

Cannabis Extraction by Supercritical Carbon Dioxide - Selection and Preparation of Feed Stock

INTRODUCTION

Carbon Dioxide (CO₂) extraction of cannabis is becoming more prevalent as the extract market grows with the spread of medical and recreational legalization. However, due to the historically underground nature of working with the substance, little true scientific experimentation and process development has occurred; even less has been published. Those new to the field have limited guidance.

The following is a compilation of the process learnings regarding feedstock selection and preparation that Supercritical Fluid Technologies (SFT) customers' companies currently working in the CO₂ cannabis extraction field, have shared with us. Due to the proprietary nature of each company's specific process, the material here will be presented in a generic way that is applicable to the majority of processors.

FEEDSTOCK SELECTION

Material selection, especially when starting extraction work, may be determined by availability. However, once there are options the following criteria should be considered.

Strain

Although there is an incredible variety of cannabis grown in the US, there are three basic distinctions:

- *Cannabis indica*—induces full body relaxation, used to treat pain or insomnia, more resinous material
- *Cannabis sativa*—induces creativity, used to treat depression, more woody material
- Cannabis Hybrid—any combination of the above two

The number of cannabis strains continues to increase as plants are bred to optimize specific traits such as:

- Yield
- Hardiness
- Concentration/balance of certain cannabinoids (generally THC and CBD)
- Flavor
- Effectiveness at treating specific ailments
- Effectiveness at inducing certain effects

Grower

Extract can only be as good as the starting material, and that is almost completely determined by the grower. This person or company has been responsible for nurturing the plants through months of growth, harvesting, and in many cases, drying or curing the material. If the grower has used pesticides, herbicides or fungicides, or has used them at the wrong time, those residues will be in the feedstock and will be concentrated in the extract. If the plant has been inadequately tended it may not fully develop the expected characteristics. Poor harvesting and storage techniques can lead to mold. Inferior curing techniques do not preserve the terpenoid content of the plant.

Feedstock type

Cannabis feed stock is available as whole plants, branches, buds, and trim (leaves, stem, and perhaps some small buds). It is available both fresh and dried. Any of these variants can be CO₂ extracted, but with differing results.

Fresh material

Freshly harvested cannabis is quite fragrant due to terpenes, the compounds responsible for scent and flavor. Extract derived from fresh material has a higher terpene content than that made from dried material. It therefore has more flavor and demands a higher price. Relatively few manufacturers use fresh material however due to the following issues:

- The scent of fresh feedstock tends to be intense, causing issues for discrete transport
- It is very perishable and must be refrigerated, frozen, or processed quickly, usually within 24 hours of harvest
- It requires more processing than dried material because of the inherent water content. Increasing the number of processing steps and, overall processing time not only adds to manufacturing costs, but it also generally results in reduced yield and some level of product degradation.
- The resulting extract tends to be sticky and hard to work with
- Acquisition costs tend to be much higher per pound than for dried material (even though a substantial portion of what you are buying is water weight)
- To get fresh material you usually need to buy the whole plant

Dried material

Terpenes are highly volatile and dissipate quickly, especially when heated or exposed to circulating air for curing. Although dried material will have a lower concentration than fresh material, dried feedstock is more readily available, has a lower cost per pound, is

more stable, and takes up less storage space than the wet version. Growers that dry and store with care will preserve more cannabinoid and terpene content than less experienced or less skilled growers. Extract derived from dried material makes up the majority of the market.

Bud/Flower

This most expensive part of the plant has the highest concentration of cannabinoids and will produce the highest yield. Optimizing the bud has been the goal of growers throughout the history of cannabis cultivation in the US.

Trim

This is the green material trimmed from the plant to expose the bud/flower consists of the leaves, non-woody stems, and immature buds (popcorn). High quality trim will be free of any woody material and have an abundance of popcorn. Low quality material will be full of stems and devoid of popcorn. Cannabinoid concentration depends on the quality of trim and extraction yield will be between flower and stem.

Stem and roots

The stems and roots are the most fibrous parts of the plant and they contain the lowest concentration of cannabinoids. They are difficult to process.

Whole plants

Plants from an indoor nursery tend to be of manageable size with stems that are pliable and of small diameter. Outdoor-grown plants, although usually healthier, can be more than ten feet high and ten feet in diameter. Processing this mass of material can be challenging, especially since the stems can be quite woody. Drying whole plants is difficult as it is hard to get consistent airflow throughout the plant, so whole plants tend to be used fresh.

PREPARING THE FEEDSTOCK

While it is possible to stuff any kind of feedstock material into the extraction vessel as is, there are a number of reasons why this is almost never done:

- Large pieces of material have limited surface area, and therefore require large volumes of CO₂ solvent for full extraction
- Loading unevenly shaped items into the extraction vessel, even if the material is compactable and strongly tamped down, will inevitably lead to air

pockets that will ensure channeling (having the CO₂ flow through one channel in the load rather than evenly throughout the load)

- Loading weights will vary as the feedstock material is non-homogeneous
- Preloading charges of material will be impossible

Both efficiency and yield are greatly improved by first breaking down the material into small particle sizes.

Grinding

The goal of grinding is to break up the plant material into very small pieces that are as homogenous as possible without degradation. This can be done using any kind of equipment that does the following:

- Cuts rather than compresses the feedstock
- Keeps the feedstock moving so that it does not heat up and release terpenes

In small-scale production a consumer grade food processor works well. In larger-scale production a commercial kitchen grade food processor is appropriate. When using a food processor, make sure to loosely pack the grinding chamber so that the machine can fully break down the feedstock without binding up, and thus heating the material. It is better to have more batches and cool material than fewer batches and warm material. At pilot-scale production (with the NPX units) an industrial grinding unit will allow flow through processing without heating.

Grinding generates cannabis dust. It should be done in a hood. If a hood is not available then personnel in the area should wear a mask and lab coat. Personnel should always wear lab gloves when handling cannabis.

PREPARING CHARGES

Pre-making extraction charges enables processing efficiency.

Prepare a form

- Get a tube (PVC, stainless steel, or other non-reactive material) that has a slightly smaller ID (inner diameter) than the extraction vessel ID.
- Measure the internal height of the extraction vessel.
- Mark that height on the tube.
- Cut the tube to be longer than that height by at least two inches.

Select charge sleeves

- The sleeve should hold the material with minimal leakage, be flexible, be non-reactive, and allow CO₂ to flow through.
- When filled, the sleeve must fit into the extract vessel without wrinkles or gaps as those would encourage channeling.

- Some common sleeves are women's stockings, cotton bags, cheesecloth bags mesh bags and mesh baskets.

Grind the material (in fume hood wearing gloves from this point on)

- Grind the quantity of material that you will use in one day. The terpenes that remain in the dry material will dissipate quickly once the surface area has been exposed; the longer the material sits after grinding the lower the terpene concentration will be.
- Keep the ground material sealed in its container except when you are actively using it.

Create the first charge (note, should be done with each new feed material)

- Put the tube into the charge sleeve with the height marking at the top.
- Tare a container that will hold more than enough volume of ground cannabis to fill the tube when compacted.
- Fill and weigh the container ($weight_1$).
- Carefully transfer as much of the material in the container as possible into the tube, tamping down firmly to compress the ground cannabis to get rid of any air pockets, until the tube is filled to the height marking.
- Weigh the container holding the remaining ground cannabis ($weight_2$).
- The load weight for each of the additional charges will be ($weight_1 - weight_2$).
- Carefully lift up the tube while pushing the ground contents into the sleeve. A flexible plunger with the same ID as the tube will help greatly.
- Remove the tube from the charge sleeve leaving the ground cannabis in the sleeve.
- Seal the open end of the sleeve by tying it off or using a cable tie.
- Put the completed charge sleeve into a sealed container until ready to use.

Create remaining charges

- Put the tube into the charge sleeve with the height marking at the top.
- Weigh out the charge ($weight_1 - weight_2$)
- Carefully lift up the tube while pushing the ground contents into the sleeve. A flexible plunger with the same ID as the tube will help greatly.
- Remove the tube from the charge sleeve leaving the ground cannabis in the sleeve.
- Seal the open end of the sleeve by tying it off or using a cable tie.
- Put the completed charge sleeve into a sealed container until ready to use.

This article is the first in a series of articles that will address the practical considerations of the extraction of cannabis. To learn more about our cannabis extraction equipment, please contact Supercritical Fluid Technologies at 302-738-3420 or info@supercriticalfluids.com