Hemp Processing, Extraction & Testing

Presented by Jamila La Malfa-Donaldson
Aberystwyth University (Wales, UK)
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Overview of Industrial Hemp

Industrial Hemp (Cannabis sativa L.)
Hemp Processing

- Extraction
- Purification
- Isolation

Testing:
- Chemical Profile
- Microbes
- Pesticides
- Residual Solvents
- Heavy Metals
- Mycotoxins

Diagram shows:
- Sesquiterpenes
- Terpenes
- Flavonoids
- Sugars
- Fats
- Lignin
- Starches
- Waxes
- Pectins
- Cellulose

Chemical Profile:
- Cannabinoids
- Pigments
- Chlorophyll
- Waxes
- Pectins
- Cellulose
Cannabinoid Testing

- LC/MS analysis
- Major and minor cannabinoids & cannflavin A
- Sample prep for high sample throughput
- Methanol extraction
- 11 cannabinoids and cannflavin A in 25 mins
Hemp Extraction Techniques

Extraction techniques for Hemp (Cannabis sativa L.) extract

- Cold press (Seeds)
  - Hemp oil

- DM with solvents including methanol, ethanol, butane, chloroform and n-hexane (Seeds, plant)
  - Hemp oil
  - Cannabinoids

- PLE (Seeds, plant, seed cake)
  - Cannabinoids
  - Hemp oil

- SFE with CO₂ (Seeds, plant, seed cake)
  - Cannabinoids (CBD,CBDA)
  - Hemp oil
  - Polyphenols
  - Flavonoids

- UAE (Seeds, plant, seed cake)
  - Hemp oil

- MAE (Plant)
  - Solvent
  - SFE (pre-treatment)
  - Hemp oil

- Solvent
  - Cannabinoids (THC,CBD,CBN)
### Solubility of Cannabinoids

<table>
<thead>
<tr>
<th>Name</th>
<th>Formula</th>
<th>Polarity</th>
<th>Molar mass (g mol⁻¹)</th>
<th>Boiling point (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol</td>
<td>C₂H₅OH</td>
<td>Polar</td>
<td>46.07</td>
<td>78.4</td>
</tr>
<tr>
<td>Butane</td>
<td>C₄H₁₀</td>
<td>Nonpolar</td>
<td>58.12</td>
<td>−1.0</td>
</tr>
<tr>
<td>Hexane</td>
<td>C₆H₁₄</td>
<td>Nonpolar</td>
<td>86.18</td>
<td>68.0</td>
</tr>
<tr>
<td>Methanol</td>
<td>CH₃OH</td>
<td>Polar</td>
<td>32.04</td>
<td>64.7</td>
</tr>
<tr>
<td>Acetone</td>
<td>C₃H₆O</td>
<td>Polar</td>
<td>58.08</td>
<td>56.0</td>
</tr>
</tbody>
</table>
Decarboxylation

Decarboxylation
- $\text{CO}_2$

CBG

CBDA synthase

CBDA

Decarboxylation
- $\text{CO}_2$

CBD

$\Delta^2$-THCA synthase

$\Delta^2$-THCA

Decarboxylation
- $\text{CO}_2$

$\Delta^2$-THC
Purification Technique: Crystallization

**General CBD Solubility Curve**

- **Labile Zone:** The solution is unstable. Small CBD crystals form spontaneously.
- **Supersolubility Curve:** Varies with process conditions.
- **Metastable Zone Width:**
- **Solubility Curve:** Fixed for a given system.
- **Metastable Zone:** CBD crystals do not form spontaneously, but growth of existing crystals will occur.
- **Unsaturated Zone:** The solution is stable in this zone. Any CBD crystals dissolve.
CBD Solubility Curves

CBD isolate in…
- Pentane
- Hexane
- Heptane
- Octane
## Crystallization of Hemp Distillate

<table>
<thead>
<tr>
<th>Solvent</th>
<th>CBD crystal purity</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heptane</td>
<td>90%</td>
<td>↑14%</td>
</tr>
<tr>
<td>Hexane</td>
<td>90%</td>
<td>↑14%</td>
</tr>
<tr>
<td>Pentane</td>
<td>91%</td>
<td>↑16%</td>
</tr>
<tr>
<td>Octane</td>
<td>97%</td>
<td>↑23%</td>
</tr>
</tbody>
</table>
Crystallization Scale-Up
Summary

- Industrial hemp as source of therapeutic compounds.
- Development and optimisation of processing methods for hemp.
- LC/MS cannabinoid profiling and testing.
- Existing and novel extraction techniques.
- Non-polar solvents better suited for cannabinoids.
- Decarboxylation of acid cannabinoids to neutral cannabinoids.
- Crystallization studies for CBD purification.
About Me

- PhD Industrial Hemp Researcher, Aberystwyth University (Wales, UK)
- MEng Chemical Engineering with Business
- +5 yrs Science Communicator
- Founder of PROHEMPOTIC
- Young Innovators Award 22-23 (Innovate UK)

Jamila La Malfa-Donaldson

contact@prohempotic.com
Thank You

Any Questions?

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