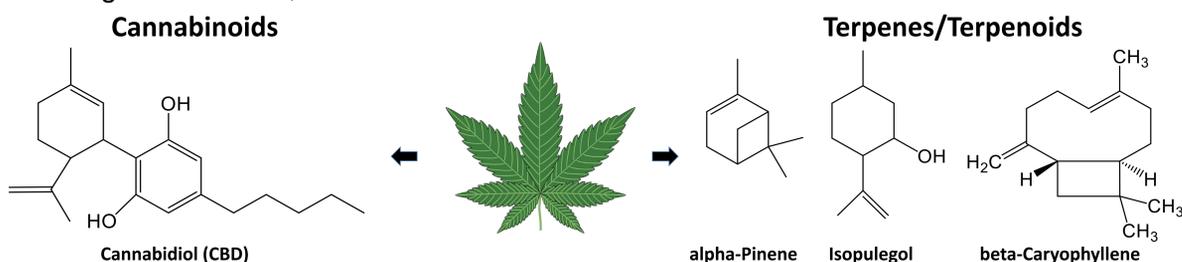


## Introduction

**A better question may be “What’s on a Cannabis Gummy Bear?”** The widespread legalization of cannabis (*Cannabis Sativa L.*) in the US at the state level has spawned the production of a wide variety of consumer products containing chemical constituents derived from the cannabis plant. These compounds are typically extracted from the plant by various means and formulated into both edible and non-edible products. The main classes of compounds found in consumer products are cannabinoids, terpenes, and terpenoids. Over time, public acceptance has grown for the use of gelatin-based products (i.e., gummies) as oral delivery vehicles for vitamins, supplements, and drugs. Cannabis gummies are no exception. Cannabis gummies are formulated in two basic ways: infused with cannabis extracts during the compounding process or coated with the extracts in a final step after the gummy has formed. Chemical analysis of any finished product requires analytical laboratories to break down the product matrix to release the compounds which may be bound strongly to matrix components within the product. Since gummies are formulated with water, it is common practice to re-dissolve the gummy in an excess of water and then analyze the aqueous solution directly or extract the solution with a suitable organic solvent. The focus of this work was to determine an efficient means of extracting cannabidiol (CBD) in a variety of gummy products followed by analyses using Gas Chromatography - Electron Impact - Mass Spectrometry (GC-EI-MS). Ultimately, we determined that CBD coated gummies could be extracted directly with organic solvents, without the need for initial dissolution in water.



## Analytical Approach

Analysis of products by GC-EI-MS required samples to be non-aqueous. Therefore, samples were prepared in three ways:

1. extracting gummy directly with organic solvents
2. slicing gummy and then extracting with organic solvents
3. dissolving gummy in water and then extracting the aqueous solution with aqueous-immiscible organic solvents



## Experimental

### Sample Preparation

**Gummy extracted whole:** One whole gummy bear was extracted with an organic solvent and the extract was analyzed by GC-EI-MS.

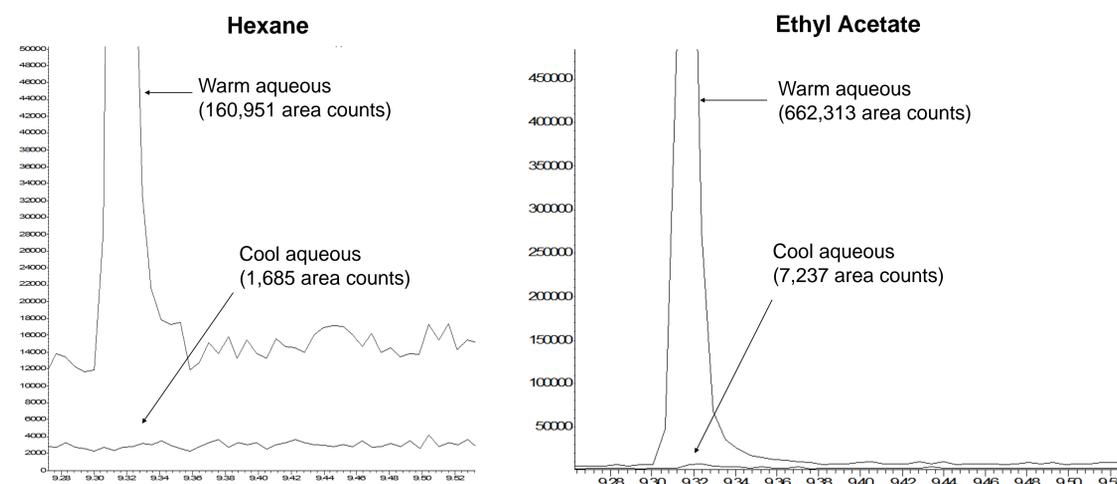
**Gummy sliced and extracted:** The remaining whole gummy bear from the previous preparation was sliced and extracted with an organic solvent extract was analyzed by GC-EI-MS.

**Gummy dissolved in water and extracted:** One whole gummy bear was dissolved in 9.0 mL of water (approx. 3 times weight of bear) in a sonicating bath and heated at 65 deg C for 80 minutes (until dissolved). A 1.0 mL aliquot of the resulting solution was then extracted with 2 mL of either hexane or ethyl acetate and the extract was analyzed by GC-EI-MS.

**GC-EI-MS Analysis:** All analyses were performed on an Agilent 7890A/5975C GC-MSD.

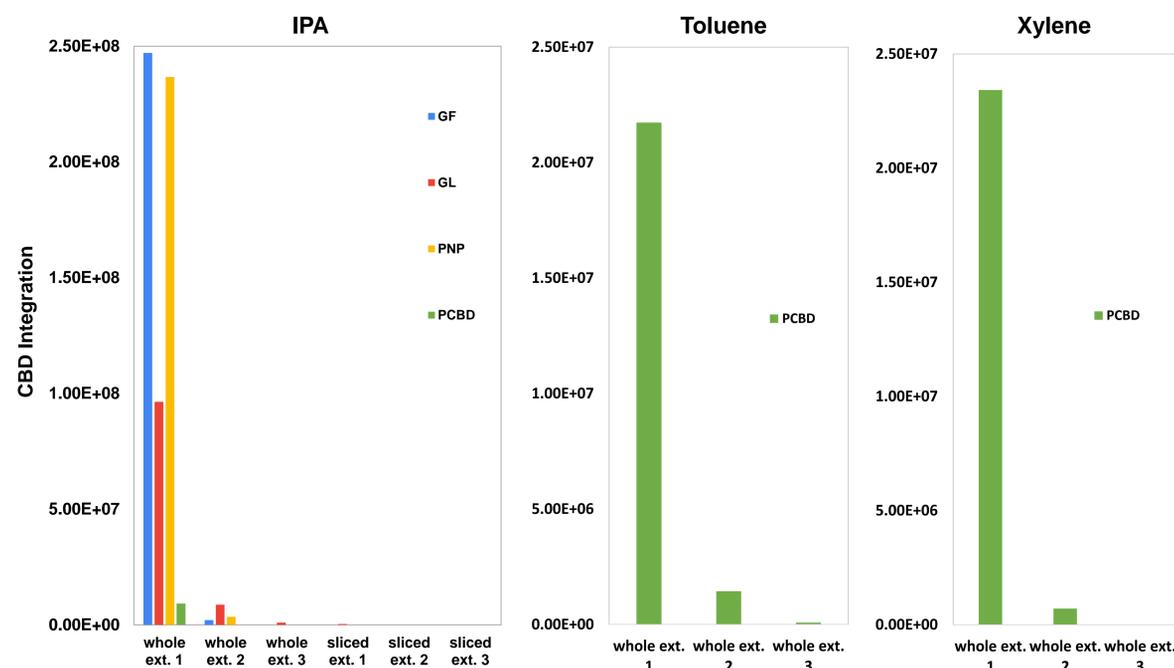
## Results

### Whole Bear Dissolved in Water:



**Figure 1:** Overlaid chromatograms show extraction efficiency of whole gummy dissolved in water (warm and cooled) with equal volumes of hexane and ethyl acetate.

### Whole and Sliced Bear w/o Water:



**Figure 2:** Plots show a comparison of whole gummy extracted with IPA, toluene, and xylene.

## Conclusions/Future Work

- When pre-dissolved in water, aqueous gummy solutions needed to be warm for efficient CBD extraction.
- The absence of CBD detection in sliced gummy extracts after initial extraction of the whole gummy indicated that CBD was present only on the surface of the product (coated).
- Ethyl acetate and IPA were more efficient than toluene and xylene at CBD extraction.
- Overall, extraction of CBD from gummies with organic solvents did not require prior dissolution in water.
- Future work: extraction efficiency of the solvents will be measured using internal standards

## References

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- [2] Micalizzi G, Vento F, Alibrando F, Donnarumma D, Dugo P, Mondello L. Cannabis Sativa L.: a comprehensive review on the analytical methodologies for cannabinoids and terpenes characterization, *J Chrom A*; 1637:2021;461864.
- [3] Ciolino L, Ranieri T, Taylor A. Commercial cannabis consumer products part 1: GC-MS qualitative analysis of cannabis cannabinoids, *For Sci Int*; 289:2018;429-437.