Enhancement of Undergraduate Chemistry Laboratory Experiences Through a Collaboration of Industry and Academia

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Background

1) Analytical instrumentation in undergraduate laboratories is critical for the scientific training of students at colleges and universities.
2) LECO Corporation is currently involved in various projects:

a) Cooperative education
b) Technology presentations
c) Mobile bus visits – Showcase technology to researchers
d) Laboratory experiments – "hands-on" instrument activities for students and faculty

Objective

To enhance education through exposure to modern analytical instrumentation (GC-TOFMS) and software

Collaboration Institutions

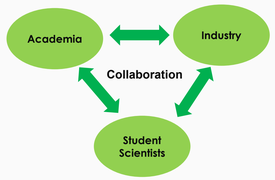
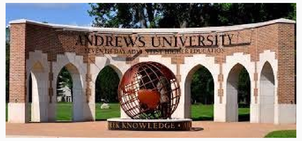


Figure 1: Project Interactive Strategy

Indiana University at South Bend

Public University, 3rd largest IU System Campus
Location: South Bend, IN
Enrollment :

- Undergraduate 4,375
- Graduate 567



Andrews University

Private Institution, Seventh-Day Adventists
Location: Berrien Springs, MI
Enrollment:

- Undergraduate 1,434
- Graduate 1,955

Figure 2: LECO Corporation Markets

LECO Corporation

Instrument Manufacturer
Location: St. Joseph, MI
Instruments:

- Analytical Science
- Metallographic Science
- Separation Science

Project Tools

Figure 3: LECO Mobile Laboratories

Figure 4: Pegasus BT 4D

Mobile Lab Instruments

- GC-TOFMS and GCxGC-TOFMS
- Low fg sensitivity
- 10^5 Linear dynamic range

L-PAL3 Autosampler

- Liquid
- Headspace
- SPME

Results and Discussion

1) Organic Chemistry

Figure 5: Acid-catalyzed dehydration of 2-methylcyclohexanol

Experimental Concepts

a) Dehydration Reactions
- Mechanism of Elimination Reactions
- Stability of Intermediates
- Hydride/Alkyl Shifts
- Thermodynamic Stability of Isomeric Alkenes

b) Gas Chromatography – Mass Spectrometry
- Total Ion Current (Separation science)
- Molecular Ion (Structural information)
- Fragment Ions (Carbocation/radical)

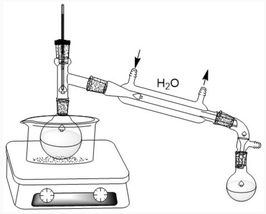


Figure 6: Simple Distillation Glassware for Dehydration Reaction

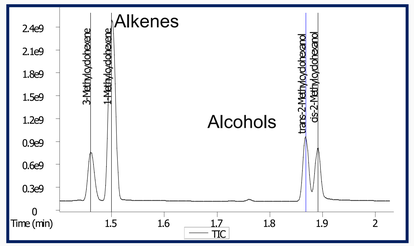


Figure 7: Product Mixture Total Ion Chromatogram

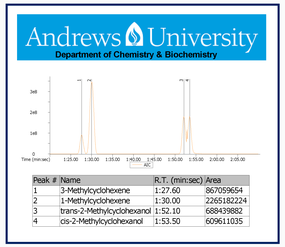


Figure 8: Mobile Lab Analysis Report

Results and Discussion

2) Instrumental Analysis: Quantitative Analysis of Acetaminophen and Caffeine

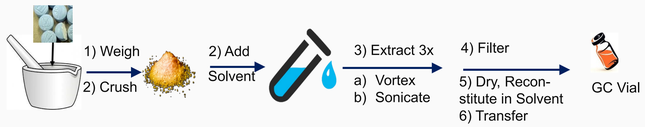


Figure 9: Sample Preparation – Extraction

Experimental Concepts

a) Quantitative Analysis
- Gas Chromatography
- Chromatographic Parameters
- Instrument Parameters

b) Mass Spectrometry
- Ionization Methods
- Mass Analyzers
- Detectors

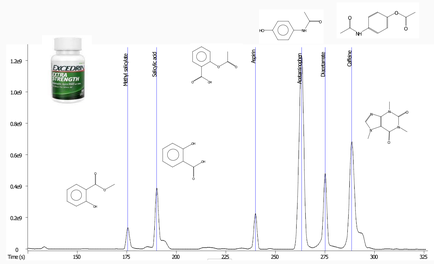


Figure 10: Analytical Ion Chromatogram Showing Selected Excedrin Constituents

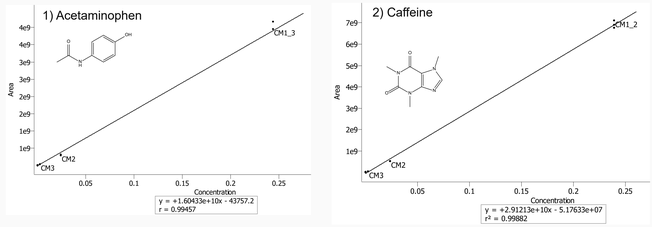


Figure 11: Acetaminophen and Caffeine Calibration Curves

Summary

1) The collaboration between academia and industry enhanced laboratory experiences through the utilization of modern-day instrumentation and software
2) Sample analyses were conducted using GC-TOFMS instruments on a mobile laboratory
3) New experiments will be developed for future mobile laboratory university projects

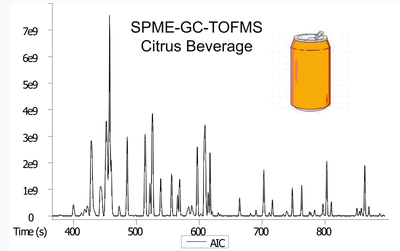


Figure 12: SPME, GC-TOFMS AIC for a Citrus Beverage