BROCKHOUSE, 'BEE'MLINES & BEESWAX, OH MY!

Studying the Effects of Pesticides on the Chemical Composition and Crystalline Structure of Beeswax.

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1. INTRODUCTION

The honey bee population worldwide is decreasing - in the United States, the number dropped from 3 million to 900 thousand in just the span of four years. It is thought that the use of pesticides, coupled with environmental factors are likely causes for the population decline

WHY DO BEES MATTER?

Bees are essential to our environment and to our economy. Without them, much of the food that we consume daily would not exist and multiple crops would disappear.

WHY STUDY PESTICIDES?

Pesticides leave residues in beeswax. They inhibit bees' long-term memory and capacity to retain important information, such as the directions to their hive. In addition, pesticides disrupt bees' abilities to reproduce. Both of these factors contribute to an increased rate of bee mortality.

HYPOTHESIS

The presence of pesticides will affect the chemical composition and alter the crystalline structure of beeswax

GOALS

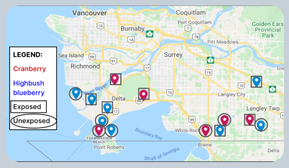
(1) Investigate differences in chemical composition within and between samples
(2) Determine the effects of pesticides on crystalline structure

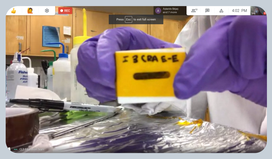
2. MATERIALS

SAMPLES

We obtained samples from Dr. Leonard Foster from UBC, who is conducting agrochemical testing for pesticide residue in beeswax. We received 14 cuvettes with two beeswax samples each, classified by apiary, crop type, and exposure to pesticides. We also took samples of beeswax from the hive on the roof of our school.

Unexposed: Beeswax samples next to crops not exposed to pesticides
Exposed: Beeswax samples next to crops exposed to pesticides
Cranberry: Beeswax samples next to cranberry crops
Blueberry: Beeswax samples next to blueberry crops

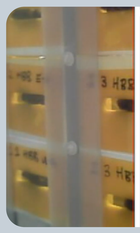


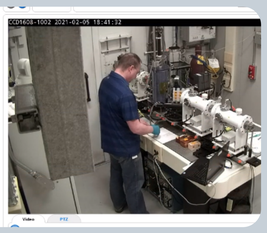


3. METHODS

IDEAS BEAMLINE

We used XRF techniques on the IDEAS Beamline to find the elemental composition of all of our samples. We plotted our data to look for similarities or differences in the elements of our samples.

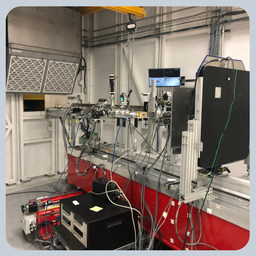




We also used the XANES technique on the IDEAS Beamline to find the species or oxidation state of bromine in each of our samples, because there was the greatest variation in the abundance of bromine in our samples based on XRF measurements. Bromine is also a component of certain pesticides.

BROCKHOUSE BEAMLINE

In addition to the IDEAS Beamline, we were fortunate enough to access the Brockhouse Beamlines, allowing us to carry out our research in further detail! We used the pair distribution function (PDF) technique to investigate the crystalline structure. Beeswax is not highly crystalline, so normal diffraction cannot be done.



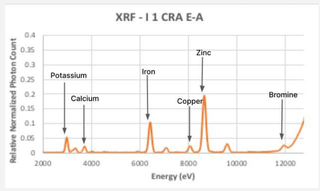
4. RESULTS & ANALYSIS

ELEMENTAL COMPOSITION

The elemental composition of our samples had some differences, which are summarized below.

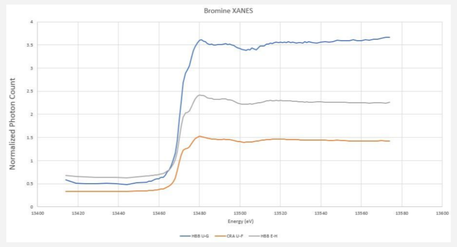
Comparison	Observations
Unexposed Cranberry vs. Unexposed Highbush Blueberry Samples	Cranberry samples have a higher relative abundance of Zinc & Bromine
Exposed Cranberry vs. Exposed Highbush Blueberry Samples	Very little variation
Unexposed Cranberry vs. Exposed Cranberry Samples	Unexposed samples have a higher relative abundance of Zinc & Bromine
Unexposed Highbush Blueberry vs. Exposed Highbush Blueberry Samples	Very little variation
Samples from the Same Geographical Area	Variation in all samples - no apparent trend based on location.

Data from Sample I 1 CRA E-A



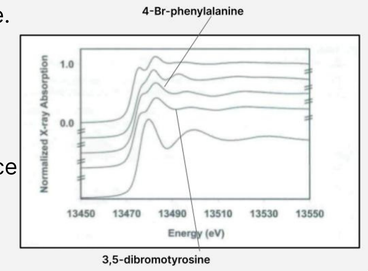
BROMINE SPECIATION

The species of bromine consistent across all of our samples was either 4-Br-phenylalanine, or 3,5-dibromotyrosine.



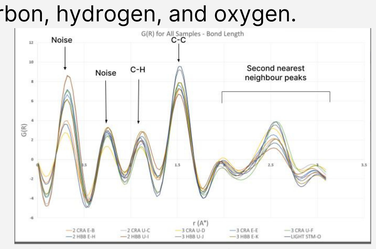
We do not believe that either compounds are naturally occurring. While we could not find much information on 3,5-dibromotyrosine, we did find that 4-Br-phenylalanine is acutely toxic, though not a known constituent of pesticides. Prior to our experiment, the IDEAS Beamline had never used XANES to scan for bromine.

Bromine XANES Reference

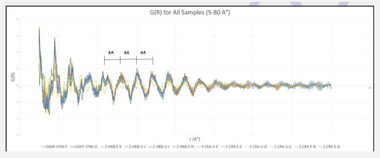


CRYSTALLINE STRUCTURE

The chemical bonds in our beeswax samples are very similar, which suggests that all the beeswax samples have a similar chemical makeup. We found carbon-carbon and carbon-hydrogen bonds, which we expected because beeswax is made of carbon, hydrogen, and oxygen.



There is a regular repeating pattern that can be seen in all samples, and indicates a chemical regularity in the not-so crystalline structure of beeswax. This discovery was surprising to us.



Overall, we found a minimal relationship between the crystalline structure of beeswax and whether or not they have been exposed to pesticides.

5. CONCLUSIONS & FUTURE RESEARCH

IDEAS BEAMLINE

The presence of pesticides does not affect the relative abundance of elements within beeswax.

Possible areas of future research:

- Conduct experiment with a larger sample size/more diverse samples (e.g. different crop types, locations around world, etc.)
- Determine whether 4-Br-Phenylalanine or 3,5-Dibromotyrosine were present/how they could have accumulated in samples

BROCKHOUSE BEAMLINE

The presence of pesticides does not change crystalline structure of the beeswax.

Possible areas of future research:

- Look more into PDF bond length
- Look at variation of crystalline structure between healthy and unhealthy beeswax
- Look into the pattern in the medium or long range of PDF (~5 - 60 angstroms)

6. ACKNOWLEDGEMENTS

We acknowledge that:

- St Thomas More Collegiate is located on the ancestral and unceded homelands of the hən̓q̓əmin̓əm̓ and Sḵwx̱wú7mesh speaking peoples
- Our samples were collected on the traditional territory of the Tsawwassen and Musqueam First Nations and of all the hən̓q̓əmin̓əm speaking people as well as the unceded traditional and ancestral lands of the Kwantlen, Katzie, Semiahmoo, Qayqayt and Kwikwetlem peoples.
- The CLS, in Saskatoon, SK, is located on Treaty Six land in the traditional territories of the Nêhiyawak (Cree), Anishinabek, Lakota, Dakota and Nakota Nations, and the homeland of the Métis.

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