

CBD Harvest and Processing

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Sandler, PhD

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Outline

- Current field update/pests
- Flowering and CBD synthesis
- Harvest
- Drying
- Testing
- Processing
- Markets

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Cannabineae.

-
- This botanical illustration depicts the Cannabineae family. It features two primary plant forms, labeled A and B. Plant A is a flowering branch with serrated, palmately compound leaves and a terminal inflorescence of small flowers. Plant B is a branch with similar leaves but with more prominent, elongated, serrated leaflets. Surrounding these main figures are thirteen numbered details (1-13) illustrating various botanical features: 1. A cluster of developing fruits; 2. A single fruit; 3. A fruit with a long, thin style; 4. Two small circular structures, likely stamens or pollen grains; 5. A fruit with a long, thin style; 6. A fruit with a long, thin style; 7. A fruit with a long, thin style; 8. A fruit with a long, thin style; 9. A fruit with a long, thin style; 10. A fruit with a long, thin style; 11. A cross-section of a fruit showing internal structure; 12. A cross-section of a fruit showing internal structure; 13. A fruit with a long, thin style.

Cannabis sativa L.

W. Müller



Current field updates and pests

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Insects

- Stalk borers- European corn borer, Eurasian hemp borer
- Corn earworm
- Aphids, mites, thrips
- Insects that chew leaves of the plant (defoliators) – caterpillars, beetles, grasshoppers, cutworms



Eurasian hemp borer



Cannabis aphid

Pest Management - Insects

- Biopesticides, soaps, and oils
- Monitor visually and with sticky traps
- Prune infested plants
- Caterpillars, etc. removed by hand picking
- Insectary plants grown around the perimeter can provide beneficial insects – green lacewings, syrphid flies, collops beetle, damsel bugs

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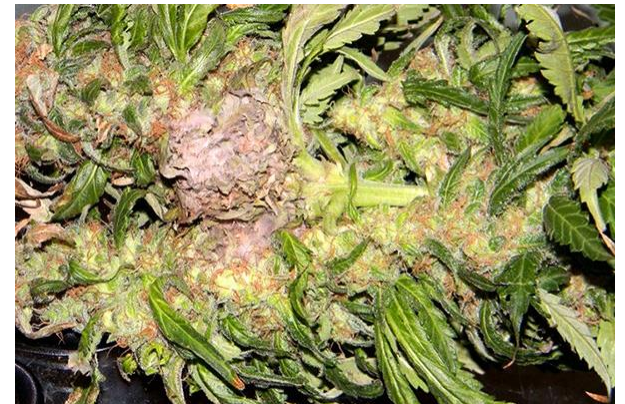
Pest Disease

- Midwest is more humid than west
- Powdery mildew (*Podosphaera macularis*)
- Gray mold (*Botrytis cinerea*)
 - Botryis – “bud rot”, inside flowers causing rot from inside out
- Alternaria
- Fusarium
- Sclerotinia

Powdery Mildew



Gray Mold



Pest Management - Disease

- May respond to oils, potassium bicarbonate, potassium phosphate
- Spacing, ventilation
- Drip irrigation – less splash

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Pest Management - Vertebrates

- Deer, humans, rabbits, mice, moles
 - Fences and other barriers
 - Traps
 - Cameras
 - Signs

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<https://www.treehugger.com/natural-sciences/its-not-easy-being-a-hemp-farmer.html>

Protection Strategies

- Scouting
- Cultural Practices
- Plant Spacing
- Pesticides
- Biological control
- Sanitation

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Key Points

- Scout regularly
- Correctly identify pests
- Assess spatial and temporal distribution
- Assess plant growth stage
- Select appropriate protection strategies
- Keep detailed records to track population trends
- Contact your state entomologist/pathologist

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Additional Resources

- <https://hempinsects.agsci.colostate.edu/hemp-insects-text/>
- <https://datcp.wi.gov/Documents/IHPesticides.pdf>
- <http://labs.russell.wisc.edu/insectlab/contact-us/>
- <https://pddc.wisc.edu/>
- <https://datcpservices.wisconsin.gov/pb/pdf/07-18-19.pdf>

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Flowering and CBD Synthesis

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What is Cannabidiol (CBD)?

- 8 Major cannabinoid acids naturally produced by Cannabis

CBGA (Cannabigerolic acid)

THCA (Δ^9 -tetrahydrocannabinolic acid)

CBDA (Cannabidiolic acid)

CBCA (Cannabichromenonic acid)

CBGVA (Cannabigerovarinic acid)

THCVA (Tetrahydrocannabivarinic acid)

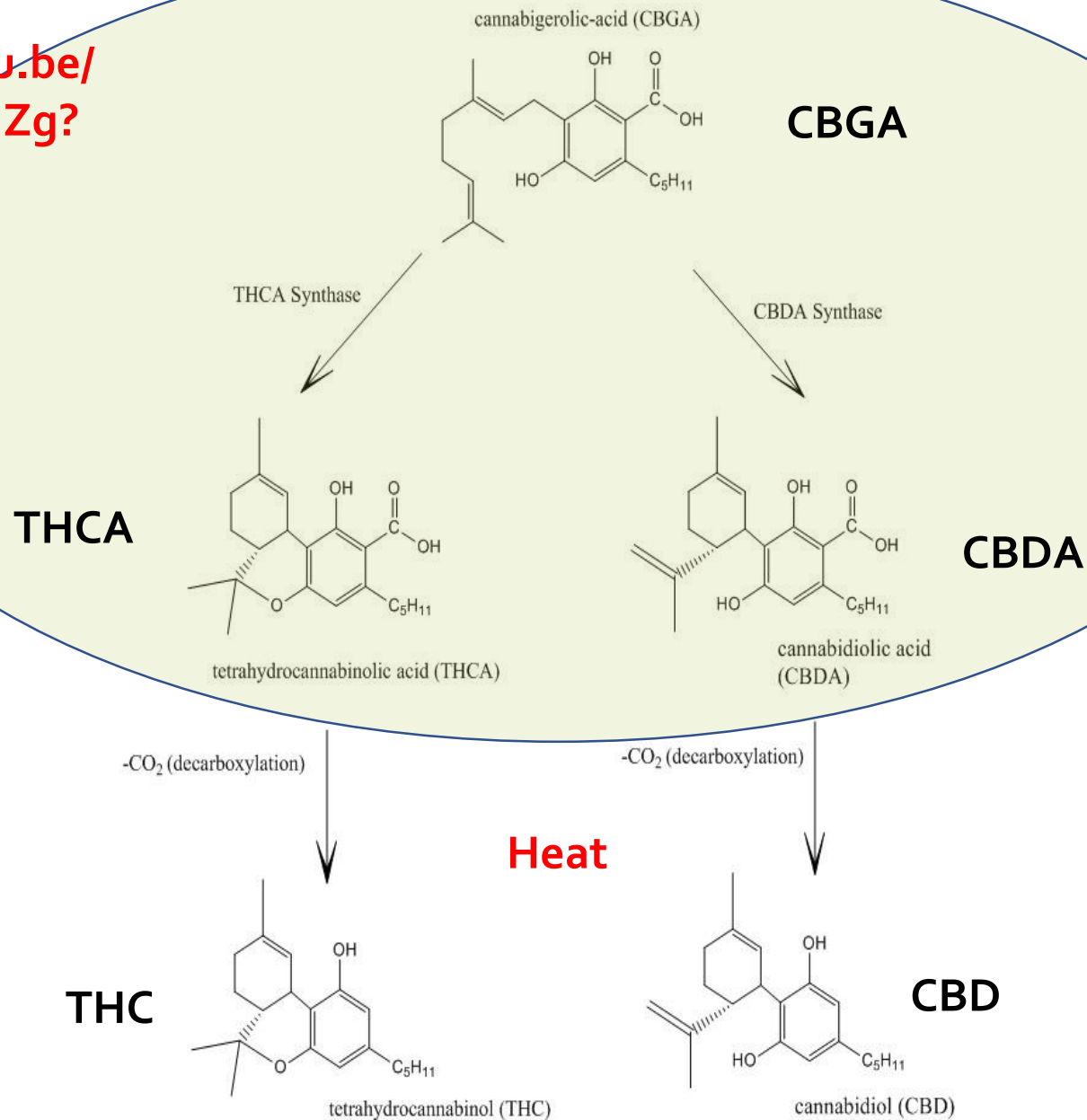
CBDVA (Cannabidivarinic acid)

CBCVA (Cannabichromevarinic acid)

THCA and **CBDA** are usually the most abundant cannabinoids in Cannabis varieties.

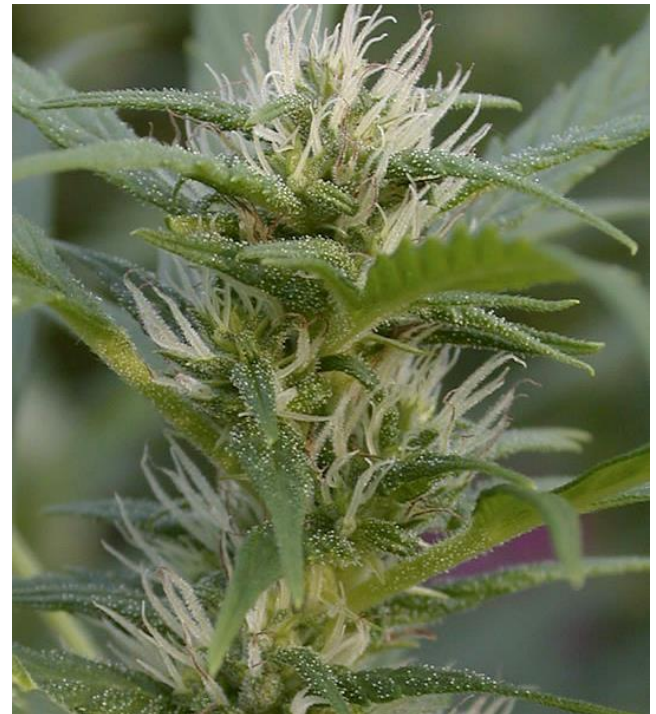
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t=548



Where does CBD come from?

- The highest concentrations of CBDA are found on trichomes of an unpollinated female flower
- Trichomes are glandular hairs found on the surface of plants
- Trichomes also produce terpenes and flavonoids which contribute to a plant's aroma and flavor profile



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Harvest

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CBD Harvest

- Visual clues on the hemp bud - trichomes on the hemp bud shift from white to milky white
- Timing
 - Mid Sept – Mid October
- Harvestable parts
 - Biomass – stems, leaves, flower buds – least labor intensive, least CBD
 - Flower – medium labor, high CBD
 - Trimmed flower – most labor, high
- Contact DATCP 30 days before harvest

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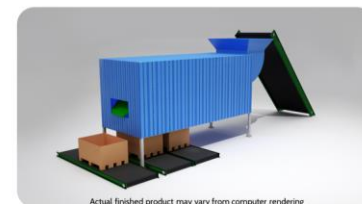
Harvest - labor

- Hand labor – cutting at base of stem and hauling plants out of field
 - Time and physical exertion
- Can grow well but suffer losses due to insufficient harvest time – labor was inadequate
- Keep track of amount of man and woman hours to bring in the harvest
 - Maintaining sharp tools during the harvest process will also save time and effort

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Harvest - Machinery

- Debudders/Buckers
- Stems (wet or dry) fed into machine
- Holes in plate sized to allow only stems to pass through
- Rollers pull stems through plate thus stripping leaves and buds
- Hemp Harvest Works

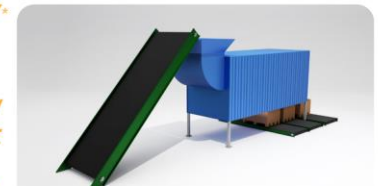


*Separate
Flower, Seed, & Stalk
from Whole Plants
All in ONE-STEP*

*Collect it ALL with the
B.O.S.S. Hemp Thresher*

**PROCESS WHOLE DRY-
PLANTS**

- SAFE
- CONTINUOUS FLOW
- VACUUM PARTICLE
SEPARATION
- SELF-CONTAINED



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Drying

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Drying

- IMPORTANT
- If hemp is dried quickly, cleanly and with minimal damage maximizes CBD amount and quality
- Too wet, too slowly, inadequate ventilation, contaminated by fungi, mold, or bacteria may spoil
 - unsaleable

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Drying

- Large ventilated barns or specialized drying chambers or equipment -under roof, out of direct sunlight
 - seed or tobacco drying units
- Drying facilities that are suitable for production of a food or medical product
 - clean, dry floors , no insect or animal infestation (birds nesting overhead) which could contaminate the drying product

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Drying considerations

- Hung from trellis, chains or other structures to maximize space utilization
- Fans or air conditioning units improve air flow
- Take care for density – ventilation very important
- Humidity control
- Ideal temperatures for drying and curing 60 - 70 F at 60% humidity
- Hemp drying machines can dry larger volumes of plant material
 - use warm, dry air and movement to speed up drying
 - excessive heat may degrade cannabinoids and vaporize terpenes

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Drying

- Whole plants or large branches hung upside down
- Large stems removed for further processing
- Can be trimmed to a greater extent
- Processors have different protocols - entire plant, process trimmed buds separately, untrimmed buds including sugar leaves but no stem or fan leaves

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Drying considerations

- Difficult to estimate square footage of drying space needed per plant
 - Dependent on phenotype, climate
- Examples:
 - using a flu-cured tobacco with 800 sq ft a grower was able to dry 1 ac (approx. 1350 plants) in 3 days
 - Another grower was able to dry approx. 1.5 ac (plant number not stated) in a 2500 sq ft barn

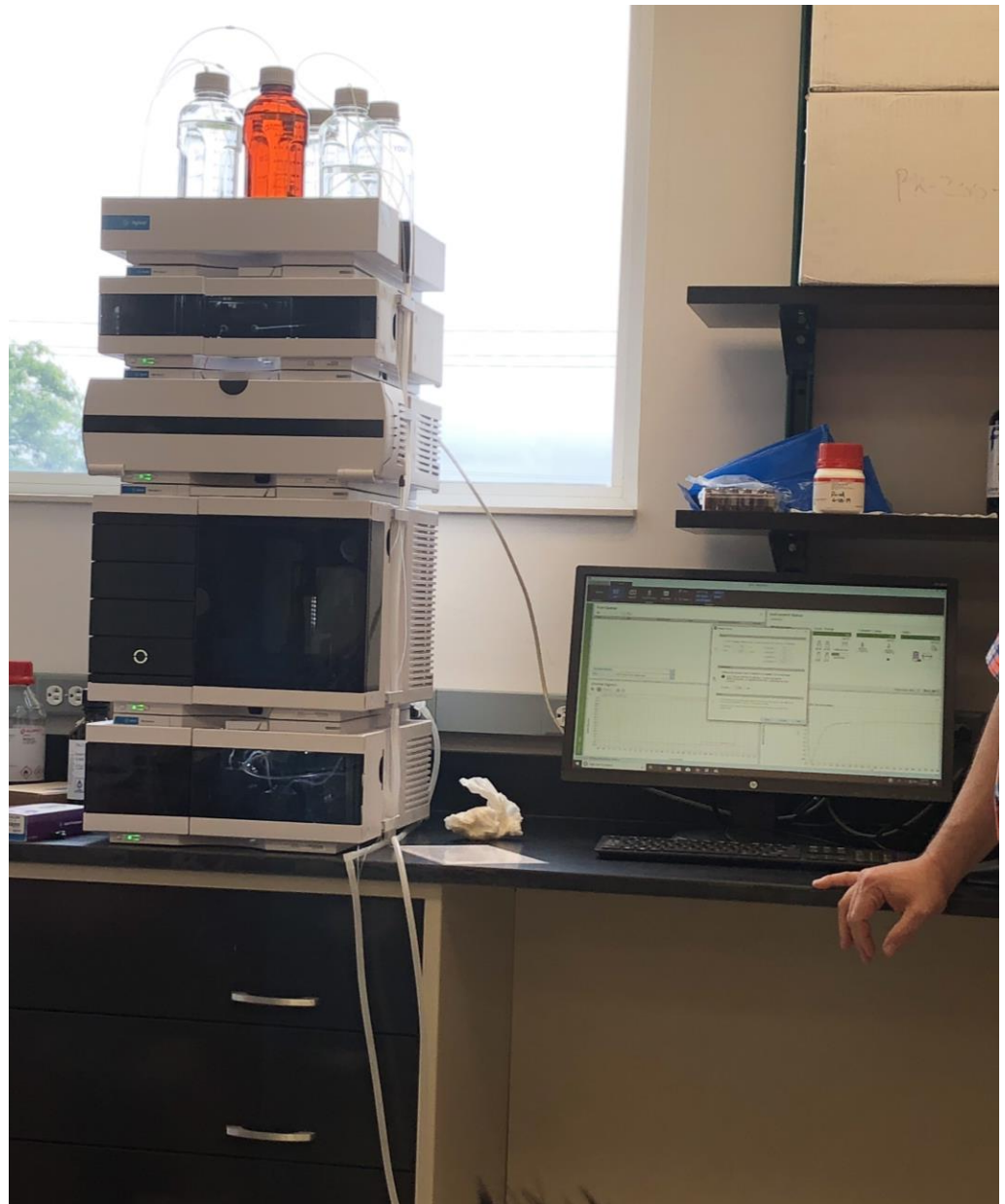
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Testing

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Cannabinoid Testing

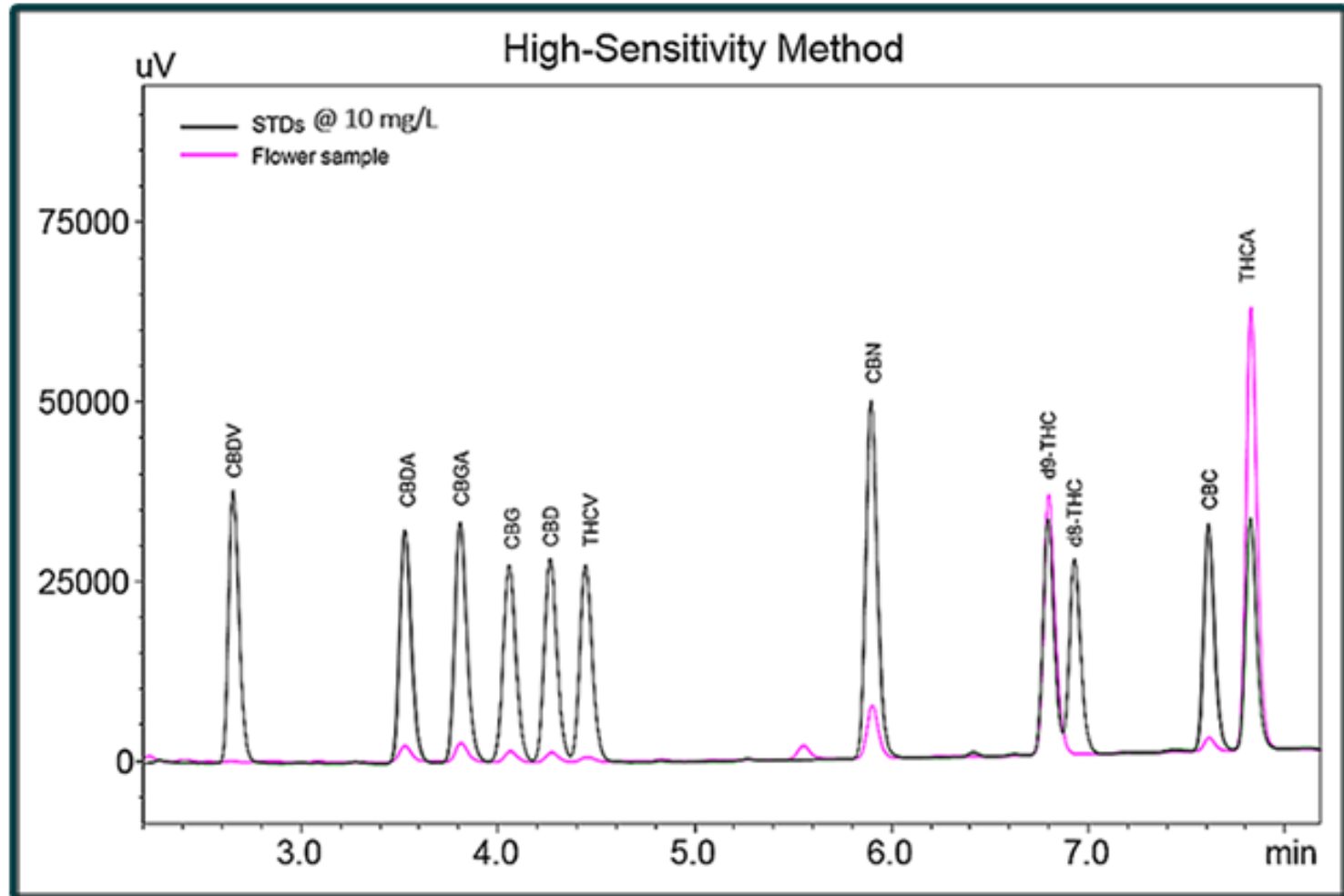
- High Performance Liquid Chromatography (HPLC)
- Cannabis flower is dried and mixed with a solvent to extract cannabinoids
- The solvent is pumped through a column that separates the cannabinoids based on their chemical properties
- Cannabinoids that are attracted to the material inside the column will travel slower and reach the detector at the end of the column later
- The detected compounds are quantified using standards of known concentrations

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Cannabinoid Testing



- DATCP calculates Total THC as delta9-THC + (THCA *0.877); round down so 0.399 => 0.3%

Certificate of Analysis



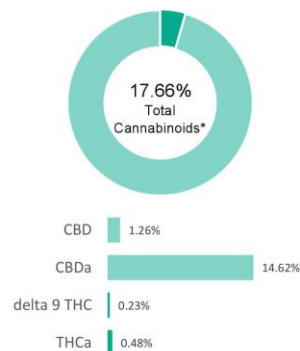
CERTIFICATE OF ANALYSIS

prepared for: INDUSTRIAL HEMP FARMS
2802 N. Nevada
Colorado Springs, CO 80909

AC DIESEL

Batch ID:	N/A	Test ID:	1928312.0012
Reported:	29-May-2019	Method:	TM14
Type:	Plant		
Test:	Potency		

CANNABINOID PROFILE



Compound	LOQ (%)	Result (%)	Result (mg/g)
Delta 9-Tetrahydrocannabinolic acid (THCA-A)	0.13	0.48	4.8
Delta 9-Tetrahydrocannabinol (Delta 9THC)	0.06	0.23	2.3
Cannabidiolic acid (CBDA)	0.10	14.62	146.2
Cannabidiol (CBD)	0.05	1.26	12.6
Delta 8-Tetrahydrocannabinol (Delta 8THC)	0.07	0.00	0.0
Cannabinolic Acid (CBNA)	0.17	0.00	0.0
Cannabinol (CBN)	0.08	0.00	0.0
Cannabigerolic acid (CBGA)	0.11	0.31	3.1
Cannabigerol (CBG)	0.06	0.00	0.0
Tetrahydrocannabivarinic Acid (THCVA)	0.11	0.00	0.0
Tetrahydrocannabivarin (THCV)	0.06	0.00	0.0
Cannabidivarinic Acid (CBDVA)	0.09	0.00	0.0
Cannabidivarin (CBDV)	0.05	0.00	0.0
Cannabichromenic Acid (CBCA)	0.09	0.76	7.6
Cannabichromene (CBC)	0.11	0.00	0.0
Total Cannabinoids		17.66	176.60
Total Potential THC**		0.65	6.51
Total Potential CBD**		14.08	140.82

NOTES:

N/A

% = % (w/w) = Percent (Weight of Analyte / Weight of Product)

* Total Cannabinoids result reflects the absolute sum of all cannabinoids detected.

** Total Potential THCCBD is calculated using the following formulas to take into account the loss of a carboxyl group during decarboxylation step.

Total THC = THC + (THCa * 0.877) and Total CBD = CBD + (CBDA * 0.877)

FINAL APPROVAL


Alex Smith
29-May-2019
10:09 AM

PREPARED BY / DATE


Greg Zimpfer
29-May-2019
10:51 AM

APPROVED BY / DATE

Testing results are based solely upon the sample submitted to Botanacor Laboratories, LLC, in the condition it was received. Botanacor Laboratories, LLC warrants that all analytical work is conducted professionally in accordance with all applicable standard laboratory practices using validated methods. Data was generated using an unbroken chain of comparison to NIST traceable Reference Standards and Certified Reference Materials. This report may not be reproduced, except in full, without the written approval of Botanacor Laboratories, LLC. ISO/IEC 17025:2005 Accredited A2LA Certificate Number 4329.02



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Additional testing

- Heavy Metals Analysis
 - Lead, Arsenic, Mercury
- Aflatoxins, Mycotoxins & Pesticides
- Terpenes
- Cannabis Microbial Testing

Green Mountain CBD

14366

V2 (Butter/Cooking Oil - Coconut Oil)

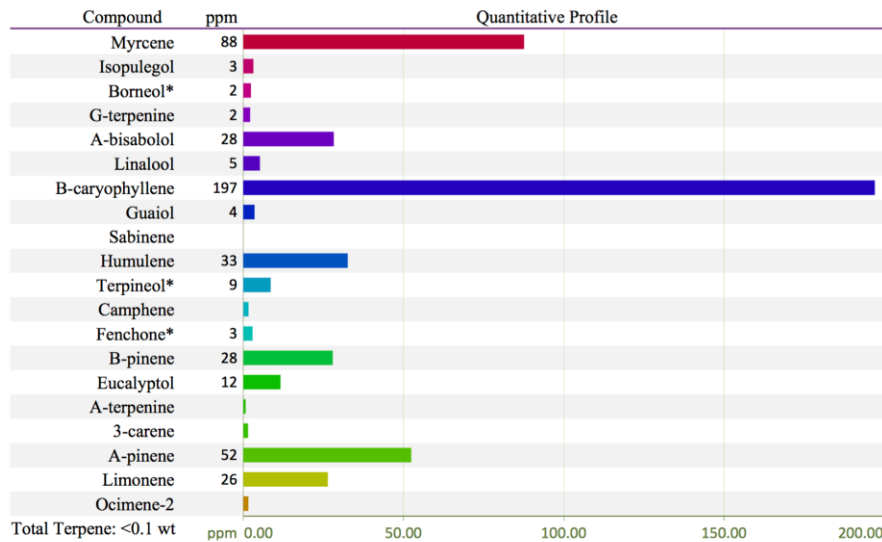
TP: Terpenes Profile [W1-10-08]

Analyst: LabTech

Test Date: 12/15/2016

The client sample was analyzed by Head-Space Gas Chromatography (HS-GC). The collected data was compared to data collected for certified reference standards at known concentrations.

14366-TP



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Processing

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Processing

- Once harvested, dried and tested the hemp is ready to be processed
- Can extract CBD rich oil from flower or biomass material
- CBD is further refined to produce CBD distillate or isolate
 - Sold or processed into finished CBD products such as oil tinctures or lotions

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CBD Extraction

- CO₂ - uses controlled pressure and heat
 - Expensive equipment, steep operational learning curve
 - End product is safe, potent, and free of chlorophyll
- Ethanol – addition of solvent
 - High-grade grain alcohol extracts cannabinoids but destroys potentially beneficial plant waxes
- Butane
 - Relatively low equipment and running cost but can be dangerous
 - Produces flavorful extracts with higher terpene content than can be achieved by CO₂ extraction
- Olive Oil
 - Can extract cannabis oils however it is perishable and should be stored in a cool, dark place



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Full Spectrum Oil

- Contains a wide range of cannabinoids naturally present in hemp, like CBD, CBN, and CBL
- Also contains the aromatic and beneficial terpenes
- Because there is no further refinement, full spectrum oil will also contain trace amounts of THC
- May provide a greater effect than CBD alone as all the cannabinoids have been shown to work better together in what is known as the “entourage effect”

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Further processing steps

- Dewaxing
- Filtration
- Solvent removal
- Distillation
- Isolation



CBD Distillate

- Further processed compounds from full spectrum oil (crude)
- Distillate typically contains around 80% CBD, includes minor cannabinoids, terpenes and other plants oils and extracts
 - because distillate still contains other cannabinoids and terpenes often considered a broad spectrum product

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CBD Isolate

- Further refined product from distillate
 - purified cannabidiol white, granular, crystals comprising up to 99.5% or more of CBD



Crude -> Distillate -> Isolate

Toll Processing agreements

- Growers sell to processors
- Growers pay processors and get products back
- Processing CBD split contract
 - split of 50:50 (or some other agreed upon amount) where processor extracts and returns half of your sample and keeps the other half as payment for the processing services

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Markets

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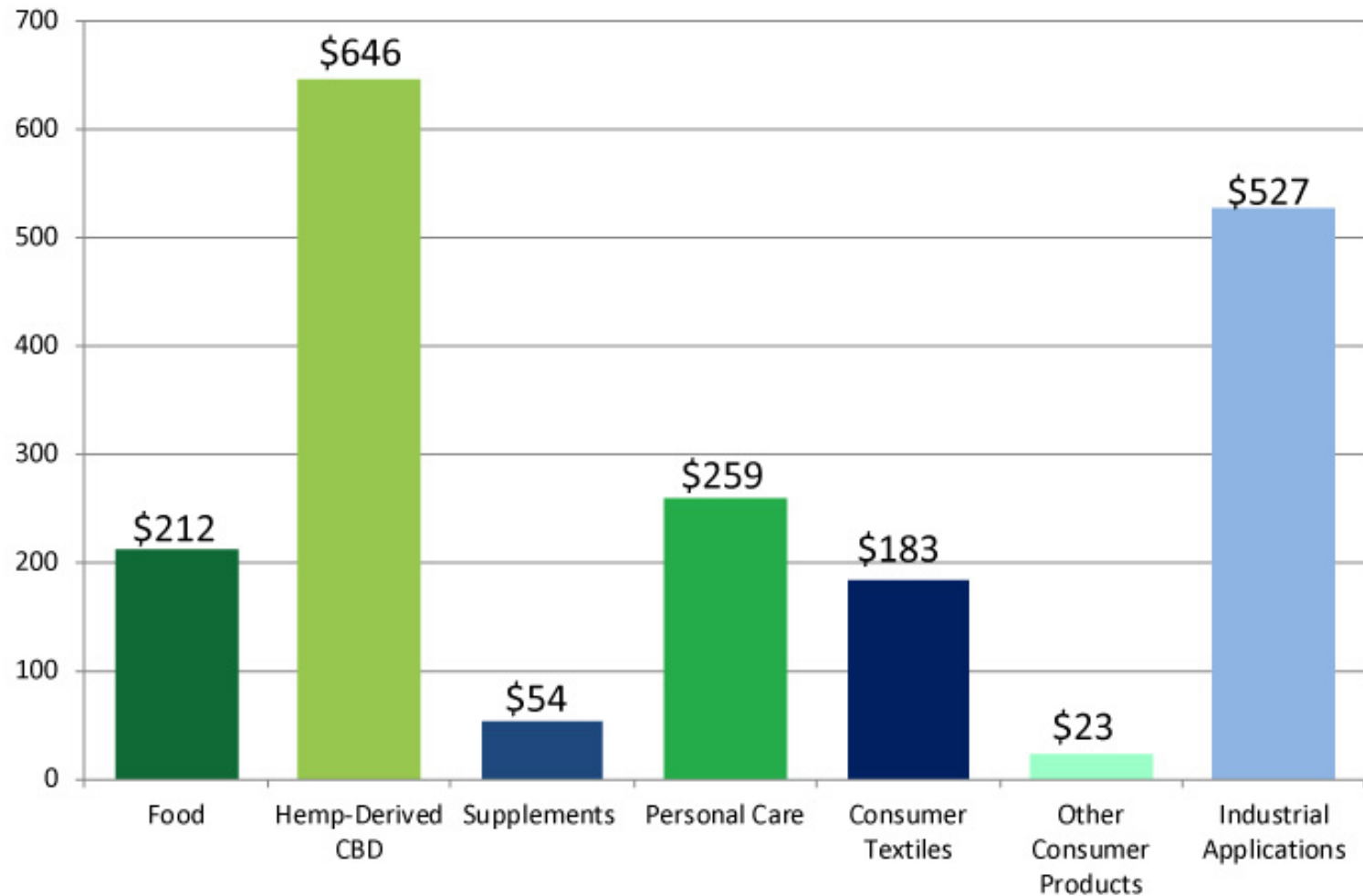
Markets

- 2015 - US hemp-based product sales totaled \$573 million
- 2016 - sales grew to \$688 million
- 2017 - sales reached \$820 million
- 2018 – sales reach \$1.1 billion
- 2019 - ???
- Include food products, industrial applications, fiber products, and CBD

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\$1.9 Billion U.S. Hemp-Based Product Sales by Category in 2022e



Source: *Hemp Business Journal* estimates (\$ mil., consumer sales)

CBD markets

- Prices vary with market and markets are changing quickly
- Examples from October 2018
- Wet weight biomass
 - From \$3.00 to \$3.65 per pound per CBD percentage: \$18,000 to \$21,900 per acre
- Purchase of dried floral material without stems, highest quality
 - \$70,000 per acre $[(\$7) \times (10\% \text{ CBD}) \times (1000 \text{ lbs})]$
 - Same material at 5% CBD and grower would gross \$10,000 per acre $[(\$2) \times (5\% \text{ CBD}) \times (1000 \text{ lbs})]$

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Increase in growers

- There will be substantially more CBD on the market in the 2019 growing season
 - Kentucky 162% increase in registered acres since 2018
 - Wisconsin increase 7x in licenses from 2018
 - Colorado currently has about 80,000 outdoor acres licensed to grow hemp, up 562% from 2017
 - Oregon currently has more than 51,000 outdoor acres licensed for hemp production, more than 1,300% from 2017
- If markets saturate prices could drop quickly
 - Will depend on demand
- What to do
 - Grow best crop possible
 - Negotiate contracts ahead of time
 - Sit on crop until market turns

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Marketing Data

- <https://extension.tennessee.edu/publications/Documents/D41.pdf>
- <https://ag.tennessee.edu/arec/Pages/budgets.aspx>
- UW River Falls/Madison marketing survey underway
 - https://uwrf.co1.qualtrics.com/jfe/form/SV_eRHhKD9NsnmNWuN

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Upcoming events

- Grain and Fiber Field day
- August 28th, 8:00am-2:30pm (hemp tour at 1:00pm),
Arlington research station
 - <https://fyi.extension.wisc.edu/news/2019/07/24/agronomy-soils-field-day-2019/>
- CBD Field days
- September 6th, 8:30am-12:00pm, Michael Fields Ag
Institute
 - <https://www.eventbrite.com/e/industrial-hemp-production-field-day-tickets-68175202867>
- September 13th, 1-5:00pm, West Star Organics
 - <https://www.eventbrite.com/e/cbd-hemp-field-day-tickets-66675384871?aff=ebdssbdestsearch>

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Click here to watch on YouTube: <https://youtu.be/UabRD3eDGZg?t=2523>

Thank you!

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University of Wisconsin-Madison

Wisconsin Hemp
Division of Extension

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18	19	20	21	22	23	24
25	26	27	28	29	30	31

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Learn about upcoming Industrial Hemp programs and events happening in Wisconsin

<https://fyi.extension.wisc.edu/hemp/>