Cannabis Commodities – One Plant; More than 25,000 Potential Products

A Closer Look at the Cannabis Derived Products Market

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www.astm.org
Agenda

- Global Status of the Cannabis Plant
- What is Cannabis?
- Marijuana vs Hemp
- Derivable Products
- Manufacturing Processes
- Packaging & Denominations
- Consumer Base
- Supply Chain Logistics
- Post 2018 Farm Bill Challenges
Global Status of Cannabis

Global Cannabis Legalization Map

- Adult-Use
- Medical
- CBD-ONLY
- Decriminalized
- Pending Medical
- Pending CBD-ONLY
- Illegal
Global Status of Cannabis

Industrial Hemp Producing Nations

Industrial Hemp

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Global Status of Cannabis
Global Status of Cannabis
What is Cannabis?

- One of the oldest known domesticated plants
- Many different uses
  - Medicinal
  - Nutritional
  - Industrial
  - Recreational
- Humans have been cultivating, processing, and consuming cannabis and cannabis derived products for more than 10,000 years
- Listed in the US Pharmacopeia up until 1941
Why is the Cannabis Plant Grown?

3 Primary Reasons

– Flowers and resins

– Seeds

– Stalk and fiber
Grown for Seed
Grown for Fiber
Grown for Resin
What Comes from What?

Flower and Resin
- Ethanol
- Essential Oils
- Cannabinoids
- Terpenes

Seed
- Seed (edible & inedible)
- Oil (edible & inedible)
- Dietary Fiber
- Protein Powders
  - *Biodiesel

Stalk
- Textiles
- Composites
- Insulative Materials
- Paper
- Animal Beading
Marijuana vs Hemp

Marijuana
Cannabis plants grown for flower and resin production

Hemp
Cannabis plants grown for fiber and/or seed production
Definition:
The term ‘hemp’ means the plant Cannabis sativa L. and any part of that plant, including the seeds thereof and all derivatives, extracts, cannabinoids, isomers, acids, salts, and salts of isomers, whether growing or not, with a delta-9 tetrahydrocannabinol concentration of not more than 0.3 percent on a dry weight basis.

All cannabinoids other than delta-9-THC have been legalized – Delta-9-THC-A under debate

USDA regulates cultivation and harvesting practices

FDA regulates food/ drug product quality and safety

Farm bill only addresses cultivation NOT processing
0.3% delta-9-THC
The arbitrary line in the sand?

Marijuana

Cannabis plant \textbf{CBD??} 0.3\% w/w delta-9-THC

Hemp

- 0.3\% a number that was influenced by the data at the time (0.2\% in Europe)

- Is there a better way to distinguish between the different types of cannabis?

- Where does CBD fit?
CBD: Blurring the Lines

Say a cannabis plant contains less than 0.3% delta-9-THC w/w but has a significant concentration of other cannabinoids - Is this hemp or marijuana?

Traditionally hemp has meant little to no resin production – 2012 marks the normalization of CBD with hemp

The introduction of CBD contradicts the hemp industry’s long standing mantra that “hemp is not marijuana”

98% of the “hemp” grown in the US is for CBD production
98% of the “hemp” grown in Canada is for seed
Most of the “hemp” grown in Europe is for fiber
Most of the “hemp” grown in China is for fiber
Fit-for-Purpose Classifications

Where we are now

Marijuana

Hemp

Where we want to get to

Resin cannabis

Nutritional cannabis

Industrial cannabis

Cannabis

Bridging the gap
Classifications of the Cannabis Plant

- Resin Cannabis
- Nutritional Cannabis
- Industrial Cannabis

Multi-Purpose Cannabis
Fit-for-Purpose Terminology

*Resin cannabis*, n—any cannabis plant that has been, or is in the process of being, cultivated for the purpose of harvesting or processing the flowers and/or collecting, separating, isolating, or extracting the resins for human/animal consumption or topical use.

– Discussion: High-THC resin cannabis refers to any cannabis plant, raw material, or product containing greater than 1% delta-9-tetrahydrocannabinol (THC) by weight. Low-THC resin cannabis refers to any cannabis plant, raw material, or product containing no more than 1% THC by weight.

*Nutritional cannabis*, n—any cannabis plant that has been, or is in the process of being, cultivated for the purpose of seed production or any other purpose intended for human/animal consumption or topical use, except for the purposes of producing the flowers and/or collecting, separating, isolating, or extracting the resins.

*Industrial cannabis*, n—any cannabis plant that has been, or is the process of being, cultivated for the purposes of fiber, textiles, biofuels, bio/phytoremediation, or any other purpose not intended for human/animal consumption or topical use.
Multi-purpose cannabis, n—any cannabis plant that has been, or is in the process of being, cultivated for multiple end uses whether that be for a combination of resin, nutritional, and/or industrial purposes.

- Discussion: Multi-purpose cannabis should be cultivated and products manufactured therefrom using the standards that apply to the quality and safety of the most stringent “purpose” and/or “use”. Example: Cannabis plants grown for seed and fiber should be cultivated under Good Agricultural Practices, i.e. Food Standards.

Hemp, n—refers to low-THC resin cannabis, nutritional cannabis, industrial cannabis, and multi-purpose cannabis containing no more than the delta-9-THC as defined by the authority having jurisdiction.
Derivable Cannabis Products

Affected Industries

- Aerospace and Shipbuilding
- Agriculture
- Asset Management
- Automotive
- Building and Construction
- Chemicals
- Consumer Products
  - Energy and Utilities
  - Environment
  - Food Processing
  - Health Care and Medical Devices
- Information Technology
- Manufacturing
  - Metals
  - Mining and Mineral Processing
- Oil and Gas
- Plastics
- Quality
- Safety and Security
- Services
- Sports and Leisure
- Textiles and Leather
- Transportation and Logistics
Nutritional Cannabis Products

- Foods
  - Whole seeds
  - Seed kernels (hearts / nuts)
  - Protein powder
  - Dietary fiber
  - Seed oil (raw / refined)
  - Supplements

- Health & Beauty Aids
  - Haircare
  - Skincare
  - Cosmetics

- Animal Feed
Industrial Cannabis Products

- Textiles
  - Fabrics
  - Linens
  - Canvas
  - Rope

- Paper Products
  - Paper
  - Cardboard

- Composites
  - Technical products
  - Molded plastics
  - Bioplastics
Industrial Cannabis Products

– Building Materials
  – Insulation (hempcrete)

– Biofuels
  – Ethanol
  – Diesel

– Animal Bedding
Resin Cannabis Products

- Food & Beverages
  - Confectionary Goods
  - Baked Goods
  - Carbonated Water
  - Soda
- Medicinal Cannabis
- Prescription Drugs
Resin Cannabis Products

- Flower
- Pre-Rolls
- Cigarettes
- Distillate
- THCA Crystals
- CBD Isolate
Introduction to Seed Processing

Overview of the Various Cannabis Seed Product Manufacturing Processes
Seed Collection

At the Farm Gate

- Harvesting
  - Threshing

- Cleaning

- Sorting / Grading

- Storage
Seed Oil Manufacturing

- Seeds appropriate for pressing are segregated from those intended for shelling (commercial scale)

- Seeds are cold pressed using expeller presses to extract the oils

- Raw oil is filtered to remove any contaminants (e.g. seed parts)

- Oil can then be further processed to improve flavor, color, and consistency

- Oil is then stored until packaged*
Seed cake/meal is produced as a result of seed oil manufacturing.

Recovered cake/meal is ground in course powder.

Powder is refined through a series of sieves and size reduction methods.

Powders are classified based on protein and dietary fiber content.

Protein powders and dietary fiber are packaged in opaque oxygen-deprived containers to preserve freshness.
Seed Kernel Manufacturing

- Seeds appropriate for shelling are segregated from those intended for pressing (commercial scale)

- Seeds are fed into a hulling machine which opens the seed

- Seed kernels are separated from the shells/husks

- Kernels are cleaned to remove any dust and shell remnants

- Kernels are packaged in opaque oxygen-deprived containers to preserve freshness
Harvesting for Seed

https://youtu.be/pXfjQFdEaOw
Cannabis Seed Product Manufacturing

https://youtu.be/V6Pn9322jmU
Introduction to Fiber Processing

Process Description and Harvesting Techniques
Cannabis Fiber Manufacturing

- Harvest
  - Field retting
  - Scutching/Cracking
  - Wet Decortication

- Decortication
  - Hurd
    - Animal Bedding
    - Building Material
  - Bast Fiber
  - Carding
    - Cottonization
      - Fine textiles and linins
  - Post Processing
    - Press molded automotive products
    - Paper products
    - Eco-textiles
    - Carpeting
    - Long Fiber
      - Heckling
        - Tow
      - Spinning
        - Long Fiber Textiles

- Press molded automotive products
- Paper products
- Eco-textiles
- Carpeting
Harvesting for Fiber

https://youtu.be/_AKUCvqppy8

https://youtu.be/GJKnz9hlB3Q
Introduction to Phytocannabinoid Extraction

Extraction Process, Solvents Used & Best Practices
Phytocannabinoid Extracts

Whole Plant
- Multiple synergistic constituents
- Ensemble Effect
- Considered more effective than synthetic cannabinoids and single molecule preparations
- Varying composition
- Concentration: 40% - 80% w/w

Mono-cannabinoid
- Single cannabinoid
- Known composition
- Ideal for formulation
- Concentration: 98+% w/w
Overview of the Phytocannabinoid Extraction Process

1. Plants are harvested
2. Dried
3. Flowers are separated from the plant
4. Refinement
5. Extraction
6. Pre-Extraction
7. Separation
8. Purification
9. Certificate of Analysis
Harvesting for Resins (manual)

https://youtu.be/U6-UX4sHTaA
Harvesting for Resins (mechanized)

Whole Plant

https://youtu.be/479x7CWdzro

Destemming

https://youtu.be/UdOG4Ua4Pmc
Harvesting for Resins (continued)

Processing for Flower

https://youtu.be/HizEep0MFeA

Processing for Extraction

https://youtu.be/PgGHXecDzO8
Designing Extraction Trains

What is the end goal?
• Whole Plant Extract
• Acid/Neutral Form
• Analytically Pure Extract

Chemical Properties
• Polar or Non-Polar
• Melting Point
• Vapor Pressure

Solvent
• Polar or Non-Polar
• Selectivity
• Refinement

Scale of Operation
• Bench Top, Pilot, or Commercial
• Validation
• Equipment Availability

Economic & Environmental Impact
• Solvent Choice
• Scale of Operation
• Waste
Solvents Used in Industry

Organic Liquid Solvents – traditional solvents used for centuries, inexpensive, some waste, 90+% recycling efficiency
– Methanol, Ethanol, Hexane & Cyclohexane, Chloroform
– Some are known carcinogens and poisons, unfit for human consumption, requiring strict safety and handling as well as mandatory residual solvent analysis

CO2 – standard in pharmaceutical industry, inexpensive, carbon neutral, high batch to batch reproducibility, 90+% recycling efficiency
– Highly selective

Propane & Butane – used in no other industry to produce extract intended for human consumption
• Extremely flammable, appropriate HVAC, VOC, and explosion precautions required when operating in an enclosed space
Phytocannabinoid Extraction Considerations

Compliance is key
• Stay on top of globally changing regulations – Single Convention

Know your building, electrical and fire codes
• Mistakes will lead to costly downtimes or worse
• Class 1 Division 1 Requirements (intrinsically safe, explosion proof, spark-less environments) – ATEX Zone 0, I and II and IECEx equivalence

VOC ventilation is critical
• CO2 is a dense gas that sinks to the ground, and expands rapidly causing asphyxiation and death
  • Complete air exchange in under 60 seconds
• Propane < Butane < Air

Not all equipment is the same
• Stamped and Certified pressure vessels and connecting lines are critical (ASME VIII Boiler and Pressure Vessels)

Reclamation of Used Solvent
• Environmental impact
• May contain contaminants
• Must be redistilled prior to reuse
Phytocannabinoid Extraction Process

https://youtu.be/PfgFh6ksBKs
Common Packaging Materials

- Resins
  - Plastic
  - Glass

- Flowers
  - Super sacks
  - Plastic
  - Glass

- Pre-Rolls
  - Hand made
  - Cigarette knock off
Common Packaging Materials

- Seeds & Seed Oils
  - Plastic
  - Mylar bags

- Fiber
  - Super sacks

- Shives
  - Plastic bails
## How Are Products Sold?

<table>
<thead>
<tr>
<th>Product</th>
<th>Weight/Count Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resin</td>
<td>By weight: gram, oz., lb.</td>
</tr>
<tr>
<td>Flower</td>
<td>By weight: gram, oz., lb.</td>
</tr>
<tr>
<td></td>
<td>By count: sacks / totes</td>
</tr>
<tr>
<td>Seed</td>
<td>By weight: gram, oz., lb.</td>
</tr>
<tr>
<td></td>
<td>By count: sacks / totes</td>
</tr>
<tr>
<td>Seed Oil</td>
<td>By volume: fl. oz., gal.</td>
</tr>
<tr>
<td></td>
<td>By count: barrel / drum</td>
</tr>
<tr>
<td>Fibers</td>
<td>By count: ft., bails</td>
</tr>
<tr>
<td>Shives</td>
<td>By weight: lb., tones</td>
</tr>
</tbody>
</table>
B2B: Consumer Base

Processors
Purchase bulk flower, seed, or stalk from the farmer
Process those raw materials into more valuable commodities

Product Manufacturers
Purchase bulk ingredients or raw materials from processors
e.g. whole seed, seed oil, stalks (bails) raw fibers, shives, extracts, etc.

Retail Outlets
Purchase finished products from manufacturers
B2C: Consumer Base

Cannabinoid Dependent
Reliant on cannabinoid therapies to have a normal life

Health Conscious
Healthy Lifestyle
Vegetarian & Vegan
Meat Substitute
Athletes & Body Builders

Adult-Use
Advocates
Enthusiasts
Naïve Consumer
Supply Chain Logistics

- Vertically Integrated Model
  - Expensive to start
  - $30 mm to $50 mm to setup fiber, seed, or flower processing
  - 150 km from the field (seed & fiber)

- Cooperative Model
  - Spilt the cost of startup
  - Work together to process and sell goods
  - Reduce risk

- Outsource Model
  - Lowest CAPEX
  - Requires fully mature market
Supply Chain Logistics

Seed to Shelf

– Farmer
  – Transportation
– Seed Cleaner (if applicable)
  – Transportation
– Processor
  – Transportation
– Product Manufacturer
  – Transportation
– Warehouse/ Fulfilment Center
  – Transportation
– Retail Outlet (or online)
  – Transportation
– Consumer
For More Information

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Thank You for Listening

www.astm.org
Types of Cannabis

Cannabis sativa

Cannabis indica

Cannabis afghanica
Cannabis Seed Oil Manufacturing
Bioactive Compounds of the Cannabis Plant

Cannabinoids – 113 known
THC, THC-A, CBD-A, CBD, CBN, CBG, CBC, THCV, CBDV…
Affect the CB1 and CB2, other ECS and various brain receptors & various liver enzymes

Terpenes & Terpenoids – 140 known
Naturally occurring hydrocarbons based on isoprene unit
Terpenoids – related to terpenes, include some oxygen functionality or rearrangement

Flavonoids - 23
Another class of botanical secondary metabolites; act as pigments
Cannaflavin A and B – unique to cannabis

Essential oils
Phenols (only 34 non-cannabinoid phenols known)
Alcohols, aldehydes, ketones, acids, esters and lactones
Other bioactive compounds

Various Hydrocarbons – 50 known
Nitrogen containing compounds
Carbohydrates
Essential Fatty Acids – Omega 3, 6 & 9
Non-cannabinoid phenols
Phytosterols – 11
Vitamin K
Carotene & Xanthophylls (pigments)
Various elements: Na, K, Ca, Mg, Fe, Cu, Mn, Zn, Hg, etc.
The Brass Tax

Resulting Products:

- Seed Oil = Essential fatty acids
- Seed Cake = Protein, Vitamins & Minerals
- And so much more!

*Per Acre Yield*

~20.5 gal seed oil
~472.5 lb. seed cake
THC Content in Food Products

How much is too much?

– Varies from country to country
– US:
  – 5 ppm in seed oil
  – 1.5 ppm in hulled seed
– Canada:
  – 10 ppm in seed oil
  – 10 ppm in whole seed
– NOVA-Institute & EIHA Recommendations:
  – 10 ppm in seed oil
  – 5 ppm in whole seed
  – 2.5 ppm in hulled seed
  – 3.5 ppm in flour/protein powder
– What about other foods? [Scientifically Sound Guidelines for THC in Food in Europe](#)

Standards for THC content in food products will allow for greater market acceptance of cannabis-based nutritional goods.
More Images