Economic Adulteration of Citrus Juice

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Economically Motivated Adulteration: Intentional food fraud for a financial advantage

Most common adulteration practices in citrus juices:

- Addition of sugars
- Addition of pulp wash
- Undeclared dilution with water or inferior fruit juices

How much adulteration is detected by the USDA?

Diversity in adulteration techniques, environment, storage conditions, genetics, or HLB status all play a role in making the detection of adulteration a difficult task

Sophisticated adulteration techniques require sophisticated testing

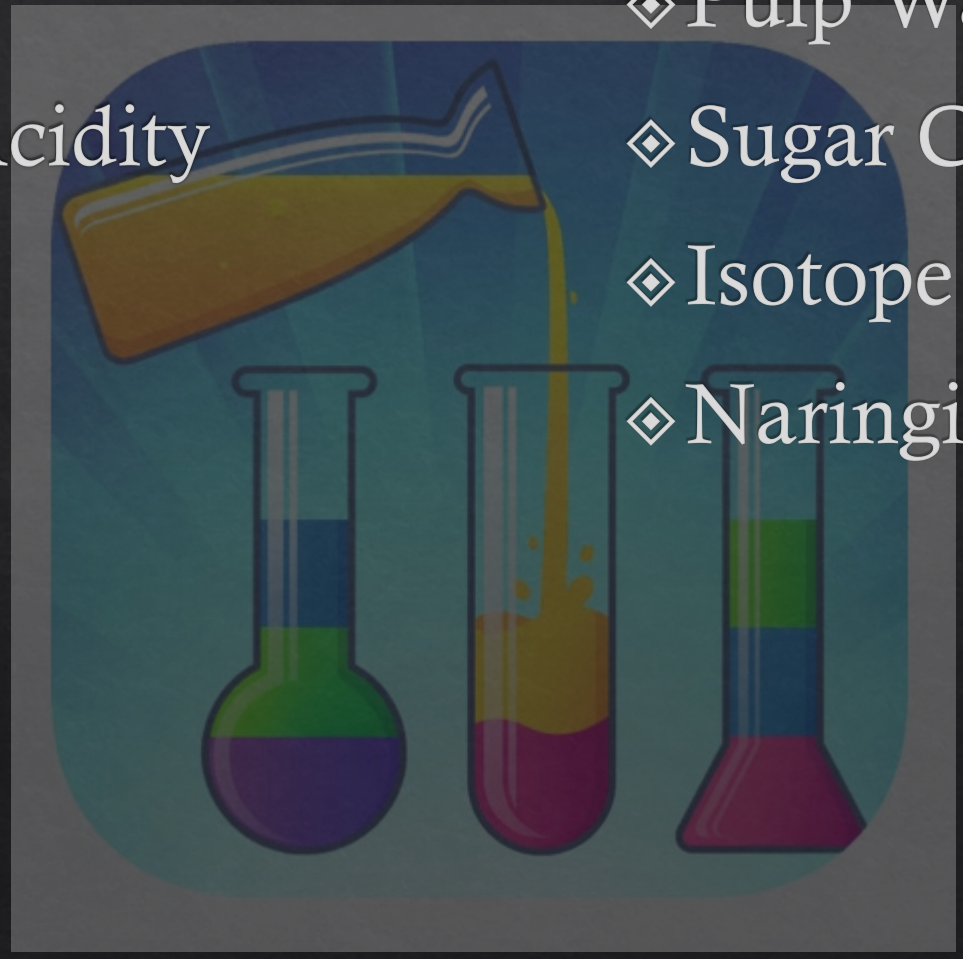
Numerous methods have been developed to detect adulteration

Not a single test. Rather, multiple tests to have a complete picture

- National Science Laboratory (NSL) – Gastonia, NC
- Director: Kerry Smith, PhD
- Branch Chief: Roger Simonds
- Chemistry Section Supervisor: Demeseh Cobb
- 30 Staff at two facilities

Juice Adulteration Analysis provided by the NSL

- Brix
- Titratable Acidity
- Formol
- Potassium
- Pulp Wash (Abs Ratio)
- Sugar Content (HPLC)
- Isotope Ratio Analysis
- Naringin (HPLC)

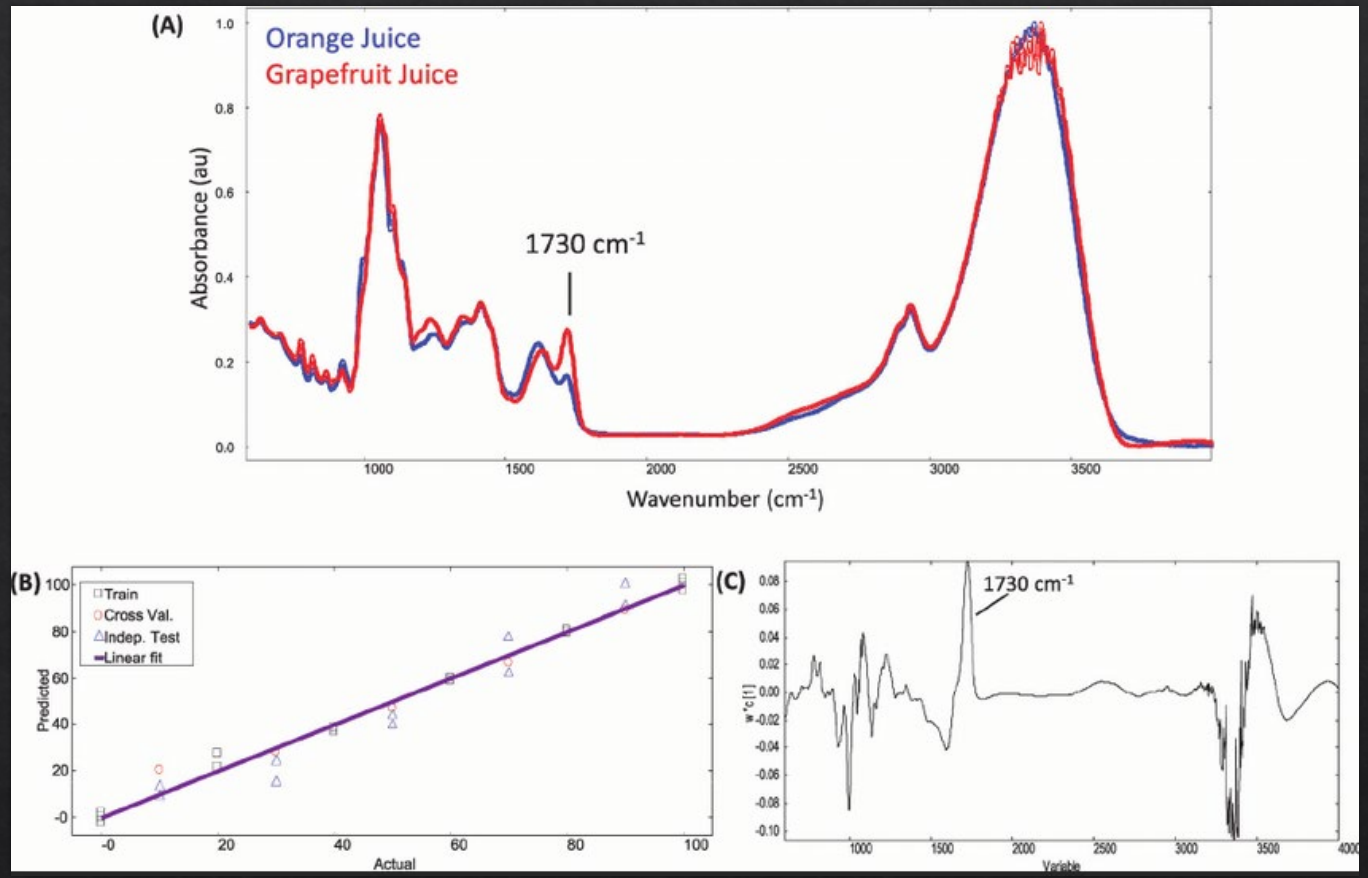


BRIX

- Determines the approximate sugar content in a juice sample
- 1 degree Brix (°Bx) = 1g of sucrose / 100g of solution
- Must meet specification

Pulp Wash

- Juice Extracted by using water in a secondary step
- Determined by UV-Vis

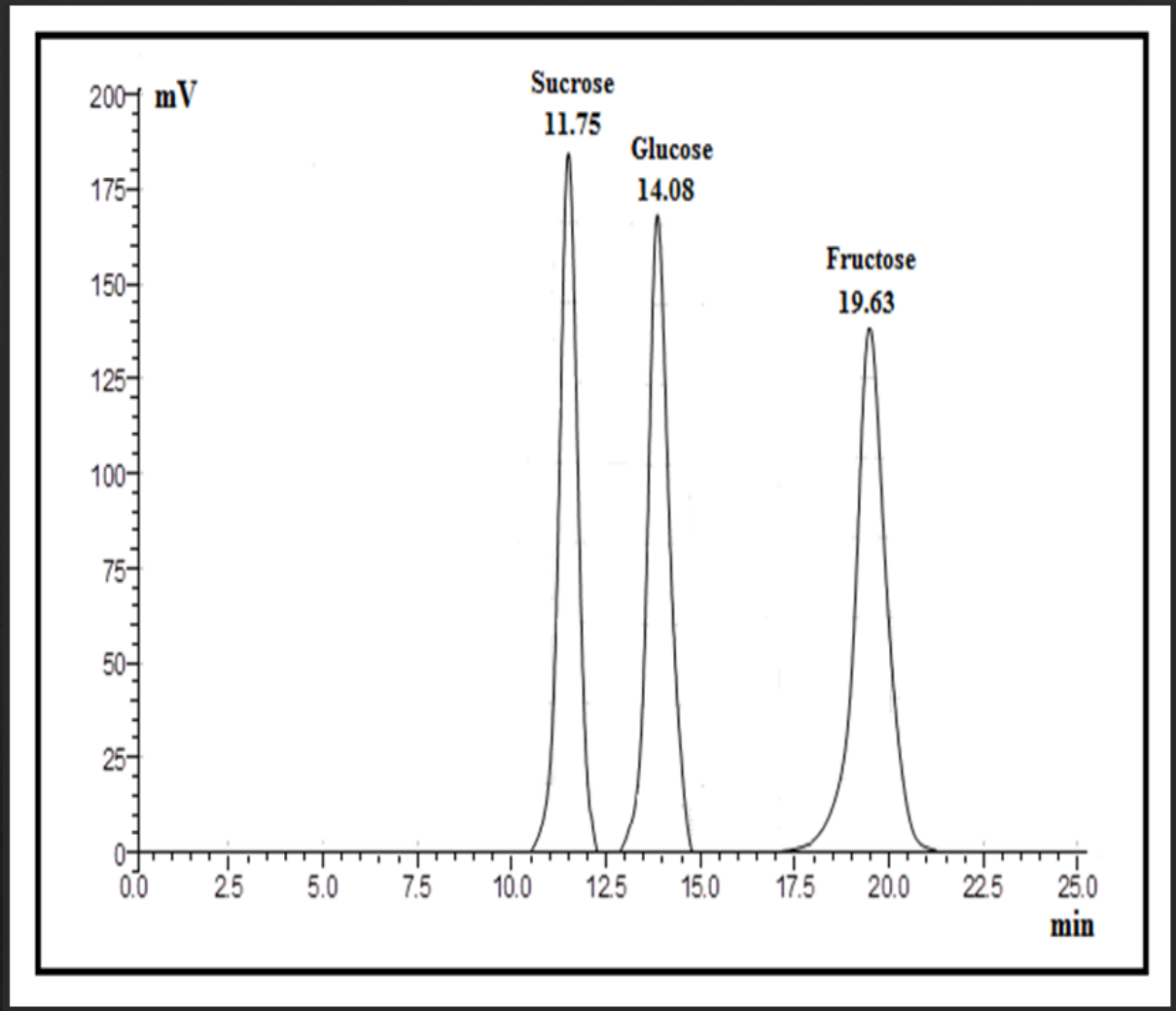


Titratable Acidity and Formol

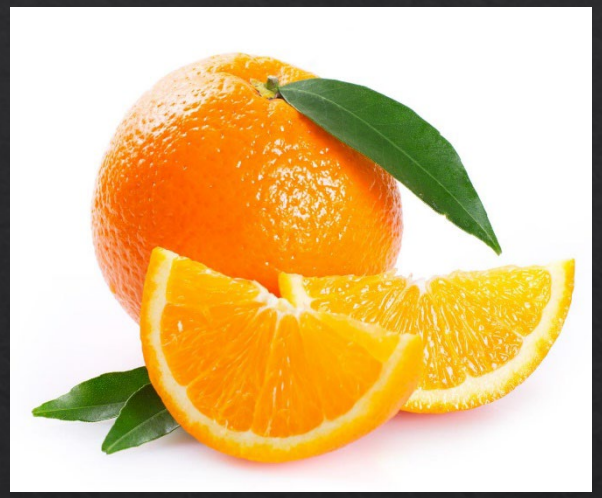
- Organic acid and amino acid determination by titration
- Excellent indicators of the authenticity of fruit juice because there naturally occurring amounts are quantifiable

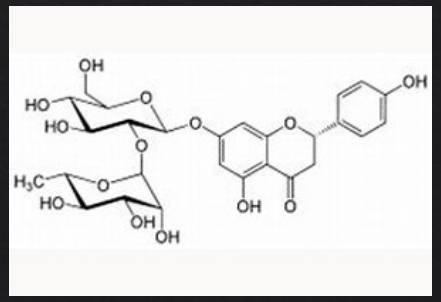
Sugar Content by Liquid Chromatography

- Sugars are separated chromatographically
- Individual sugar values and their ratios and must meet standard
- Oligosaccharides and Polysaccharides indicative of syrup must not be present in pure citrus juice



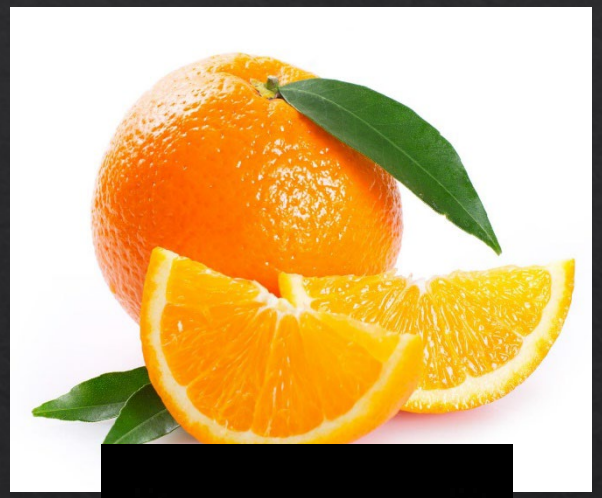
Liquid chromatography of Naringin

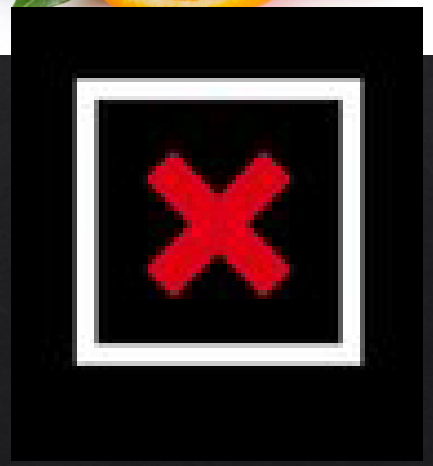


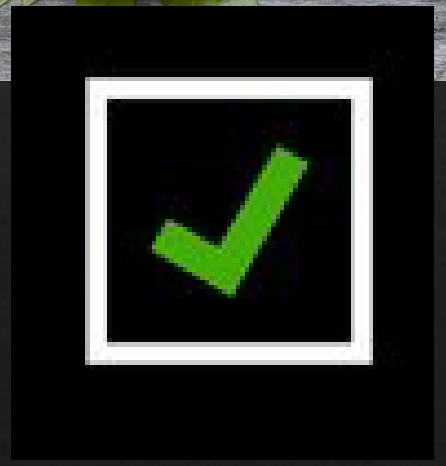


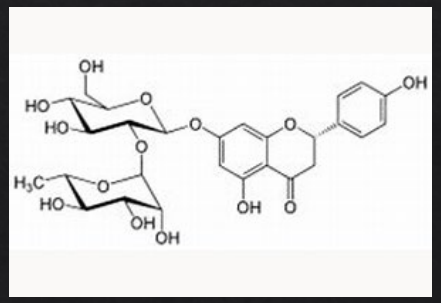
Naringin

Liquid chromatography of Naringin







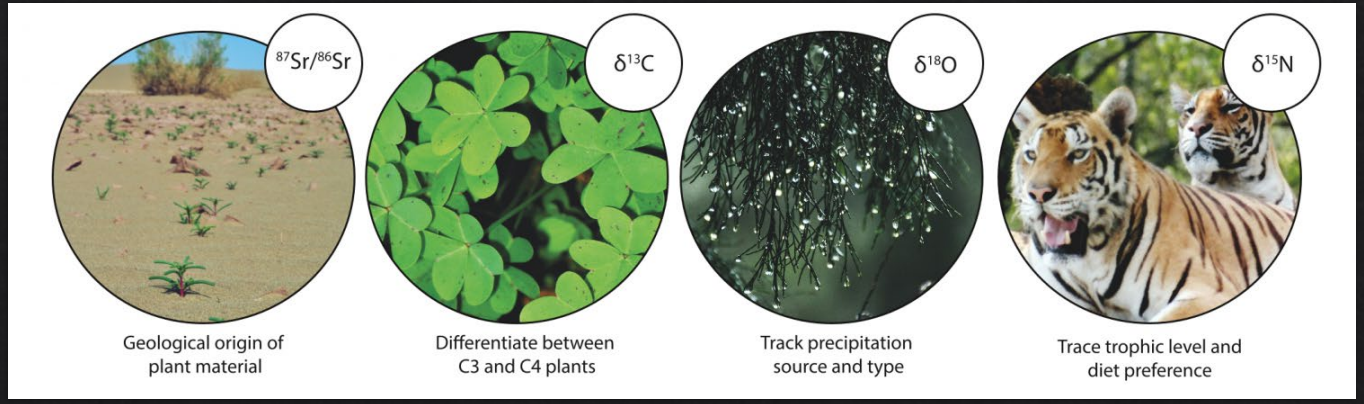


Naringin

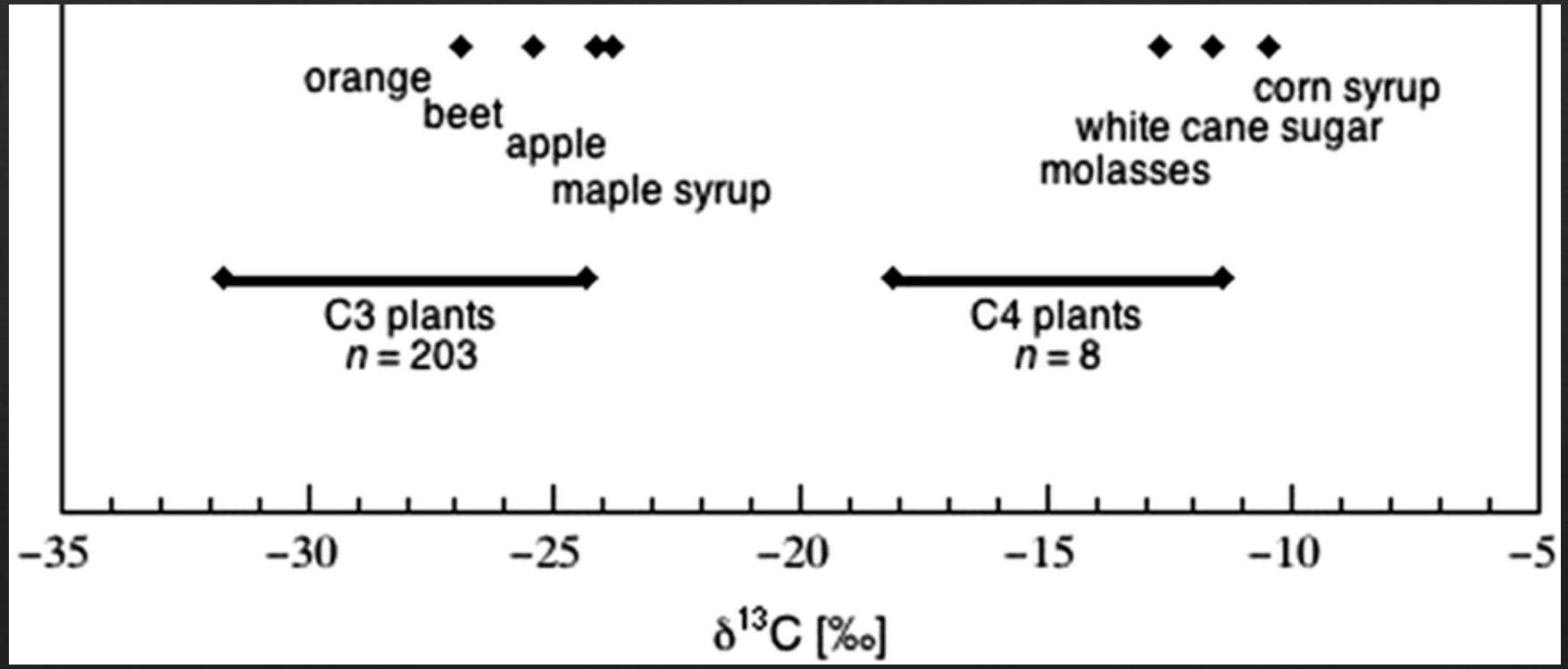
$$\delta^{13}C_{Sample} = \left\{ \frac{\left(\frac{^{13}C}{^{12}C}\right)_{Sample}}{\left(\frac{^{13}C}{^{12}C}\right)_{Reference}} - 1 \right\} * 1000$$

Isotope Ratio Analysis

- Nature's fingerprint
- Identifies addition of sugars from C4 plants
- Identifies addition of ground water



Stable carbon isotope ratio analysis (SCIRA)



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The future of adulteration testing for orange juice

- LC-IRMS
  - Analysis of isotope ratios of sugars or organic acids as they are separated with liquid chromatography
  - Very successful with applying this technique to detect adulteration in honey
- Current methods are targeted, but what about untargeted methods?
- Whole-picture metabolomics fingerprint testing

We already have these instruments in our lab!

Questions?

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