



Cannabis Processing for THC, CBD & Terpenes

Initiated 5/2/14. Current version 9/18/14

The unique smell of cannabis does not arise from cannabinoids, but from over 100 terpenoid compounds.

from: Cannabis and Cannabis Extracts: Greater Than the Sum of Their Parts? 2001
<http://cannabis-med.org/data/pdf/2001-03-04-7.pdf>

Eat a Mango 1 hour before consuming Cannabis. Mangos are high in Myrcene which increases the effects of THC. Especially if it's a less potent strain, you should notice more of a "zing"....:) [167°C – 332°F myrcene boiling point - phil]

from: Terpenes (PDF) <http://terpenes.weebly.com/uploads/6/1/3/4/6134576/terpenes.pdf>

Prepare Ground Cannabis

Dry cure and freeze fresh cannabis flower. Freezing helps break trichomes (resin glands). Fresh is ideal for optimum terpene content. Grind.

Extraction. Option 1: Extract with ETOH

Pre-extraction Decarboxylation (optional)

Decarboxylation activates THC and CBD, a process which proceeds rapidly above 105°C.

Dry Oven Decarboxylate: Select time/temp parameters (see attached), Lay ground cannabis flat up to 0.5 inch deep on unbleached baking paper on a pizza stone. Many terpenes will be lost (2013 - http://www.cannabis-med.org/data/pdf/en_2013_01_1.pdf) by the time/temp of decarboxylation. However, many important terpenes will remain (2001-
<http://cannabis-med.org/data/pdf/2001-03-04-7.pdf>).

ETOH Extraction

Extract with high proof ethanol at room temperature: cover & and stir occasionally for 30 minutes for light finish, up to 5 days for maximum extraction. Press. Concentrate with room-temp evaporation (use a fan). To avoid green staining, best with high potency, low leaf chlorophyll bud.

This tincture is used either

1. as 5 - 20 drops to a favorite drink. Water typically. Use as mixologist bitters. Monkey Fruit extract would be worth trying. Best if further aged for a week. or...
2. to make a salve. Tincture gets mixed with coconut oil - olive oil - bees wax. For salve, I layer the tincture on top of an oil/wax base and evaporate the ethanol at room temperature. Next I warm the oil/wax base to consistency of thick syrup and mix.

Note: Chlorophyll

Chlorophyll is highly soluble in alcohol, as well as coconut oil. It is undesirable for cosmetic reasons: stains clothing when in salves, increases salve vulnerability to mold, creates an off taste in tinctures.

Green hues can be partly removed using sunlight or a light from a high UV source, like a grow lamp. The UV radiation in the sunlight will quickly break down chlorophyll in a thin tincture and the breakdown products are amber, so the green color is altered. Alas, UV radiation also destroys cannabinoids, but fortunately at a much slower rate, and three or four hours in the sun is usually enough for light green hue, won't be sufficient for dark hue.

See: Polishing Extracts <http://skunkpharmresearch.com/getting-the-green-and-waxes-out-afterwards/>

Extraction. Option 2: Extract with Olive Oil in Water Bath

Oils are less aggressive solvents than ETOH. In order to dissolve the cannabinoids, the olive oil must be raised to a temperature above the cannabinoid 66°C / 151°F melting point.

Extract with olive oil, heated with water bath at 98-100°C. 120 minutes. Press.

To increase cannabinoid removal, you increase time beyond 120 minutes, and use heat cycles. It is more efficient to break up resin glands by the continual expansion and contraction through heating and cooling the solution in 30 minute cycles. Depending on the quality of bud, you may perform about 3 cycles of 30 minutes on heat and 30 minutes off, up to 6 cycles. Raise the temperature, stirring constantly, for 30 minutes. Remove the solution and allow it to cool to room temperature for 30 minutes. Repeat

Keep the boundary layers separated, by consistently aggravating the solution of ground cannabis and olive oil. The boundary layers are best described as the partially dissolved solvent/solute, the sedimentary solute layer which sinks to the bottom, and the freshest least saturated solvent which floats to the top. These layers must be consistently mixed during dissolution cycles.

Press, strain and filter the solution.

Olive oil extract can apparently be quite rich in cannabinoids (and terpenes) on a weight basis. A 2013 Italian study with olive oil extract used 100mL olive oil (92 grams, 3.4 US oz) to extract 10 grams cannabis at 20% THC (2 grams). In my experience, that is a practical ratio for the kitchen also. Olive oil weighs 920 grams per liter, the Italian study cannabis olive oil would have been <0.5% THC.

I read somewhere that olive oil doesn't reach saturation until about 33% cannabinoids and terpenes. To pump up the potency of the oil extract, you can also extract fresh material with partially saturated oil.

Extraction. Option 2: Extract with Olive Oil in Water Bath (continued)

Comment: This long extraction approach, which keeps the temperature below 105°C where rapid decarboxylation can occur, is ideal for high terpene retention. It is ideal for storing not-yet-decarboxylated product, because active THC and CBD would be subject to oxidation to CBN: THC and CBD, is better retained in the neutral form for later decarboxylation (as in cooking).

When pre-extraction decarboxylation used, we expect this product to have higher CBN:active THC/CBD than the equivalent ETOH extracted product.

See: Comment on Small Batch Questions (2011 - <https://www.greenpassion.org/index.php/topic/29078-canna-coconut-oil-small-batch-12-cup-question/?p=389845>)

Extraction. Option 3: Classic Canna Butter

https://www.youtube.com/watch?v=hUDyVzV_n-Q

Post-extraction Decarboxylate with Grape seed Oil Bath (Optional. Olive oil & butter)

Decarboxylation activates THC and CBD, a process which proceeds rapidly above 106°C.

Hot Grape Seed Oil Bath Decarboxylate: Select time/temp parameters (see table 1, page 4). I expect that the many terpenes lost in oven decarb (dry) will be retained in hot non-polar oil decarboxylation. Commonly used in discussions is a 121°C/250°F oil bath. At 250°F, 300 ml olive oil extract starts giving off CO₂ bubbles in 10 to 15 minutes and quits giving off CO₂ bubbles in between 20 and 30 minutes. Since we can never know the exact starting state of carboxylation, observed bubbles is the most accurate method available.

The more efficient decarb regimen (145°C/293°F for 7 minutes) is well above the boiling point of many terpenes, and terpene loss is conceivable to me thus I need to test for terpene potency at the hotter process.

Detail: Decarboxylation why?

Trim and flower THC and CBD molecules are bound to a carboxyl group (COOH). Detaching the carboxyl group activates THC and CBD, termed decarboxylation.

Temperature / Time combinations for Decarboxylation

See the “1990” chart (attached at the end of the last page) from the Journal of Chromatography, 1990. This is for a hash oil style marijuana extract (not loose ground marijuana) and appear to be higher temperatures and longer durations than many would recommend for 1-2 grams of ground cannabis. If the flower is piled thick and deep as happens with a big process - then it will take more heat and time than for the hash oil in order to penetrate to the center mass of the ground cannabis.

The sensible oven temperature range for hash oil is 106°C to 150°C / 223°F to 302°F, with cook time from 6 minutes to an hour. Cook past the optimum time, and the conversion of THC and CBD to CBN will outpace decarboxylation.

Have a reliable oven thermometer, don't rely on the oven dial setting. Use a pizza stone, or ceramic tiles, or similar mass to help stabilize the heat level. Crack the oven door every 5 minutes to look at it. If it smokes then it went too hot for too long.

Table 1: Phil's Times and Temperature s for Decarboxylation of Olive Oil vs Small Quantities of Flower

Flower, ground, small quantity, minutes	Olive oil, minutes	Temperature, Fahrenheit	Notes
3	5	325	Per VICcannamist recipe
4	6	302	Note: THC boiling point at 315
5	7	293	Per Journal of Chromatography, 1990
5	7	284	Note: Traces of THC vaporize at 284
8	16	275	Phil's target for hot oil bath decarboxylation
9	18	270	Note: olive oil prevents terpene boil away
10	21	265	
12	23	260	
13	26	255	
14	27	252	Per Journal of Chromatography, 1990
15	29	250	Per forum discussion
17	34	246	Note: β-caryophyllene boiling point of 246
18	36	244	Phil's target for dry oven decarboxylation
20	41	240	
23	46	235	
26	52	230	
29	58	225	
30	60	223	Max terpenoids but at loss of THC/CBD to CBN

Notes related to Phil's time/temp table

Per the chart (attached at the end of the last page) from the Journal of Chromatography, 1990, you can decarboxylate hash oil (and I gather from forum postings, large quantity of ground flower) at 106°C / 223°F for 60 minutes. I find that half that, 30 minutes, works for small amounts (1-2 grams) of ground cannabis to retain max terpenoid complexity. I would consider processing at temperatures this low because minor terpenoids with boiling points

well below THC provide contribute valued complexity in therapeutic performance. Downside of low temperature, extended time, is relatively high conversion of THC & CBD to CBN.

Decarboxylate below β -caryophyllene boiling point of 119°C / 246°F as per Cannabis and Cannabis Extracts: Greater Than the Sum of Their Parts? 2001 - <http://cannabis-med.org/data/pdf/2001-03-04-7.pdf>. An anti-inflammatory, β -caryophyllene is the most common sesquiterpenoid.

Decarboxylate at "240°F. for 30-45 minutes" for cancer patients suggested by Got Cancer? Decarb.. (2013 - <http://patients4medicalmarijuana.wordpress.com/2013/04/18/got-cancer-decarboxylate-your-cannabis/>).

Per attached chart from the Journal of Chromatography, 1990, decarboxylate hash oil at 122°C / 252°F for 27 minutes vs 106°C / 223°F for 60 minutes. The faster, higher temperature process sacrifices some terpenes for substantial gains in THC.

Per the chart from the Journal of Chromatography, 1990, decarboxylate hash oil (and I assume large quantity of ground flower) at 150°C / 302°F for 6 minutes [4 minutes for small amount of ground cannabis] to retain max THC. If you do this 6 minute recipe, consider adding time (another minute?) for drying, or you may stop short of peak conversion efficiency.

Decarboxylate at 325°F (160°C [sic – closer to 163°C]) for 5 minutes. VICS Cannamist recipe (http://www.thevics.com/recipe_cannamist.html).

Avoid THC boiling point 157°C / 315°F See:

- <http://michiganmedicalmarijuana.org/topic/35900-the-importance-of-decarboxylation-in-edible-making/>
- <http://patients4medicalmarijuana.wordpress.com/2013/04/18/got-cancer-decarboxylate-your-cannabis/>

Background Notes

Prior to May 2014, I had been slow oven decarboxylating small quantities of loose ground MJ at 105°C / 223°F for 60 minutes to retain maximum terpenes. Hash oil decarbed for an hour at 223°F loses out on about 25% of the full potential THC and CBD because of subsequent degradation to CBN. We have established that this slow low temperature approach makes highly effective tinctures and salves. At this point I moved to explore faster cook at higher temperature, with increased decarboxylation efficiency. Hoping to feel increased effect without loss of quality.

For several years prior to 2014 I was making tincture using the VICS Cannamist time/temp of 325°F for 5 minutes (http://www.thevics.com/recipe_cannamist.html). I have since figured there must be a temp conversion problem: 160°C is 320°F, not 325°F. Along with our oven running about 10 degrees hotter than set means I ran hotter than ideal. I was satisfied at the time that it was working, it certainly worked better than no decarboxylation. In retrospect it appears my VICS Cannamist recipe batches were likely overcooked! An

indication they were overcooked is that batches at 105°C / 223°F for 60 minutes had equivalent potency to 325°F for 5 minutes when lower potency expected. My subsequent lower temperature (223°F) oven approach produces a more potent tincture than the higher temperature (325°F) approach. The Feb-Mar-Apr minimum-temperature (223°F) ETOH tincture-based salves we shared with friends certainly worked, and we believe the THC content was part of that effect. This could have had more to do with how concentrated via evaporation of the ETOH.

I intend to explore oil decarboxylation in the 105°C to 150°C / 223°F to 302°F range to avoid the risk of lower terpenoid quality when using the oven (dry) method.

Another Table:

Smoking points:

250°F: Butter starts here.

320°F: Olive oil, unrefined

350°F: Coconut Oil, unrefined

375°F: Olive oil, extra virgin

420°F: Grape seed oil, almond oil

More References:

2014: Comment. Got Cancer? Decarboxylate your cannabis.

(<http://patients4medicalmarijuana.wordpress.com/2013/04/18/got-cancer-decarboxylate-your-cannabis/#comment-43108>) Decarboxylation occurs when cannabis is heated to 240 degrees Fahrenheit for 30 – 45 minutes. I get that if for hash oil. I expect more like 15 to 25 minutes for ground cannabis.

2014: How to Decarboxylate Cannabis (<http://greenstyleconsulting.us/decarboxylate/>)

Advocates more time at temp. 240°F / 115°C for 60 minutes. I attribute this to high moisture in their trim and kief, plus the larger quantity apparently used. Oven setting was 240°F but temperature control was poor with substantial time dipping to 229°F.

2013: Cannabis Oil: chemical evaluation of an upcoming cannabis-based medicine.

(http://www.cannabis-med.org/data/pdf/en_2013_01_1.pdf) p 4. *two olive oil extractions using different heating durations (4, 5) based on popular Youtube videos [15] and, p10 it is not feasible to perform decarboxylation of cannabinoids, without significant loss of terpene components... Retaining the full spectrum of terpenes present in fresh cannabis material should therefore be a major focus during optimal Cannabis oil production... Of the solvents tested, this leaves olive oil as the most optimal choice for preparation of Cannabis oils for self-medication. Olive oil is cheap, not flammable or toxic, and the oil needs to be heated up only to the boiling point of water (by placing a glass container with the product in a pan of boiling water) so no over-heating of the oil may occur. After cooling down and filtering the oil, e.g. by using a French coffee press, the product is immediately ready for consumption. As a trade-off, however, olive oil extract cannot be concentrated by evaporation, which means patients will need to consume a larger volume of it in order to get the same therapeutic effects. and, p5 The use of olive oil as extraction solvent was found to be most beneficial based on the fact that it extracted higher amounts of terpenes than the other solvents/methods, especially when using an extended heating time ([10g cannabis, 100 ml olive oil, 100°C, 120 min; protocol 5). This may be explained by the*

highly non-polar but also non-volatile character of olive oil, resulting in a good solubilization of terpenes while limiting their loss by evaporation.

2013: Decarboxylation is confusing. "The temperature at which this occurs is debatable, since many reports I have viewed on the subject do not agree." says Rick Simpson on Facebook https://www.facebook.com/permalink.php?id=298774923502987&story_fbid=337818342994309

2013: BadKitty You Tube clip. (<https://www.youtube.com/watch?v=SEa9a1riXI8>) Great alternative approaches (double boiler, oven bags), [Advocates shorter time than I would expect \(see 10:35\)](#). Recommends 105°C / 220°F for 30-35 min for freshly dried crop, 10-20 min for poorly stored, old dried out herb. Possibly partial decarboxylation is as intended for their medicinal consumer base to allow higher consumption.

2012: Decarboxylating Cannabis: Turning-THCA into THC.

(<http://www.marijuanagrowershq.com/decarboxylating-cannabis-turning-thca-into-thc/>)

Great comments into 2014. such as *I decarb at 275 for 15 minutes [if for hash oil, 8 minutes for ground cannabis] and, on decarb time/temps, the best and most forgiving range was 250 deg for 30 min [if for hash oil, 15 minutes for ground cannabis] and, the extraction process should take.. 5 days with shaking every day and, re: my first clue to making cannabutter: water is probably the best medium for releasing the trichomes from the vegetative matter. I simmer at just below a boil for about two hours. Depending on the elevation at which you do this, the 200+ degrees should decarboxylate the THCA.* --- This post was the source of my Jan-April 2014 low temperature approach. Says "staying under 246.2° Fahrenheit there should be little if any inadvertent vaporization of plant compounds that might produce medicinal benefits. [Disputed in 2013 -

http://www.cannabis-med.org/data/pdf/en_2013_01_1.pdf] I do need to qualify the above statement by saying that some terpenes actually evaporate to some degree while the plant is growing and there is not much that can be done about it." This post is also why I don't cover during low heat decarb. This post is also why my decarbing temperature has been too high for ground cannabis vs for hash oil.

2007: Dr. Diane. 2013. Youtube instruction video. <http://www.youtube.com/watch?v=vs66uyiH968>

2006: Definitive Green Dragon Thread. <http://boards.cannabis.com/concentrates/82380-definitive-green-dragon-revised-updated-combined.html>

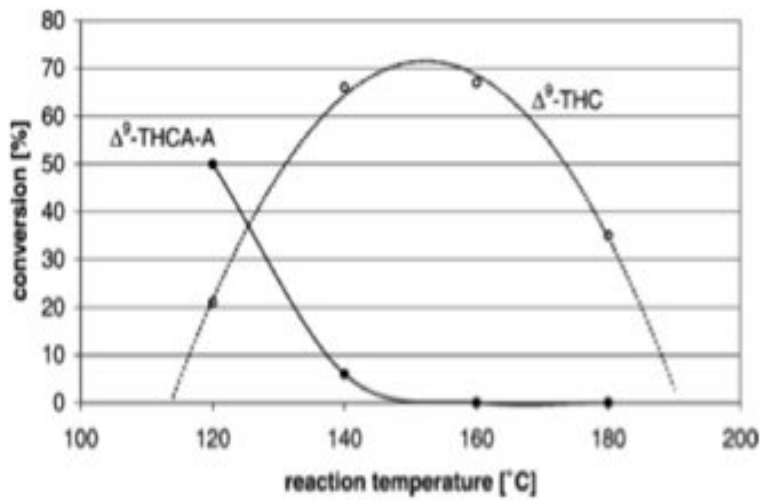
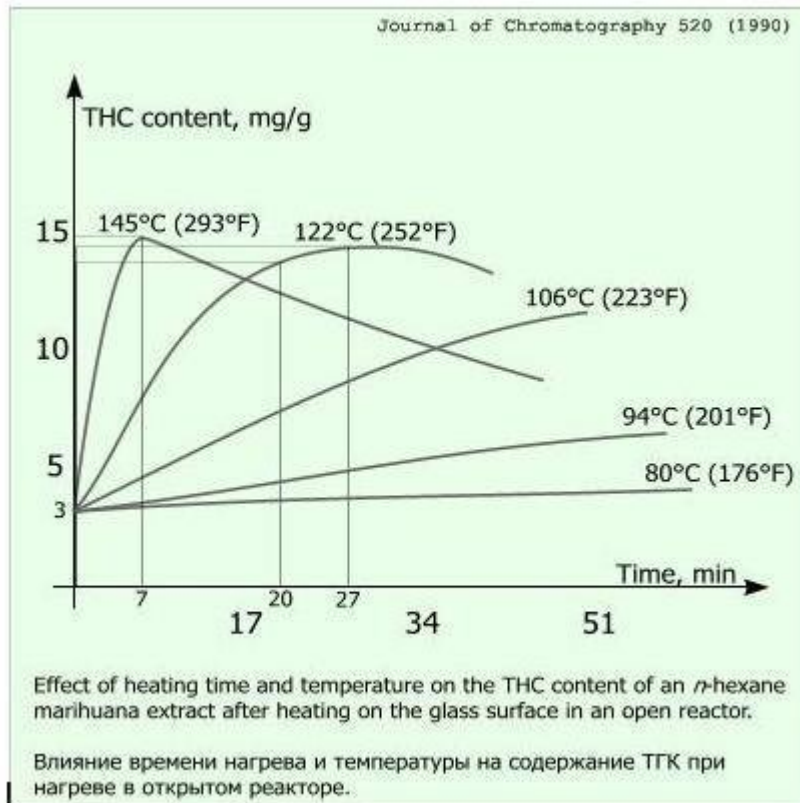
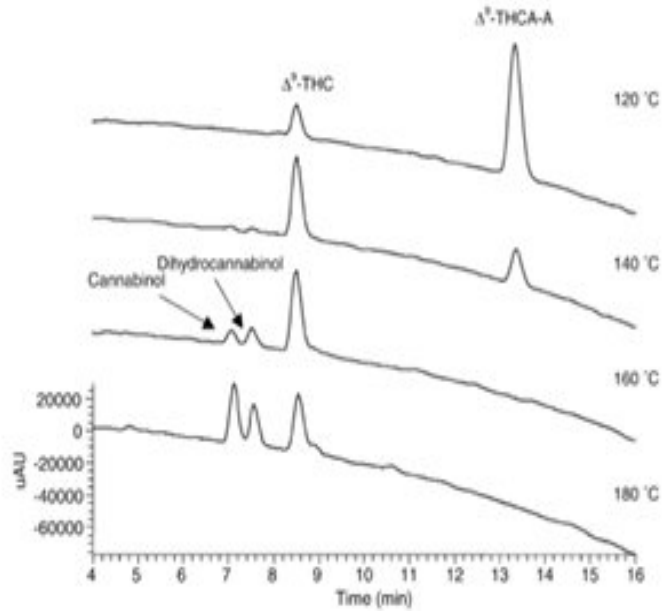


Fig. 8. Conversion of Δ^9 -THCA-A into Δ^9 -THC prior to HPLC analysis.



Note: I take the “1990” hash oil minutes: 7 min at 145°C/293°F, 27 min at 122°C/252°F, and use them straight for olive oil (300 ml typical) and larger quantity of herb (500 gm), but will reduce time by half for smaller quantity (1-2 grams) of ground herb: 4 min at 145°C/293°F, 14 min at 122°C/252°F.