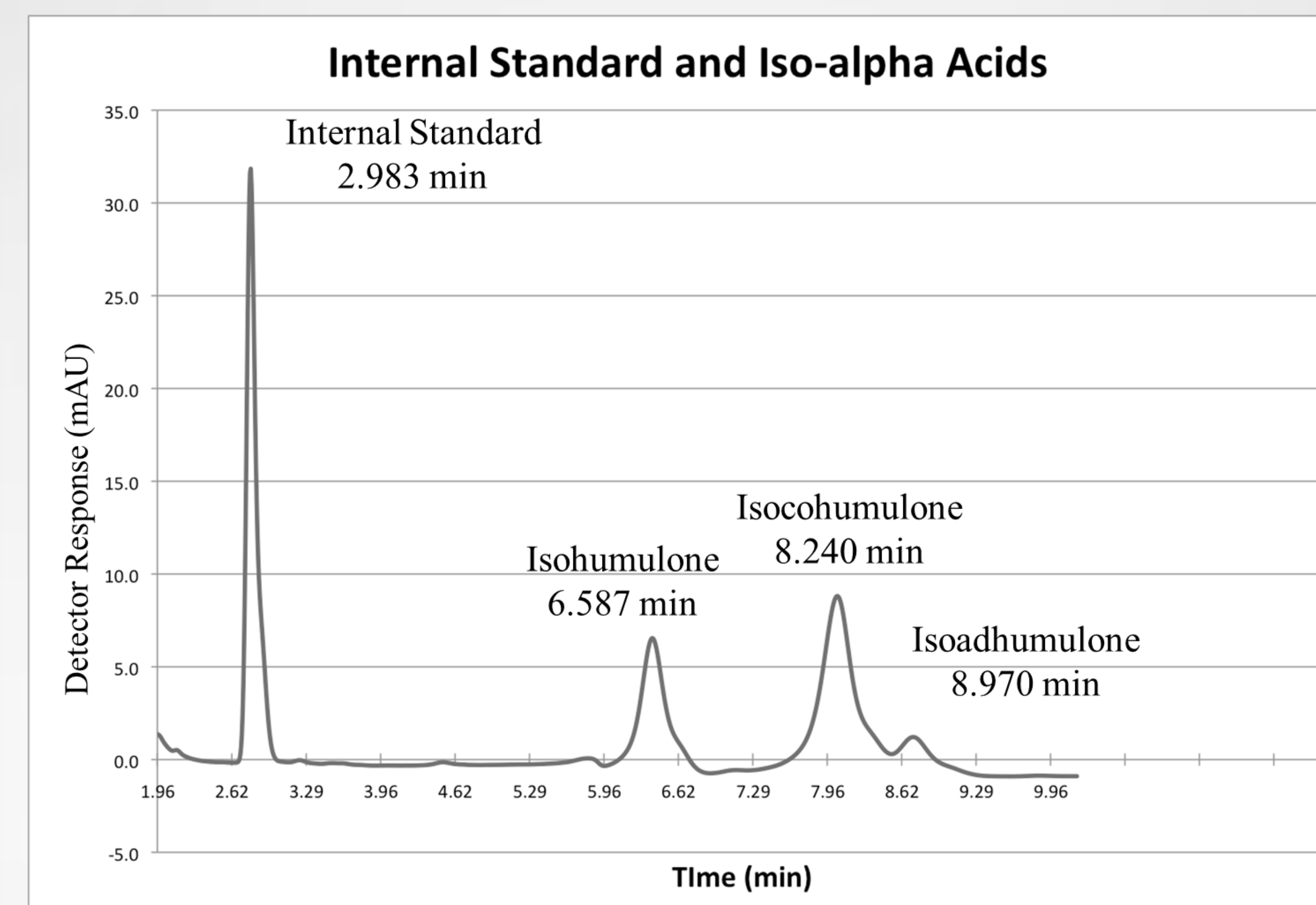
A Hewlett Packard Series 1100 HPLC, with the following experimental parameters, is used to separate, identify, and quantify components of mixtures.

- HP series 1100 column (4.6 x 250 mm, C18, 5 mm) set to 35°C
- Mobile phase consists of 750 mL HPLC grade methanol, 240 mL E-pure water, 10 mL H₃PO₄(85%)
- Detection wavelength of 270 nm
- 2.0 mL/min flow rate
- 20 µL sample loop



$$\frac{I_s}{[S]} = F \frac{I_x}{[X]}$$

I_s = total peak area of internal standard
 $[S]$ = concentration of internal standard
 F = response factor
 I_x = total peak area of iso-alpha acids
 $[X]$ = iso-alpha acid concentration (IBU)



T (±1°C)	k (min ⁻¹)
60	0.0015 ± 0.0001
72	0.0032 ± 0.0002
80	0.0085 ± 0.0001
100	0.025 ± 0.004
E_a (kJ/mol)	75 ± 7

Future Work

- Measure rate constants of thermal degradation at lower temperatures (down to room temperature)
- Use Gas Chromatography/ Mass Spectrometry to determine thermal decomposition products

Acknowledgments

- Zachary Vincent, Jasper Shotts, Daniel Ohlson, and other previous research students
- Paul Ennis
- ASBC
- Rockslide Brewery
- Kannah Creek Brewing Company

