Research

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Report #1

Cannabis Extraction and Post-Extraction Technology in North America and Europe



How Disruptive Technology Can Take The Cannabis Industry To A Higher Level

The cannabis industry in North America is in a race to build and expand growing operations to meet the projected demand in the coming years. With a CAGR ("Compound Annual Growth Rate") of about 30%, legal cannabis sales is the fastest growing sector of the US economy, estimated to reach \$27 billion USD in sales by 2020 (\$6.7 billion USD in 2016), according to ArcView Group.

Licensed cannabis growers not only want to **grow and sell raw cannabis** (in form of dried flowers) to recreational users and/or medical patients, but they want to **produce and sell extracts** (in form of oils, concentrates, tinctures, edibles etc.) with inherently much higher margins. Naturally, there is great interest from growers to add value to their raw product. The industry knows that most of the money will be made in this subsector. It's like diamond's cutting and polishing sector, where rough diamonds become margin-high brilliants. With a CAGR of 63%, **extracted cannabis oil sales** are projected to grow twice as fast as legal cannabis sales, according to the Hemp Business Journal.

One of the extracts of cannabis in high demand today is CBD (cannabidiol). CBD extracts with less than 0.3% THC are legal in all US states and can be shipped across state lines.

The Hemp Business Journal estimates that the market for CBD extracts will grow to \$2.1 billion USD by 2020 (a 700% increase from 2016), while Greenwave Advisors estimates the CBD market to grow to almost \$3 billion USD by 2021.

There is also a strongly growing demand for THC extracts and consumables from recreational users, medical patients and pharmaceutical companies as an increasing number of people in North America do not want to smoke (or vapor) cannabis for various reasons, e.g. health concerns, side-effects, dosage etc.

Company Details



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"Cannabidiol (CBD) is the part of the cannabis plant that doesn't get you 'high' like the THC side of the plant. It is typically used for health reasons instead of for recreational purposes. The CBD products are either derived from industrial hemp plants or marijuana plants." (Source: Forbes "The Cannabis Market That Could Grow 700% By 2020")

"Cannabidiol (CBD) is a natural constituent of the industrial hemp plant that promotes and supports the nutritional health of aging bodies." (Source: US Government Patent #6,630,507: "Cannabinoids as Antioxidants and Neuroprotectants")

Problem

Today, meeting the projected future demand for cannabis extracts is problematic, it's not feasible due to **supply constraints**. Typically, today's operating extraction technologies are inefficient, costly and/or dangerous.

Any drug for medical use requires precise dosage, but, in order to achieve this, one needs **appropriate supply with consistent potency and purity**. This is still a big challenge in today's cannabis industry and maybe why currently there are no natural whole cannabis plant derived drugs approved by the FDA. There are however <u>3 synthetic</u>, or manmade, cannabis derived drugs approved by the FDA that are not from the natural whole cannabis plant.

The use of any extract or compound for **medical purposes** requires a dependable supply; the extract's ingredients must be exact and predictable. Finally, the extract must be pure with no other chemical contaminants to prevent adverse sideeffects. Today, the cannabis industry continues to have great difficulties in fulfilling these **basic requirements**. The pharmaceutical industry and FDA require reliable supply of crystalline isolate with a purity of 99% or better.

Most hemp or cannabis growers lack the technical expertise to consistently produce plants with the same chemical composition. Small growers with limited capital are using their funds to expand their growing facilities rather than for producing plants with identical chemical properties.

Home-made extraction systems are not capable of supplying the required quantity, quality or consistency of bulk isolated cannabinoids that are required for accurate and predictable compounding.

Even the highest quality systems available are inadequate as these can only process a few pounds per hour and typically require lengthy pauses to recycle in a **batch process**. Multiple batch runs result in lost production and







extra down time. To achieve volume production, multiple systems are needed, which are costly and require a large production space. In addition, the technologies are <u>dangerous</u> because they use highly volatile and explosive solvents with open-air batch operating systems. The market needs a **continuous, closed-loop system!**

Solution

Originally developed and patented some 40 years ago for use in the petrochemicals industry, fiber film separation technology is commercially proven and is still used today in the oil filtration sector.

John Massingill, Ph.D. worked at Dow Chemical for 25 years and is the inventor and patent owner for the Fiber Reactor™ technology, which was designed to be used in the plant-based bio-oil and biodiesel fields. Today, the newly evolving cannabis industry is offering much better margins.

Dr. Massingill is a Member of the Board and the Head of the Scientific Research Team at Fiberlab Technologies LLC in Austin, Texas. Fiberlab Inc. is the majority controlling shareholder of Fiberlab Technologies.

Fiberlab Inc. (FLI) is a privately held company that was founded and is managed by its CEO, Edward Klaeger IV, who has worked in the clean renewable energy industry for the last 15 years with a special focus on clean technology for the past 3 years. Mr. Klaeger was introduced to Dr. Massingill and the Fiber Reactor™ for use to eliminate the corrosiveness of corn oil used in producing biofuels.

In June 2016, Klaeger founded Fiberlab™ Inc. to become a leading provider of scalable extraction and post-extraction technology for the cannabis/MMJ (medical marijuana) and industrial hemp industries in North America and Europe.

At the request of Mr. Klaeger, Dr. Massingill modified the Fiber Reactor[™] to create the Cannabinator[™] Fiber Film Separator[™] (FFS[™]) technology and added a high volume proprietary front-end cold filtered extraction and back-end high-tech purification and cannabinoid separation devices for a scalable continuous flow process. The result is a safe and secure, fully integrated, closed-loop, patented and proprietary Cannapūr™ continuous flow operating system for processing of cannabis/MMJ and industrial hemp cannabinoids rapidly on a high scale.

The Cannabinator[™] is an all-stainlesssteel, patented and fully automated continuous flow system that provides scalable, high-throughput processing with clean cannabinoid separation and purification at a substantially lower cost, to achieve greater potency and higher purity than any other currently used method, making Fiberlab[™] *The Leading Provider of Disruptive Technology for the Cannabis Industry*[™].

In June 2017, commercial production with the first Cannapūr[™] system began in Aurora, Colorado (100% owned by Fiberlab[™]), which is already generating revenues.

A larger second Cannapūr[™] system is currently being manufactured in Austin for installation in California in Q4 2017 (start-up revenues expected in November), which will provide 4 times the capacity with the same Cannabinator[™] footprint as the smaller Colorado system. This second system is an 80,000 gallons/year Cannapūr™ system in Los Angeles that is 100% owned by Fiberlab Technologies. This system will create Fiberlab brand products for the retail and medical market while bulk processing will be done on contract. The first contract partner is Elixr L.A. Based in Los Angeles, Elixr is a retail supplier of cannabis-based THC vapor pens that is made up of a group of former NFL players.

Plans include at least 5 more systems in 5 more partnerships through the end of 2019. Fiberlab[™] utilizes a BOO (Build, Own, and Operate) business model based on its patented Fiber Film Separator[™] (FFS[™]) cannabinoid separation and purification technology.

CAPEX (total investments) required for this turn-key system is \$1.1 million USD of which at least 60% will be provided by Fiberlab[™].



Fiberlab's Hemp Performance 100.00% 80.00% 60.00% 40.00% 20.00% 0.00% ∆9-THC THCa CBD CBDa CBN CBG тнсу Total Crude Hemp Extract 0.38% 0.00% 9.55% 6.98% 0.00% 0.00% 0.00% 16.91% 1.05% FLI CBDa Concentrate 0.00% 0.00% 78.52% 0.00% 0.00% 0.00% 79.57% FLI CBDa Isolate 0.00% 0.00% 99.63% 0.00% 0.00% 0.00% 0.00% 99.63% Fiberlah can also convert CBDa into CBD at an 87 77% vield Source: Fiberlab Inc









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Fiberlab's system produces and sells custom cannabinoid products with up to 100% potency and up to 99.995% pure concentrates, distillates and isolates (crystalline) that can be produced to individual customer specifications or a patient's prescription. **Crystalline isolates** are ideally suited for the pharmaceutical industry (accurate largescale production for accurate microdosing of separated cannabinoids for pharmaceutical compounding).

Fiberlab Inc. can produce high purity cannabinoids concentrates, powders and isolates:

THC Concentrate (70-95% potency):



CBD Concentrate (50-90% potency):



THCa Powder (90-99% potency):



THCa Isolate (99-100% potency):



CBDa Isolate (99-100% potency):



CBD Isolate (99-100% potency):



Fiberlab[™] has already commercialized these 6 cannabinoid products for bulk enrichment, purification, separation and (if desired) crystallization. Other cannabinoid separations, such as **CBC, CBN, CBG** and **THCV**, are in development.

Fiberlab[™] is not only capable of producing **separated cannabinoids** with high purity, but also the **full spectrum** of cannabinoids and terpenes as an added product for desired flavor and effect.

Fiberlab[™] is about to launch its web shop for its legal cannabinoid products that contain less than 0.3% THC.

Fiberlab[™] Inc. will also be selling directly to dispensaries, retailers and caregivers.

Fiberlab[™] already has 2 distribution partners: <u>MMJ Compounding LLC</u> (Colorado) and <u>Elixr L.A.</u> (California), and is negotiating other strategic partnerships.

Fiberlab[™] Advantage

Fiberlab[™] does not sell its systems, they utilize a BOO (Build, Own, and Operate) business model using its own capital equipment built according to customer specifications. Thanks to economies of scale and superior products produced, Fiberlab[™] will maximize margins and real value per customer over the course of its operational lifetime.

Outsourcing to Fiberlab[™] has many advantages. At this stage of the cannabis market, competition is limited to companies extracting cannabinoids from their own harvest. They must purchase batch process equipment and set up a facility, as well as hire and train a staff. They must take on responsibility of becoming a fully licensed process manufacturer using a dangerous process (completely different from the remainder of their business). The main problem is their processing is not scalable. For competitors to increase their production, they need more equipment and more staff. Fiberlab[™] has a highly skilled staff to train operators for its closed-loop, continuous flow process.

The Fiberlab[™] process is safe, fully automated, has a smaller footprint with greater throughput and lower costs, to produce very consistent results with much higher purity than competitors.

Fiberlab[™] can produce cannabinoids on an industrial scale. Its proprietary system can easily process 1-20 million gallons (3,700 to 74,000 tons) per year. The system does not lose efficiency when smaller volumes are desired. This means greater economies of scale and lower production costs (OPEX) than any other system currently in commercial operation.

Fiberlab's average production cost per gram of CBD is generally lower than any competitor currently in the market.

Overall, Fiberlab's low-cost toll processing technology will disrupt the cannabis extraction industry globally as its competitive advantages are compelling.

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THC, THCa, CBD and CBDa

"Two cannabinoids receiving more attention due to their medicinal potential is THCa (delta-9-tetrahydrocannabinolic acid) and CBDa (cannabidiolic acid). In the most fundamental explanation, these cannabinoids are the precursors to their more infamous and recognized counterparts, THC and CBD. Found only in fresh, unheated, unprocessed cannabis flowers, and produced by glandular trichomes, they differ not only in molecular structure, but also in how they interact within the human body. Due to its molecular structure, THCa doesn't stimulate the psychoactive effects, or high, as its decarboxylated counterpart. However, both THCa and CBDa interact with the human endocannabinoid system (ECS), but in a vastly different methodology than its natural form.

In brief, THCa and CBDa influence the ECS without being a cannabinoid receptor antagonist. Even so, it appears to influence the endocannabinoid system by releasing and inhibiting mechanisms responsible for inflammation and autonomic nervous system functions. Because of their influence on the endocannabinoid system, and ability to modulate a variety of biological actions, creating extracts without disrupting their molecular structure is of particular interest throughout the cannabis industry. Instead of using heat to create an extract, cold-process extractions essential retain THCa-CBDa concentrations while producing a readily-available solution." (Source)

Fiberlab™ utilizes proprietary cold-press extraction to feed the Cannabinator™, which is another competitive advantage for Fiberlab™.

"THCa is the main constituent in raw cannabis. THCa converts to D9-THC [=THC] when burned, vaporized, or heated for a period of time at a certain temperature. Although THCa has no psychoactive effects of its own, it acts as a cannabinoid receptor agonist, and in so doing helps in its neuroprotective (brain protection) effects. THCa is known to act as an anti-inflammatory agent. Clinically, THCa is fundamental in the production of cannabis that is utilized for medical purposes such as production of cannabis tea. In addition, THCa has been utilized effectively as a biomarker together with THCv in testing drugs and in differentiating between approved processed varieties of cannabis used for medicinal purposes and other materials from cannabis plant that can be used by patients.

THCa not only has anti-proliferative abilities that are crucial in helping inhibit the growth of cancerous cells, but also, it has anti-spasmodic abilities that helps subdue muscle spasms and therefore has potential use among epileptic patients. THCa has been shown to be more effective than THC or CBD for regulating the functions that support the endocannabinoid system while reducing pain caused by inflammation. It is well known that THC and CBD are effective for improving mood in response to physical pain, however they do a little to influence the causes of pain or systemic disease in comparison to THCa.

Patients that use THCa prefer it to CBD or THC for long-term synergistic benefits that restore health and wellness which influences mood. " (Source)

Common Extraction Technologies

According to <u>Herb</u>, 2 types of extraction methods are the most common and popular today: **BHO** (Butane Hash Oil; also known as dab, wax, shatter, honey, crumble) and **Supercritical CO₂** (Carbon Dioxide at high PSI). BHO tends to feature stronger terpene expression than CO₂ (terpenes are important flavor and aroma molecules found in plant resins. There are over 140 different terpenes in a plant; the more terpenes present in concentrate the better as terpenes enhance the medicinal effects of cannabinoids). However, BHO is more likely to contain residual solvents, which can be toxic (even 1% would be dangerous especially if swallowed or used to make edibles). The BHO technology is highly explosive and not environmentally friendly (petroleum product). Due to the dangers, BHO extraction is illegal in California (see also "California Bill Could Disrupt Cannabis Concentrate Production by Limiting Butane Extraction"). Other US states could follow California's lead, especially if alternative, safer methods of extraction become commercially available.

CO₂ extraction relies on very high pressure, which strips the plant clean. However, during the CO₂ extraction process, many of the terpenes are removed. CO₂ also has a lengthy purification process, which is required to remove co-extracted constitutes such as waxes and plant fats. However, this extraction process takes away from the final cannabinoid and terpene profile. For this reason, CO₂ extracts are often considered a weaker product with a lower THC content between 50-75% that contains unwanted paraffins. The average yield of CO₂ extraction systems is only 15-20%. With the CO₂ extraction process, the costs are high and the output per hour is limited in production scale.



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Largest Projected State Cannabis Markets by 2020

GreenWave





Projected State Counts of Legal Marijuana Markets (Incl. DC)







2016 State Market Share



U.S. Retail Marijuana Sales Projections (\$ Billions)



~26.3M Potential Patients (Medical) **\$3,200** Average Patient Spend/Year

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~30M Active Users Ave (Recreational)

\$1,500 Average Consumer Spend/Year

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