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Extraction Magazine

ISSUE 12 Mar/Apr 2020

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The Extraction Artist's Splotch of Oil

By Jason S. Lupoi, Ph.D.

The organoleptic experiences of different cannabis extraction products are based on their chemistry. The terpenes, of course, provide flavor and aroma in addition to prolific medicinal properties. Take borneol, for example. The isolated terpene (a white powder) is still wonderfully fragrant, although its scent reminds me of the marriage of the fresh woods and a strong, pine-scented cleaning solution. And, unlike the rumors regarding myrcene [1], borneol has been shown to ferry molecules across the blood-brain barrier. [2] Beta-Caryophyllene is peppery and spicy. The terpene isolate (oil) that I have smells like clove. Caryophyllene is resilient throughout the extraction process, and many vape pen products seem to have aromas reminiscent of peppers and cloves.

Medicinally, caryophyllene is very special. It's been studied in treating addiction [3] and in chronic pain [4], to lightly pepper the discussion with its accolades. These and many other terpenes are taking on more advanced roles within the hemp industry now that cultivators are targeting resin and not fiber production. In the further evolved cannabis product blueprints, terpenes are being added in bulk to mimic a chemovar or in isolated form to achieve a desired physiological outcome (e.g., sleep).

Cannabinoids taste bitter. In a product like a cannabidiol (CBD)-infused water, that slightly bitter taste imparts confidence that the liquid is *actually infused* with CBD juxtaposed to a glorified version of packaged tap water or equivalent. It's sad that some commercial CBD products don't contain CBD. [5] So, that trademark bitterness ought to at least signal the medicine's presence.

Other molecules in extracts cause dark colors or vegetal tastes. Depending on the consumer's palate, one person might favor crude oil products like Rick Simpson Oil (RSO), regardless of its thick mouthfeel and bitter taste. Many people swear by RSO. Another person, though, might want as much of that bitterness, taste of plant matter, and waxes and chlorophyll, to be stripped out, resulting in an amber or golden elixir, clean and much more subtle. There's an organoleptic solution for everyone.

It's almost like a splotch of paint, not very beautiful perhaps, but plentiful with possibilities. The extraction artist doesn't need to add more color to the painting. Rather, they refine their products to remove unwanted ingredients like pigments or waxes, navigating from blackened to golden hues. What experience are you trying to create? Your adventures as a product designer begin there.

This issue of *Extraction Magazine* continues our discussion regarding ways of refining cannabis and hemp extracts. From cryogenic ethanol extraction to the use of microwaves for botanical terpene isolation or multi-stage filtration strategies, the extraction artist has many ways to concentrate and beautify their craft.

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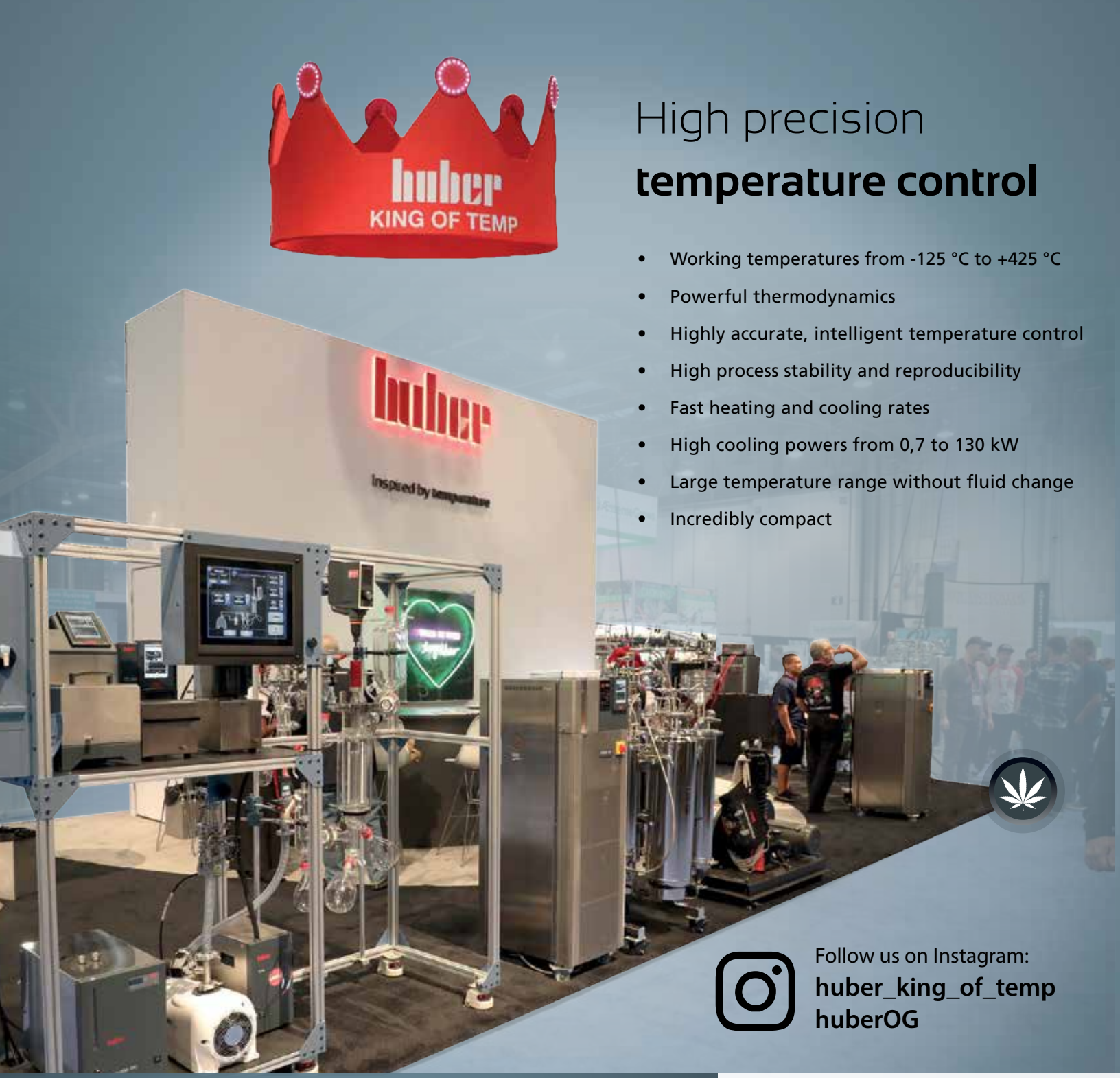

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Improving Brand Loyalty with Microwave Terpene Extraction

By Roberto Federico-Perez, Ph.D., Milestone Inc

The psychoactive nature of cannabis is widely understood as an effect of the cannabinoids present in the plant. Cultivation Cultivation focuses not only on enhancing and modulating these effects but also in growing varieties with a better smel and taste to improve their consumer appeal. These sensory properties of cannabis rely on terpene content. The structure and proportion of terpenes result in unique organoleptic profiles that differentiate cannabis plants from one another. The extraction of terpenes from cannabis, therefore, opens the door for the manufacturing of various cannabis derivatives with a distinctive branding.

Principle of Microwave Extraction

Microwave extraction is an emerging technology that enables obtaining terpene extracts that are true to the original plant profile. The technique works by taking advantage of the polar molecules present in the plant material. Water molecules are the main contributor to microwave absorption. In the presence of microwaves, water molecules exhibit multiple vibrational states that generate heat. The steam released by this process carries over the volatile compounds present in the plant. Since terpenes are immiscible in water, they are easily recovered after condensation in a separate vessel where they form a layer on top of the aqueous phase due to their lower density.

Using microwaves for extraction poses several advantages compared to other techniques. For instance, as opposed to conventional steam distillation that utilizes conduction as a heat transfer method, a more uniform mechanism can be achieved by microwave irradiation, avoiding major temperature gradients since microwaves act on the water molecules *in situ*. This allows for an improved efficiency and shorter extraction times. [1] In addition, microwave extraction can be used to process fresh or fresh frozen material, which does not undergo the potential loss of terpenes during the drying or curing process. [2] The use of fresh cannabis with high moisture is restricted in other extraction techniques like CO_2, where water can lead to the formation of carbonic acid.The ETHOS X Microwave Extraction System (Figure 1) integrates the principle of operation described above into a streamlined process. The unit consists of a reactor vessel of variable capacity that is loaded with cannabis and placed into a microwave cavity. The vessel is then attached to an external setup that comprises a stainless-steel condenser connected to a water chiller and a graduated glass collection vessel. Once the microwave program starts, water eventually evaporates and condenses into the graduated glass vessel where the user can keep track of the accumulation of terpenes throughout the run. Water is constantly recirculating back into the reactor to ensure an adequate microwave absorption and a carrier medium for the extracted terpenes.

Extraction Procedure

A typical microwave method includes a series of wattage steps that progressively increase the microwave power supplied to the cannabis material. The system monitors the temperature by using a contactless sensor that reads the bottom of the reactor. The overall microwave program, however, is defined by the wattage supplied at a given time. Method optimization depends on the kind of plant material used, but ultimately consists of determining when condensation occurs in order to reduce the microwave power to sustain the evaporation of water.

An important parameter that dictates the amount of power to be supplied is the amount of material to be processed. Approximate nominal loads for fresh material are around 1, 2.5, or 6 pounds depending on the volume of the vessel (2,

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5, or 12-L, respectively). In a similar way, about 0.5, 1, or 2.5 pounds of cured material can be accommodated in the corresponding vessel. Since water is the microwave-absorbing agent, cured cannabis requires an additional rehydration step. This is normally performed by adding water equivalents to the material in either a 2:1 or 3:1 ratio.

Expected yields for microwave-extracted terpenes are strongly dependent on the quality of the starting material. Anecdotally, these yields range within 0.3-1.0% for fresh or fresh frozen cannabis, and 1.0-1.5% for cured cannabis, as reported by users. These yields are calculated using the original mass as a basis. Although many plants yield colorless terpenes, some cannabis varieties show light yellow to light orange colorations. This has no impact on their smell and flavor profile. Moreover, clarity is a consistent characteristic among all microwave-extracted terpenes, as no particulates or extraneous materials or compounds are carried into the final product.

A relevant feature of microwave extraction is its ability to be selective toward highly volatile compounds (i.e., terpenes), allowing for a pure extract. Heavier compounds with additional functional groups, such as cannabinoids, are retained within the plant material without modification and are not present in the final extract. Therefore, delta-9-tetrahydrocannabinol (THC) and cannabidiol (CBD) can subsequently be extracted by conventional approaches.

Often these additional methods require dry feedstock to ensure an optimal performance (e.g., CO_2 extraction). To achieve this, a common technique that can be coupled to the microwave process is the use of a forced air oven that allows for a fast removal of the remaining moisture in the material. Tables 1 and 2 describe the terpene profile in the original fresh frozen flower and final extract, respectively, and Table 3 shows the cannabinoid content in the flower pre- and post-extraction. [3] Differences in cannabinoid content in the flower pre-and post-extraction can be attributed to variable sample sizes at each stage of the analysis.

Productivity and Microwave-Extracted Terpenes

Since many processors are looking for scalable solutions, they utilize the higher throughput option to run as much material as possible in a single run. For a 12-L vessel, a complete run takes about 60 minutes. Additional scalability can be reached by running units in parallel. Table 4 shows a productivity estimation based on use in an average workday. The kind of material used, different ranges of yield, and the number of parallel units are factored into this assessment. As an example,

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Flower pre-extraction	
Compound	Mass %
δ-Limonene	0.131
β-Myrcene	0.067
β-Caryophyllene	0.067
Linalool	0.065
α-Humulene	0.030
β-Pinene	0.024
α-Pinene	0.013
α-Bisabolol	<LOQ
α-Terpinene	<LOQ
Camphene	<LOQ
Caryophyllene oxide	<LOQ
Cis-Nerolidol	<LOQ
Cis-Ocimene	<LOQ
δ-3-Carene	<LOQ
Eucalyptol	<LOQ
γ-Terpinene	<LOQ
Guaiol	<LOQ
Isopulegol	<LOQ
p-Cymene	<LOQ
Terpinolene	<LOQ
Trans-Nerolidol	<LOQ
Trans-Ocimene	<LOQ
Total %	0.37

Table 1

Terpene extract	
Compound	Mass %
δ-Limonene	26.959
β-Myrcene	12.829
Linalool	6.029
α-Humulene	4.927
α-Pinene	2.576
Trans-Nerolidol	2.258
β-Pinene	1.607
Cis-Nerolidol	1.182
Camphene	0.956
α -Bisabolol	<LOQ
α-Terpinene	<LOQ
β-Caryophyllene	<LOQ
Caryophyllene oxide	<LOQ
Cis-Ocimene	<LOQ
δ-3-Carene	<LOQ
Eucalyptol	<LOQ
γ-Terpinolene	<LOQ
Guaiol	<LOQ
Isopulegol	<LOQ
p-Cymene	<LOQ
Terpinolene	<LOQ
Trans-Ocimene	<LOQ
Total %	59.323

Table 2

Compound	Pre-extraction	Post-extraction
	Mass %	Mass %
THCa	6.043	0.954
Δ^9-THC	0.164	3.905
Δ^8-THC	0.144	<LOQ
THCV	<LOQ	<LOQ
CBDa	<LOQ	<LOQ
CBD	<LOQ	<LOQ
CBDa	<LOQ	<LOQ
CBDV	<LOQ	<LOQ
CBGa	<LOQ	<LOQ
CBG	<LOQ	<LOQ
CBN	<LOQ	<LOQ
CBC	<LOQ	<LOQ
Total potential THC	5.464	4.742
Total cannabinoids	6.658	5.211

Table 3

Table 4

Fresh Frozen Material					
Yield	1 Unit	2 Units	3 Units	4 Units	5 Units
0.30%	41g	82g	123g	163g	204g
0.50%	68g	136g	204g	272g	341g
0.70%	95g	191g	286g	381g	477g
Cured Material					
Yield	1 Unit	2 Units	3 Units	4 Units	5 Units
0.30%	41g	82g	123g	163g	204g
0.50%	68g	136g	204g	272g	341g
0.70%	95g	191g	286g	381g	477g

*Estimations based on 5 lbs of fresh frozen and 2.5 lbs of cured material run every 75 minutes for an 8-hour shift in a 12-L vessel (6 runs per unit)

Table 5

Distillate cost/g	Total distillate cost	Total 1 g vape carts	Distribution price per 1-g cart	Gross revenue	Profit
$5.00	$4,625.00	1000	$20.00	$20,000.00	$15,375
$10.00	$9,250.00	1000	$40.00	$40,000.00	$30,750
$15.00	$13,875.00	1000	$60.00	$60,000.00	$46,125

running six runs per day with fresh frozen material at an average yield of 0.5% would generate 68 g of terpenes with a single system, or 341 g if using six units.

The figures shown above can be used as general guidelines for calculating the return on investment in this technology. A classic application for cannabis-derived terpenes is vape pen manufacturing. When using distillate rich in THC, a cut of terpenes is added to produce a characteristic taste and flavor to the cartridge, which ultimately leads to a branded product. Although the proportions between distillate and terpene may vary, a conventional 7.5% terpene cut can be used for illustration purposes. Assuming a 1000 g batch of vape cartridge mixture, this proportion translates into 75 g of terpenes for every 925 g of distillate. For a typical cartridge size of 1 g, a thousand cartridges can be produced if there is no loss through packaging. The cost of distillate and the distribution price of every cartridge fluctuates depending on the market and the regulatory situation of each state, but these two factors ultimately determine the potential profit in this simplified model. Table 5 shows a profit calculation based on different cost and price point levels on these two variables.

With the ongoing interest in cleaner methodologies that are not solvent based due to regulatory and safety concerns, microwave extraction poses an effective alternative to obtain terpenes with a process that is simple and easy to implement. A short processing time and the flexibility of using fresh or cured material results in higher quality terpenes. Since terpenes are one of the main vehicles that generate brand recognition for cannabis derivatives, enhancing extract quality is an excellent approach to generate a loyal customer base for growers and processors seeking to establish their product on the market.

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The Big Freeze – Using Cryogenic Extraction to Create Golden Perfection

By Seth Oxhandler, High 5 Edibles

At High 5 Edibles in Santa Fe, New Mexico, we developed a protocol that allows us to go from plant material to highly refined cannabis oil from our first pass through our short-path distillation (SPD) head designs in three days without active filtration or winterization. State-certified, 3rd-party lab reports have illustrated results in the 90th percentile for delta-9-tetrahydrocannabinol (THC) concentration.

This process can be done with the simple application of chemistry and for less than every commercial ethanol machine. Furthermore, we use cold in a range where these machines cannot operate. Now, *there* is a point to focus on. With a look across the spectrum of ethanol extraction machines readily available on the market, I can't find one that has seals that will hold the cold as low as we go in the near cryogenic range, which we euphemistically call cryogenic extraction.

In the true cryogenic range, -150°C to -272°C, theoretically, molecular motion comes as close as it can to ceasing. There are no machines that operate in that temperature range, and you don't need one any way. By utilizing thick gauge stainless steel barrels, cold ethanol, dry ice, and liquid nitrogen, we can get there.

To start, I like to pre-freeze the plant material. Freezing tends to make things expand. In the case of cannabis, it forces the oil to extrude through the plant material. So, with that said, let's keep the frozen material frozen and set aside. We need to prep the solvent.

The solvent (200 proof ethanol, organic, food-grade) does all the work—not a machine. The solvent will dissolve the oil from the plant material and hold it in suspension. I prefer to have ethanol in a freezer overnight as well. Because we cannot achieve super-cold with a freezer (think of it as just a step down), I like to prep the stainless-steel cans with dry ice so that they are super-cold too.

Place bagged plant material into the cold steel can. Add liquid nitrogen and ice-cold ethanol to the can simultaneously. Keep in mind that extreme cold can have an

extreme reaction. If you are not well versed in the mix ratio, you're going to want to step back while pouring. If you're wearing sneakers that are woven, your toes will know you are working with cold.

If you find you're down in the -135°C to -145°C range, your solvent is cold enough that uncut plant material will not leach out green. Your "wash," unless the material comes from an outside grow, should have a golden hue, and not green or any other color. I have had this wash method not work to golden perfection when I used cannabis grown outdoors because you cannot account for the particles of dirt on the material from the air.

Once you have achieved the lowest temperature possible in your facility, taking into account your geographic location, relative achievable indoor temperature (our first year, we had no air conditioning!), and the elevation, since elevation effects the boiling point, it's time to prepare your bagged plant material for soaking. I've read a lot about the quick ethanol wash method. Personally, I don't subscribe to it. Because we get our temperatures so low, we allow the plant material to soak until the wash temperature in the vessel rises to approximately -90°C. At that point, we remove the plant material.

This is when we actually walk away. Most facilities actively filter their wash at this point, utilizing everything from vacuum Buchner funnels to larger commercial designs. We utilize passive filtration at this stage for two reasons. First, we've found that running liquid through most filters freezes the process. After all, it's *really* cold. So, we found we had to wait. Also, active filtration requires active cleaning. Passive filtration requires no additional equipment. We simply wipe out the bottom of the extraction vessels when we are done.

Decarboxylation is achieved while we turn wash into crude through vertical distillation on Day 2 of our protocol. We utilize a vacuumed-sealed design such that, when done with a run, we never break the system down for cleaning. It's self-cleaning…almost. Because the system is sealed, we simply run a small amount of ethanol through. This both cleans and sterilizes the system for the next run. None of the regimens required for rotary evaporators apply. I admit, sometimes it feels like cheating. But that's how we make crude for distillate.

Day 3 is probably like anyone else's short-path refinement day. We utilize our own SPD head designs on either a 5-L, 12-L, or 22-L boiling flask. Heads range from 4450 mm to 150 mm. The vacuum is powered by an Edwards 45i that ensures that we can pump out enough volume, so we always look forward to refinement days. Looking back at the progression of our organic ethanol extracts, by going up in THC concentration and down in temperature, the two points intersect to create the mark of perfection we expect to see in the lab reports that characterize our extracts.

Envisioning Cleaner, Clearer Extracts through Product Filtration

By Drew Stahr, Filter Products Company

Visual clarity and the odor profile of hemp and cannabis extracts are the first indicators of product quality. Particulate, cloudiness, and off-odors may indicate poor processing, potential contamination, and spoilage. Because customers have more choices than ever, successful producers must emphasize product safety, quality, and consistency. Extraction processes have evolved as relevant commercial technologies, instrumentation, and sanitary-grade equipment have been adapted to the hemp and cannabis industries. While many advancements have been made regarding commercial hemp and cannabis extraction, commercial-scale extract filtration capabilities are often lagging. Some processors still rely on antiquated, labor intensive techniques, such as over-sized Buchner funnels, residential water filter housing, and home-brew filter columns, which result in inconsistent and unsatisfactory results.

An optimized filtration system requires a comprehensive look at the extraction technique, the planned throughput, and the required finished product characteristics.

An Overview of Extract Filtration

There is no "better" or "worse" extraction process from the filtration perspective, but the extraction solvent (cold ethanol, supercritical carbon dioxide (CO_2), hydrocarbon, (medium chain triglycerides (MCT) oil, etc.) significantly influences the approach to filtration.

As an example, cold ethanol extraction results in a crude extract that contains biomass residue, chlorophyll, and plant lipids. In a batch filtration process, the following filtration arrays are highly effective at refining the crude ethanol extract: (i) Coarse Filtration; (ii) Fine Filtration; (iii) Color Mitigation & Odor Correction; and (iv) Polish Filtration.

This four-stage filtration system assumes that an appropriate biomass containment bag is used during the extraction process to provide a crude extract that is free of bulk biomass and other particulate.

- **Stage 1** – Coarse Filtration typically uses felt bag or nominally rated cartridge filters to catch loose biomass and bind semi-solid free waxes and lipids that are drawn out during winterization.

- **Stage 2** – Fine Filtration removes nearly all particulate and plant derived lipids. Pleated synthetic filter cartridges and cellulose/diatomaceous earth (DE)-based media are both highly effective, depending on process scale.

- **Stage 3** – Color Mitigation & Odor Correction is achieved by exposure to activated carbon, which strips chlorophyll and carburized impurities from the extract to yield a transparent golden amber extract. Activated carbon also removes impurities that are responsible for unpleasant odors or tastes in final products. Note: activated carbon can bind molecules of interest, like cannabidiol or delta-9-tetrahydrocannabinol.

- **Stage 4** – Polishing Filtration serves as an insurance policy before solvent recovery, ensuring no particles or semi-solids reach the solvent recovery equipment. Generally, this is accomplished with an absolute-rated membrane filter, rated between 1.5- and 0.45-micron.

  Note: Nominally rated filters have efficiencies below 95%. Absolute rated filters have efficiencies greater that 99.9%

Compared to ethanol extraction, hydrocarbon and CO_2 crude

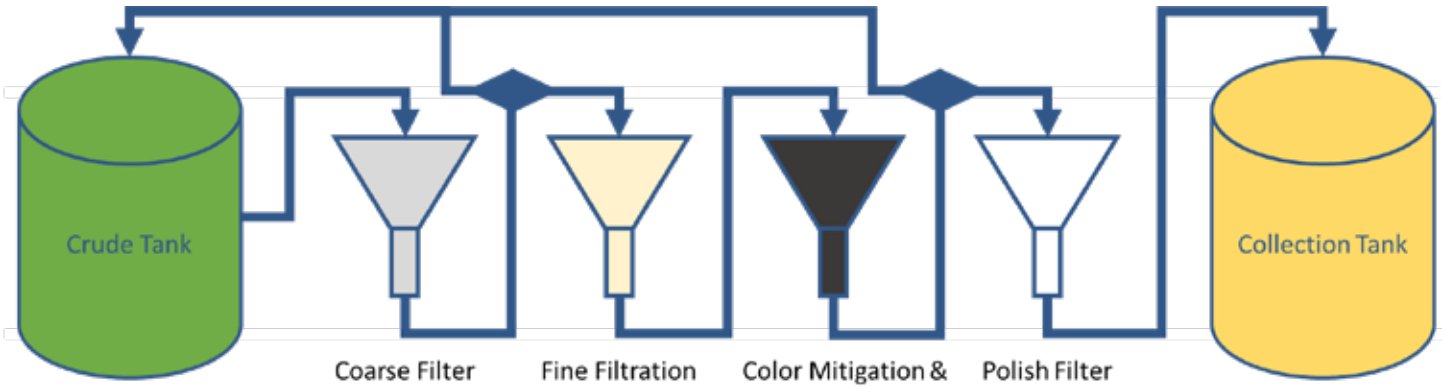

Figure 1 - Schematic overview of a four-stage filtration system

extracts contain less biomass but higher lipid content. The coarse filtration step can often be eliminated, leaving a three-stage filtration process that is similar to the last three stages outlined above.

MCT-derived extracts also benefit from multi-stage filtration, but an added filtration process is required due to differences in extract viscosity and density. Activated carbon and DE is added directly to the extract and homogenized to increase exposure between the extract and the filtration aides in a process known as *body-feeding*. These body-fed aids are then removed in the multi-stage filtration process.

Recirculation

Perhaps the most overlooked area for optimization in extract filtration is recirculation of extracts through the Fine Filtration and Color Mitigation & Odor Correction Filtration stages. Recirculation allows the filtration media to shed loose substrate initially, which is re-captured on subsequent passes through the same filter. This is especially true for activated carbon medias. Recirculation also allows many medias to wet-out, swell slightly, and reach their optimal working state.

In addition to product quality benefits, properly monitored recirculation provides two compelling financial benefits: recirculation through activated carbon ensures that a greater degree of the activation potential of the carbon is utilized before filter change-out; and recirculation through one or more stages before the polish filtration stage significantly reduces the loading on the absolute-rated membrane filters.

Sizing Your Filtration System

Matching batch and daily extraction throughput are critical when designing and selecting filtration equipment. An undersized system will result in slow throughput, increased maintenance and filter changeout time, and lost employee productivity. Conversely, an oversized system will result in increased extract loss, decreased filtration effectiveness, unnecessary capital and utility expense, and under-utilized filter media.

Fine Tune Your Filtration System

To get the most out of your filtration system, it must be fine-tuned at commissioning, but system calibration cannot stop there. Flow rates, recirculation ratios, media types, micron ratings, and differential pressure parameters need to be optimized as your raw materials, extraction parameters, and end-product objectives change. Ignoring these process parameters will translate to inefficiencies and waste in your production process.

About the Author

Drew Stahr is General Manager and Chief Applications Engineer at Filter Products Company, based in Richmond, Virginia. Drew holds a BSME degree from Mississippi State University and an MBA from the University of Wisconsin. Filter Products Company is a leader in specialty filtration solutions for critical applications, including the food, beverage, and pharmaceutical industries. Filter Products Company serves the hemp and cannabis processing industry with custom filtration solutions, consumable media, and customer-specified biomass containment bags for both OEM and processor clients.

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Distillation of Aromatic Plants

By Rob Brown, Extract Consultants

Steam and/or water distillation is a common scalable method used to extract essential oils from aromatic plants. Essential oils, or the essences of any plant, are complex combinations of volatile aroma chemicals. These oils are used in every consumer product that contains a smell or flavor.

Examples of familiar oils and their end products include peppermint oil, popular for chewing gum and oral care, eucalyptus oil, which is traditionally used in breathing and cough/cold remedies, and tea tree and/or citronella oil, which are often used in anti-fungal and bug repellent products. Each of these powerful essential oils contain dozens of separate molecules but they're typically made up of one or two key chemical components. For example, peppermint oil is dominated by menthol, tea tree oil by terpinen-4-ol, and eucalyptus oil by 1,8-cineole, aka eucalyptol.

To understand distillation, we must first understand the equipment and how it works. In a typical distillation unit, often referred to as a still, there are five basic but critical components: heat source, pot, condenser, separator, and container.

The heat source is anything that can boil water to generate steam. Whether the process involves steam that's injected into the pot holding the biomass or water sitting in the pot with the biomass, heat must be generated to turn water into steam to extract the oil from the plant. In the modern United States production of commercial essential oils, the heat source is a boiler fueled by a natural gas, diesel, or gasoline. In developing countries like Morocco, for example, water is boiled using direct fire to a pot of water, producing steam for extraction. The heat source will turn water into steam. Once steam is generated, it's either injected into a pot, sometimes called a tub or a retort, which is designed to hold the biomass to be distilled into oil.

Pots are typically stationary units where harvest biomass is collected and stored to later be brought to the still. Pots can also be a mobile unit on a trailer in order to harvest biomass

straight from the field. This pot is then taken to the still where it doubles as a distillation pot. The pot is engineered to either be heated at the bottom, in the case of water distillation, or in steam distillation, in which an opening at the bottom connects to a steam line from the boiler to inject steam into the bottom of the pot.

The pot is covered and sealed with a tight lid designed to connect to a vapor line attached to the condenser. As you can imagine, the hot water turns to steam and cooks the aromatic plant, releasing the oil and turning it into a vapor that migrates to the top of the pot, up through the vapor line, and into the condenser.

The condenser is a long winding tube made of copper or stainless steel that is submerged in a container containing cold water. Water and essential oil vapors travel through the vapor line and into the condenser to be cooled and turned back into a liquid. The finished liquid, which is now a mixture of aromatic essential oil and water, flows out of the condenser and into a receiving container.

This container also acts as a separator for the liquid oil and water to, you guessed it, separate! Oil and water are not miscible and do not like each other. Naturally, two layers are created, one oil and one water, and can be easily separated from one another, leaving the producer with finished, steam-distilled essential oil.

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Meet Our Advisory Board
The AC Braddock Chapter

By Jason S. Lupoi, Ph.D.

In recent issues, we've provided insight into why we've chosen specific people to serve on our advisory boards. Some are actively involved in the cannabis industry; others have witnessed their expertise become quite relevant in this nascent, legal industry. Our advisory boards aren't just for show or to name drop for increased sales. For us, a solid advisory board is like a giant brain that we can tap into when we need to extract nuggets of knowledge. They are co-navigators of our mothership.

You'll notice in any born teacher the willingness to advise and educate. To them, teaching comes as naturally as the sunrise and sunset. And the really good ones have mastered the knack of taking the complex and reducing it until it can be more readily digested by the layperson. After all, science or technology or medicine aren't just for an elite fraction of humankind, like some famous Greek philosophers would have had us believe. [1]

In this installment, you'll meet AC Braddock of Eden Labs, an *Extraction Magazine* advisory board member whose eloquent way of educating is readily apparent from just taking in a few sentences. And as you'll soon read, her philosophy is a natural and synergistic fit for EM.

EM: What brought you to the cannabis industry?
AC: We live in a world that has forgotten, dismissed, or purposely disparaged the use and protection of the natural world and our integral part in it. Focusing on plants as a source of health and well-being for humans as well as the planet forces us to look at the current science of this relationship medically, environmentally, and socially. We are out of step with our environment and each other as a species.

The pillars of the cannabis industry solve these problems. *Cannabis sativa* provides medicine, preventative medicine (aka nutraceuticals), clothing, shelter, food, and gives us the ability to repair the damage caused by the prison industrial system, racism, addiction to pharmaceutical drugs, war post-traumatic stress disorder, plastics, etc. We have recently discovered the endocannabinoid system. What is new is actually ancient. The knowledge of how we are supposed to live is in us and this plant and always has been.

EM: Why do you want to dedicate your education and resources to this industry?
AC: This industry is a gift for any creative businessperson, healthcare provider, social activist, the sick, and those seeking more spirituality in their lives. I have given it my all because it has the potential to give back tenfold of what we all put into it.

EM: How have you seen the industry evolve?
AC: LOL, that is an entire interview in itself. A lot has happened since 1999. The "industry" began as a medical solution and was fully grounded in health and well-being. Then, around 2014, the focus changed with the lack of access to banking in order to expand. Instead of existing businesses growing organically or seeking funding like any other legal business, they had to seek outside funding sources. Many of these sources gouged the industry with exorbitant interest rates, took large equity positions for small injections of funds, pushed out owners, etc. This influx of green-rush money also debilitated businesses owned by women and people of color who could not compete for those kinds of funding mechanisms. This significantly affected how and why products were being made, which created a market with less informed consumers, low grade products and unstable IPOs [initial public offerings].

Recently, I've seen a transition occurring from the highly destructive business practices of early green rushers who ignored why the industry existed to a recent wave of investment from the previously risk averse and crossover from other industries based in health and wellness, farming, environmentalism, and the medical sciences. Integration with another mission-driven industry gives these industries more political power to transform regulations and laws that inhibit the growth of modern, science-driven industries like cannabis.

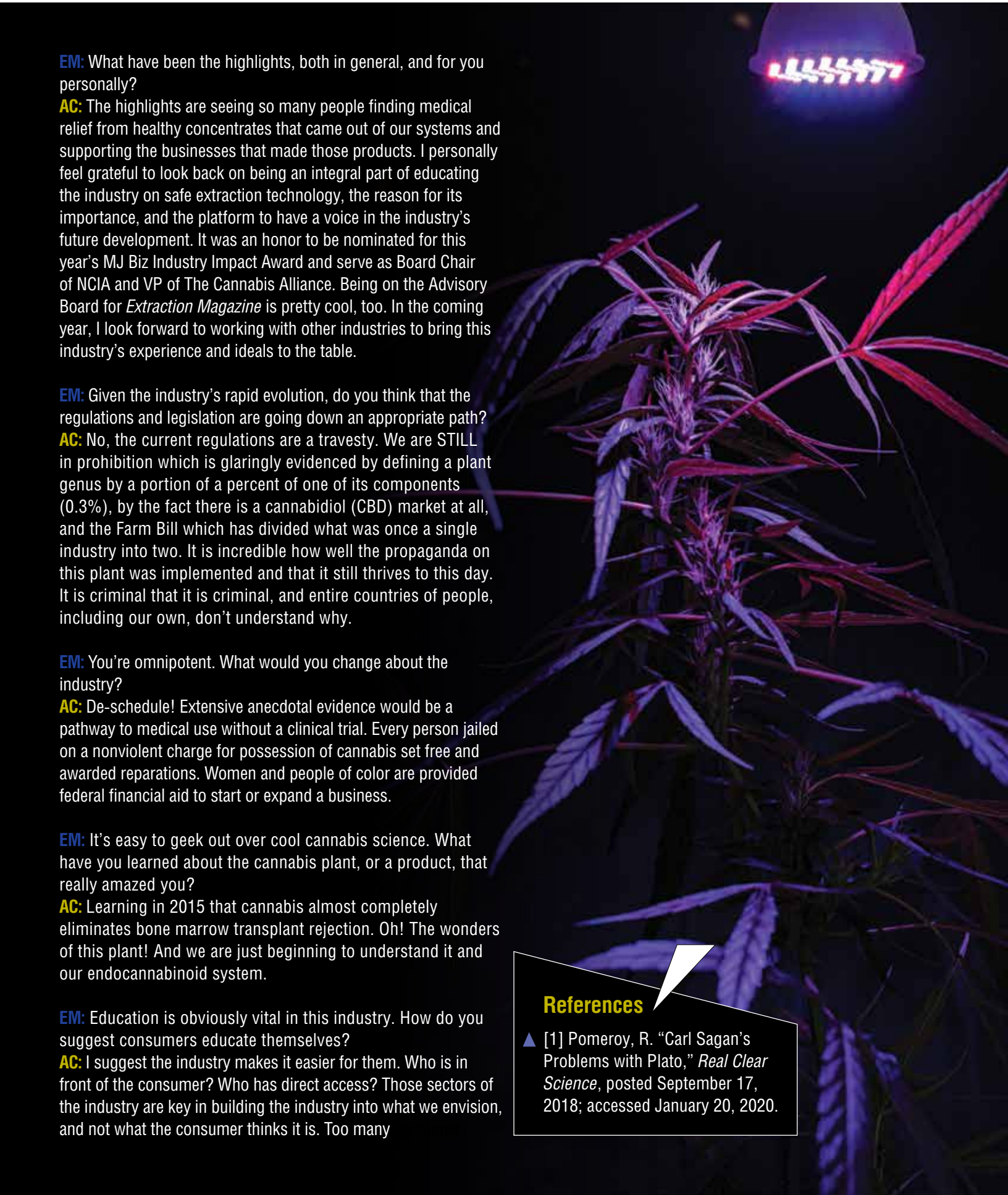
EM: What have been the highlights, both in general, and for you personally?
AC: The highlights are seeing so many people finding medical relief from healthy concentrates that came out of our systems and supporting the businesses that made those products. I personally feel grateful to look back on being an integral part of educating the industry on safe extraction technology, the reason for its importance, and the platform to have a voice in the industry's future development. It was an honor to be nominated for this year's MJ Biz Industry Impact Award and serve as Board Chair of NCIA and VP of The Cannabis Alliance. Being on the Advisory Board for *Extraction Magazine* is pretty cool, too. In the coming year, I look forward to working with other industries to bring this industry's experience and ideals to the table.

EM: Given the industry's rapid evolution, do you think that the regulations and legislation are going down an appropriate path?
AC: No, the current regulations are a travesty. We are STILL in prohibition which is glaringly evidenced by defining a plant genus by a portion of a percent of one of its components (0.3%), by the fact there is a cannabidiol (CBD) market at all, and the Farm Bill which has divided what was once a single industry into two. It is incredible how well the propaganda on this plant was implemented and that it still thrives to this day. It is criminal that it is criminal, and entire countries of people, including our own, don't understand why.

EM: You're omnipotent. What would you change about the industry?
AC: De-schedule! Extensive anecdotal evidence would be a pathway to medical use without a clinical trial. Every person jailed on a nonviolent charge for possession of cannabis set free and awarded reparations. Women and people of color are provided federal financial aid to start or expand a business.

EM: It's easy to geek out over cool cannabis science. What have you learned about the cannabis plant, or a product, that really amazed you?
AC: Learning in 2015 that cannabis almost completely eliminates bone marrow transplant rejection. Oh! The wonders of this plant! And we are just beginning to understand it and our endocannabinoid system.

EM: Education is obviously vital in this industry. How do you suggest consumers educate themselves?
AC: I suggest the industry makes it easier for them. Who is in front of the consumer? Who has direct access? Those sectors of the industry are key in building the industry into what we envision, and not what the consumer thinks it is. Too many



References

[1] Pomeroy, R. "Carl Sagan's Problems with Plato," *Real Clear Science*, posted September 17, 2018; accessed January 20, 2020.

facing companies are following an uneducated market instead of creating an educated one. The general market has no idea what a terpene is or has never heard of tetrahydrocannabivarin (THCV). They don't understand that a high delta-9-tetrahydrocannabinol (THC) or CBD product is lacking in extended medical use and effect without the other constituents in a chemovar. This is a once-in-a-lifetime opportunity to create an industry. Create a science-based product that can stand the test of time and educate the consumer on why they want it. The consumer needs a trusted source of information. Google only goes so far! If business-to-consumer companies can create or support brands that people can trust by providing an easily digestible, scientific-based education, the entire industry will flourish. (*Editor's Note: Amen.*)

EM: If you could tell someone just one thing about cannabis, what would it be?
AC: What is new is ancient and if you could only take one plant to a desert island, it should be this one. It will nourish you, cloth you, shelter you, and prevent as well as treat illness.

EM: Do you foresee cannabis extraction evolving much in the future?
AC: We already know how to take plants apart and put them back together again. The question is: why are we doing it? What I hope to see is less manipulation of the plant and more focus on the plant and how it interacts with other living organisms. Then, how do we extract for a heavier concentration of certain components while keeping the chemovar primarily intact? How do we provide a pure, solvent-free product while keeping the chemovar intact? Yes, we can spike a product with single molecules, but to make products with only a few molecules of the chemovar is old science and won't stand the test of time.

EM: What kinds of technology do you think are needed in any sector of the industry?
AC: Recycling or repurposing waste across all sectors and using the plant itself for its packaging, composting, etc.

EM: You do a little bit of crystal gazing. Where do we go from here? What does 2020 bring us?
AC: 2020 brings us further global legalization, a continued fight against the stigma of THC and all related THC molecules (tetrahydrocannabinolic acid (THCA), THCV, etc.), and a growing unity with natural products. Most of our future relies on politics and the upcoming elections. Our entire legal industry is based on politics, not on science. If it were based on science, we would not have a CBD market right now or a Farm Bill. We would have a new medical industry based on individualized medicine and preventative health primarily utilizing botanicals.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