Successful Methods to Eliminate Toxic Contaminants from Cannabis Extracts

Sorbtech

Rose Habib, A-1 Extract

Robert Kerr, Sorbent Technologies

[Date]

Who is Sorbent Technologies?

Established in 2000, Sorbent Technologies has specialized in products for chromatography and purification. We assist universities, government labs, and industry—Pharma, Biofuel, Materials, Food and Beverage, CMOs and CROs—with method development and optimization.

We provide one of the industry's broadest product lines and the scientific expertise to assist our clients with projects ranging from analytical methods to full-scale process with both standard and complex chemistries.

Sorbtech delivers solutions for small, large and bio molecules, synthetic and natural products. Our company is committed to helping chemists to identify and offer the most efficient, cost-effective solutions for their applications.

We offer the highest quality chromatography products:

- TLC plates
- HPLC columns
- GC columns
- SPE cartridges
- Flash Cartridges
- Bulk Adsorbents
- Various other products for laboratory and production.

Sorbtech and Cannabis Purification

For the past 5 years we've worked with companies in the cannabis industry to assist in extracting high quality CBD from Hemp, in separating cannabinoids, providing analytical products for testing and now for delivering solutions for the very challenging process of decontamination of cannabis extracts in production.

Over the past two years, as the cannabis industry has grown and become legal in more states, we've gotten daily calls from customers asking to help them in decontaminating their cannabis extracts.

While Sorbtech is committed to offering the best solutions to purification challenges, this decontamination issue has become a challenge for us. Why? There are no current standardized methods to utilize stationary phases—such as florisil or silica gel—for this application by the manufacturers of these products,

We decided to begin research and testing with our own resources: our time, our money, and connections to identify the best methodology.

The Current Situation in Georgia

Although Georgia passed a Medical Marijuana bill in 2015, State law still bans growing, buying or transporting Cannabis.

Because of the current Georgia Laws, Sorbtech cannot do research in-house to develop methods and to optimize the use of different chromatography products for decontamination. Therefore, in March 2018 we started working with a colleague, Rose Habib and an established testing lab, Cascade Labs, in Oregon to begin the process of developing methods for decontamination.

There is no Silver bullet. However, we are committed to discovering the best route to take.

The Challenge

Our customers, and numerous others in the industry, require a solution to remove contaminants from their cannabis extracts and resolve their decontamination problems.

It's important to note that decontamination of cannabis extract is very complex chemistry and there's no defined methodology.

Our Process

First, we wanted to identify the best way to condition the extract to perform optimally on the selected stationary phase for maximum adsorption of the contaminants while maintaining an efficient flow rate.

Then we wanted to understand the adsorption capacity of the different stationary phases for contaminants while maintaining the yield of the valuable cannabinoids, terpenes and other compounds along with the ability to recondition the stationary phase for multiple runs and longer purification cycles.

Our focus is to develop an efficient and cost-effective solution to decontaminate cannabis extracts to meet state regulations, while minimizing any loss of yield of valuable compounds for our customers and the growing industry.

No Substitute for Detailed Knowledge

The purpose of this eBook, which accompanies the webinar located at https://www.sorbtech.com/cannabis-webinar, is to share our knowledge with you regarding successful decontamination of cannabis extracts. Sorbtech has significant expertise in natural products purification as well as the separation sciences, however, numerous companies in the cannabis arena don't have this same breadth of knowledge and experience.

Additionally, we've noticed that in the cannabis industry—in particular, systematic knowledge is more rare than frequent.

What Our Customers Tell Us They Need

They ***don't*** need to be put through the maze to nowhere.

They ***do*** need a reliable, efficient and cost-effective methodology to decontaminate their cannabis extracts to pass state regulations while maintaining valuable yield of their cannabinoids and related compounds.

They need to know what works and what does **not** work

And We at Sorbtech are going to provide this information using experimental data.

Presenting: Episode One

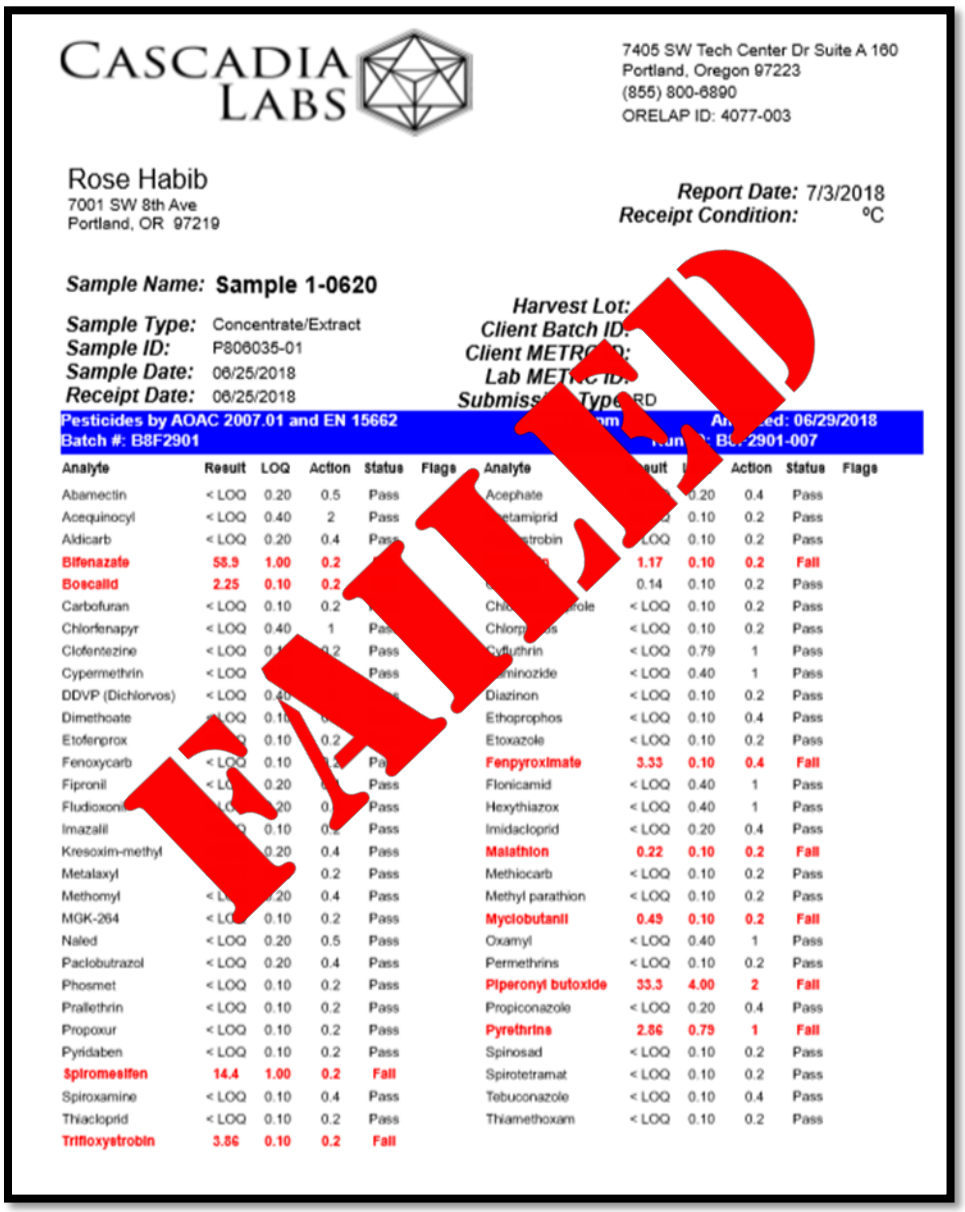
***The Continuing Saga of Cannabis Purification to remove harmful contaminants to provide safe products for the consumer while meeting state regulations*.**

The point being, these studies are ongoing. As mentioned previously, there's no silver bullet for your research. However, this eBook delivers a methodology created by Dr. Kerr and executed by Rose Habib. They have teamed up to examine solutions for eliminating contaminants from cannabis extracts.

Start with Cannabis Plant Material

After Extraction, After Distillation, **Before Treatment**

- 59 contaminants were assayed
- 49 contaminants were at low levels or non-detectable levels—the batch passed for those contaminants
- 10 Contaminants were at high levels—the batch FAILED for those contaminants and overall



CASCADIA LABS

7405 SW Tech Center Dr Suite A 160
Portland, Oregon 97223
(855) 800-6890
ORELAP ID: 4077-003

Rose Habib
7001 SW 8th Ave
Portland, OR 97219

Report Date: 7/3/2018
Receipt Condition: °C

Sample Name: **Sample 1-0620**

Sample Type: Concentrate/Extract
Sample ID: P806035-01
Sample Date: 06/25/2018
Receipt Date: 06/25/2018

Harvest Lot:
Client Batch ID:
Client METRC ID:
Lab METRC ID:
Submiss Type: RD

FAILED

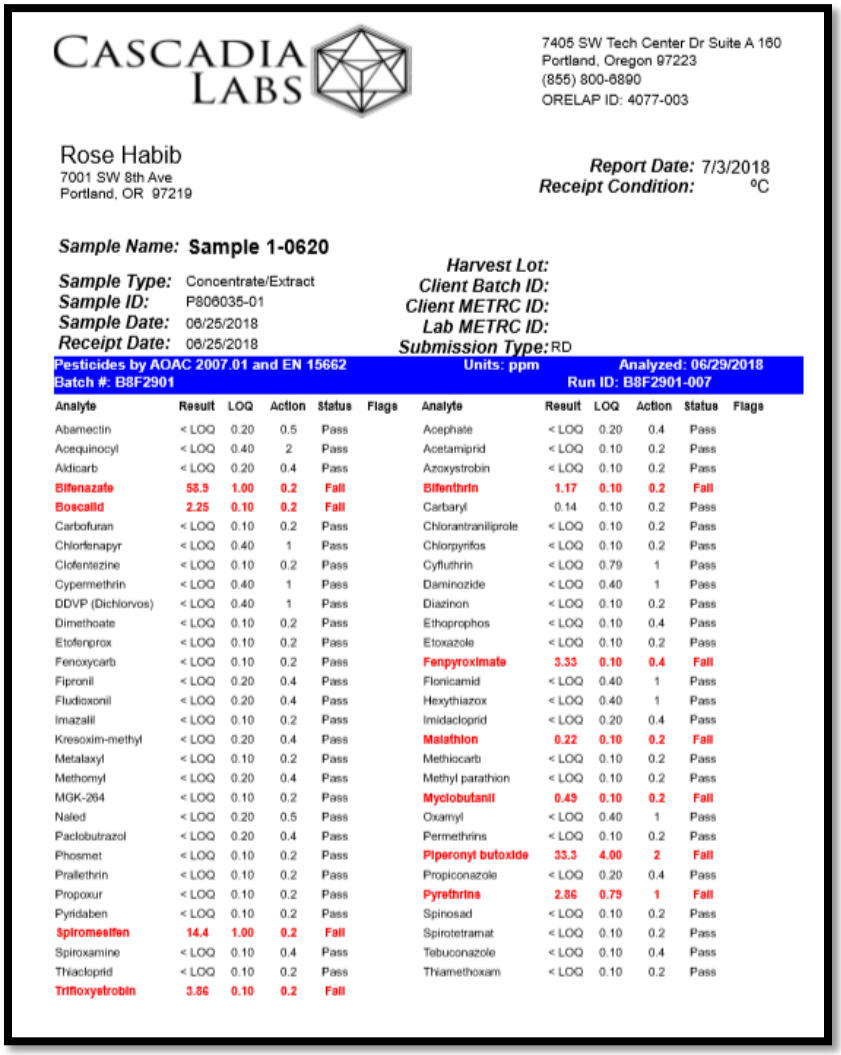
Pesticides by AOAC 2007.01 and EN 15662 — Analyzed: 06/29/2018
Batch #: B8F2901 — Run #: B8F2901-007

Analyte	Result	LOQ	Action	Status	Flags	Analyte	Result	LOQ	Action	Status	Flags
Abamectin	< LOQ	0.20	0.5	Pass		Acephate		0.20	0.4	Pass	
Acequinocyl	< LOQ	0.40	2	Pass		etamiprid		0.10	0.2	Pass	
Aldicarb	< LOQ	0.20	0.4	Pas		strobin	LOQ	0.10	0.2	Pass	
Bifenazate	**58.9**	**1.00**	**0.2**				**1.17**	**0.10**	**0.2**	**Fail**	
Boscalid	**2.25**	**0.10**	**0.2**				0.14	0.10	0.2	Pass	
Carbofuran	< LOQ	0.10	0.2			Chl trole	< LOQ	0.10	0.2	Pass	
Chlorfenapyr	< LOQ	0.40	1	Pas		Chlorp s	< LOQ	0.10	0.2	Pass	
Clofentezine	< LOQ	0.1	0.2	Pass		Cyfluthrin	< LOQ	0.79	1	Pass	
Cypermethrin	< LOQ			Pass		minozide	< LOQ	0.40	1	Pass	
DDVP (Dichlorvos)	< LOQ	0.40				Diazinon	< LOQ	0.10	0.2	Pass	
Dimethoate	< LOQ	0.10				Ethoprophos	< LOQ	0.10	0.4	Pass	
Etofenprox	< LOQ	0.10	0.2			Etoxazole	< LOQ	0.10	0.2	Pass	
Fenoxycarb	< LOQ	0.10	0.2	Pa		**Fenpyroximate**	**3.33**	**0.10**	**0.4**	**Fail**	
Fipronil	< LOQ	0.20		Pass		Flonicamid	< LOQ	0.40	1	Pass	
Fludioxoni	< LOQ	0.20	0.	Pass		Hexythiazox	< LOQ	0.40	1	Pass	
Imazalil	< LOQ	0.10	0.2	Pass		Imidacloprid	< LOQ	0.20	0.4	Pass	
Kresoxim-methyl	< LOQ	0.20	0.4	Pass		**Malathion**	**0.22**	**0.10**	**0.2**	**Fail**	
Metalaxyl	< LOQ	0.10	0.2	Pass		Methiocarb	< LOQ	0.10	0.2	Pass	
Methomyl	< LOQ	0.20	0.4	Pass		Methyl parathion	< LOQ	0.10	0.2	Pass	
MGK-264	< LOQ	0.10	0.2	Pass		**Myclobutanil**	**0.49**	**0.10**	**0.2**	**Fail**	
Naled	< LOQ	0.20	0.5	Pass		Oxamyl	< LOQ	0.40	1	Pass	
Paclobutrazol	< LOQ	0.20	0.4	Pass		Permethrins	< LOQ	0.10	0.2	Pass	
Phosmet	< LOQ	0.10	0.2	Pass		**Piperonyl butoxide**	**33.3**	**4.00**	**2**	**Fail**	
Prallethrin	< LOQ	0.10	0.2	Pass		Propiconazole	< LOQ	0.20	0.4	Pass	
Propoxur	< LOQ	0.10	0.2	Pass		**Pyrethrins**	**2.86**	**0.79**	**1**	**Fail**	
Pyridaben	< LOQ	0.10	0.2	Pass		Spinosad	< LOQ	0.10	0.2	Pass	
Spiromesifen	**14.4**	**1.00**	**0.2**	**Fail**		Spirotetramat	< LOQ	0.10	0.2	Pass	
Spiroxamine	< LOQ	0.10	0.4	Pass		Tebuconazole	< LOQ	0.10	0.4	Pass	
Thiacloprid	< LOQ	0.10	0.2	Pass		Thiamethoxam	< LOQ	0.10	0.2	Pass	
Trifloxystrobin	**3.86**	**0.10**	**0.2**	**Fail**							

This is a “Moderately” Contaminated Batch

--with about 100 ppm of contaminants, including:

- Bifenazate (Pesticide, Cabazate)
- Boscalid (Fungicide, Anilide)
- Spiromesifen (Insecticide, Tetronic Acid)
- Trifloxystrobin (Insecticide, Oximino-acetate)
- Bifenthrin (Insecticide, Pyrethroid)
- Fenpyroximate (Insecticide, Pyrazole)
- Malathion (Insecticide, Organophosphate)
- Myclobutanil (Fungicide, Triazole)
- Piperonyl Butoxide (Non-toxic Synergist, Safrole derivative)
- Pyrethrins (Insecticide, Pyrethrin)



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ORELAP ID: 4077-003

Rose Habib
7001 SW 8th Ave
Portland, OR 97219

Report Date: 7/3/2018
Receipt Condition: °C

Sample Name: **Sample 1-0620**

Sample Type: Concentrate/Extract
Sample ID: P806035-01
Sample Date: 06/25/2018
Receipt Date: 06/25/2018

Harvest Lot:
Client Batch ID:
Client METRC ID:
Lab METRC ID:
Submission Type: RD

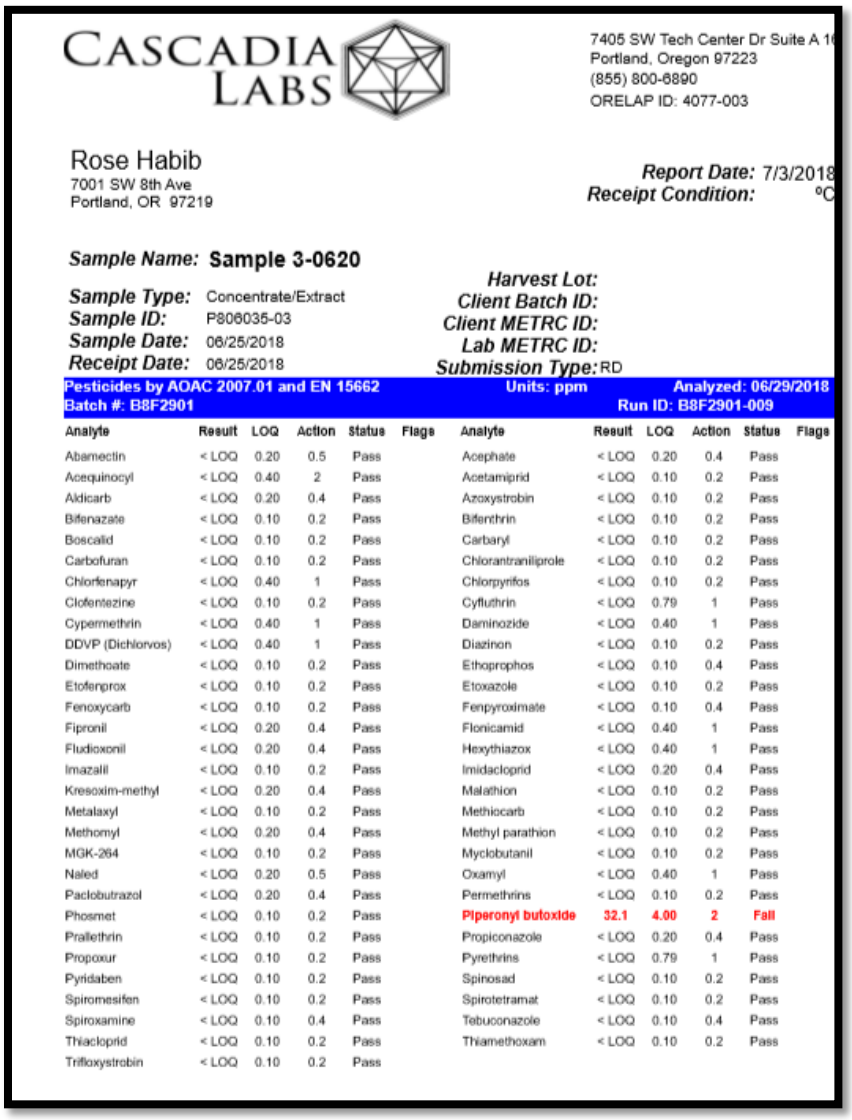
Pesticides by AOAC 2007.01 and EN 15662 | **Units: ppm** | **Analyzed: 06/29/2018**
Batch #: B8F2901 | **Run ID: B8F2901-007**

Analyte	Result	LOQ	Action	Status	Flags	Analyte	Result	LOQ	Action	Status	Flags
Abamectin	< LOQ	0.20	0.5	Pass		Acephate	< LOQ	0.20	0.4	Pass	
Acequinocyl	< LOQ	0.40	2	Pass		Acetamiprid	< LOQ	0.10	0.2	Pass	
Aldicarb	< LOQ	0.20	0.4	Pass		Azoxystrobin	< LOQ	0.10	0.2	Pass	
Bifenazate	**58.9**	**1.00**	**0.2**	**Fail**		**Bifenthrin**	**1.17**	**0.10**	**0.2**	**Fail**	
Boscalid	**2.25**	**0.10**	**0.2**	**Fail**		Carbaryl	0.14	0.10	0.2	Pass	
Carbofuran	< LOQ	0.10	0.2	Pass		Chlorantraniliprole	< LOQ	0.10	0.2	Pass	
Chlorfenapyr	< LOQ	0.40	1	Pass		Chlorpyrifos	< LOQ	0.10	0.2	Pass	
Clofentezine	< LOQ	0.10	0.2	Pass		Cyfluthrin	< LOQ	0.79	1	Pass	
Cypermethrin	< LOQ	0.40	1	Pass		Daminozide	< LOQ	0.40	1	Pass	
DDVP (Dichlorvos)	< LOQ	0.40	1	Pass		Diazinon	< LOQ	0.10	0.2	Pass	
Dimethoate	< LOQ	0.10	0.2	Pass		Ethoprophos	< LOQ	0.10	0.4	Pass	
Etofenprox	< LOQ	0.10	0.2	Pass		Etoxazole	< LOQ	0.10	0.2	Pass	
Fenoxycarb	< LOQ	0.10	0.2	Pass		**Fenpyroximate**	**3.33**	**0.10**	**0.4**	**Fail**	
Fipronil	< LOQ	0.20	0.4	Pass		Flonicamid	< LOQ	0.40	1	Pass	
Fludioxonil	< LOQ	0.20	0.4	Pass		Hexythiazox	< LOQ	0.40	1	Pass	
Imazalil	< LOQ	0.10	0.2	Pass		Imidacloprid	< LOQ	0.20	0.4	Pass	
Kresoxim-methyl	< LOQ	0.20	0.4	Pass		**Malathion**	**0.22**	**0.10**	**0.2**	**Fail**	
Metalaxyl	< LOQ	0.10	0.2	Pass		Methiocarb	< LOQ	0.10	0.2	Pass	
Methomyl	< LOQ	0.20	0.4	Pass		Methyl parathion	< LOQ	0.10	0.2	Pass	
MGK-264	< LOQ	0.10	0.2	Pass		**Myclobutanil**	**0.49**	**0.10**	**0.2**	**Fail**	
Naled	< LOQ	0.20	0.5	Pass		Oxamyl	< LOQ	0.40	1	Pass	
Paclobutrazol	< LOQ	0.20	0.4	Pass		Permethrins	< LOQ	0.10	0.2	Pass	
Phosmet	< LOQ	0.10	0.2	Pass		**Piperonyl butoxide**	**33.3**	**4.00**	**2**	**Fail**	
Prallethrin	< LOQ	0.10	0.2	Pass		Propiconazole	< LOQ	0.20	0.4	Pass	
Propoxur	< LOQ	0.10	0.2	Pass		**Pyrethrins**	**2.86**	**0.79**	**1**	**Fail**	
Pyridaben	< LOQ	0.10	0.2	Pass		Spinosad	< LOQ	0.10	0.2	Pass	
Spiromesifen	**14.4**	**1.00**	**0.2**	**Fail**		Spirotetramat	< LOQ	0.10	0.2	Pass	
Spiroxamine	< LOQ	0.10	0.4	Pass		Tebuconazole	< LOQ	0.10	0.4	Pass	
Thiacloprid	< LOQ	0.10	0.2	Pass		Thiamethoxam	< LOQ	0.10	0.2	Pass	
Trifloxystrobin	**3.86**	**0.10**	**0.2**	**Fail**							

Start with Cannabis Plant Material

After Extraction, After Distillation, **After Treatment**

- 59 contaminants were assayed
- 49 contaminants were at low levels or non-detectable levels—the batch passed for those contaminants
- One contaminant (a non-toxic synergist) was at a high level—the batch FAILED
- We have a separate solution for that one



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ORELAP ID: 4077-003

Rose Habib
7001 SW 8th Ave
Portland, OR 97219

Report Date: 7/3/2018
Receipt Condition: °C

Sample Name: **Sample 3-0620**

Sample Type: Concentrate/Extract
Sample ID: P806035-03
Sample Date: 06/25/2018
Receipt Date: 06/25/2018

Harvest Lot:
Client Batch ID:
Client METRC ID:
Lab METRC ID:
Submission Type: RD

Pesticides by AOAC 2007.01 and EN 15662 | **Units: ppm** | **Analyzed: 06/29/2018**
Batch #: B8F2901 | **Run ID: B8F2901-009**

Analyte	Result	LOQ	Action	Status	Flags	Analyte	Result	LOQ	Action	Status	Flags
Abamectin	< LOQ	0.20	0.5	Pass		Acephate	< LOQ	0.20	0.4	Pass	
Acequinocyl	< LOQ	0.40	2	Pass		Acetamiprid	< LOQ	0.10	0.2	Pass	
Aldicarb	< LOQ	0.20	0.4	Pass		Azoxystrobin	< LOQ	0.10	0.2	Pass	
Bifenazate	< LOQ	0.10	0.2	Pass		Bifenthrin	< LOQ	0.10	0.2	Pass	
Boscalid	< LOQ	0.10	0.2	Pass		Carbaryl	< LOQ	0.10	0.2	Pass	
Carbofuran	< LOQ	0.10	0.2	Pass		Chlorantraniliprole	< LOQ	0.10	0.2	Pass	
Chlorfenapyr	< LOQ	0.40	1	Pass		Chlorpyrifos	< LOQ	0.10	0.2	Pass	
Clofentezine	< LOQ	0.10	0.2	Pass		Cyfluthrin	< LOQ	0.79	1	Pass	
Cypermethrin	< LOQ	0.40	1	Pass		Daminozide	< LOQ	0.40	1	Pass	
DDVP (Dichlorvos)	< LOQ	0.40	1	Pass		Diazinon	< LOQ	0.10	0.2	Pass	
Dimethoate	< LOQ	0.10	0.2	Pass		Ethoprophos	< LOQ	0.10	0.4	Pass	
Etofenprox	< LOQ	0.10	0.2	Pass		Etoxazole	< LOQ	0.10	0.2	Pass	
Fenoxycarb	< LOQ	0.10	0.2	Pass		Fenpyroximate	< LOQ	0.10	0.4	Pass	
Fipronil	< LOQ	0.20	0.4	Pass		Flonicamid	< LOQ	0.40	1	Pass	
Fludioxonil	< LOQ	0.20	0.4	Pass		Hexythiazox	< LOQ	0.40	1	Pass	
Imazalil	< LOQ	0.10	0.2	Pass		Imidacloprid	< LOQ	0.20	0.4	Pass	
Kresoxim-methyl	< LOQ	0.20	0.4	Pass		Malathion	< LOQ	0.10	0.2	Pass	
Metalaxyl	< LOQ	0.10	0.2	Pass		Methiocarb	< LOQ	0.10	0.2	Pass	
Methomyl	< LOQ	0.20	0.4	Pass		Methyl parathion	< LOQ	0.10	0.2	Pass	
MGK-264	< LOQ	0.10	0.2	Pass		Myclobutanil	< LOQ	0.10	0.2	Pass	
Naled	< LOQ	0.20	0.5	Pass		Oxamyl	< LOQ	0.40	1	Pass	
Paclobutrazol	< LOQ	0.20	0.4	Pass		Permethrins	< LOQ	0.10	0.2	Pass	
Phosmet	< LOQ	0.10	0.2	Pass		**Piperonyl butoxide**	**32.1**	**4.00**	**2**	**Fail**	
Prallethrin	< LOQ	0.10	0.2	Pass		Propiconazole	< LOQ	0.20	0.4	Pass	
Propoxur	< LOQ	0.10	0.2	Pass		Pyrethrins	< LOQ	0.79	1	Pass	
Pyridaben	< LOQ	0.10	0.2	Pass		Spinosad	< LOQ	0.10	0.2	Pass	
Spiromesifen	< LOQ	0.10	0.2	Pass		Spirotetramat	< LOQ	0.10	0.2	Pass	
Spiroxamine	< LOQ	0.10	0.4	Pass		Tebuconazole	< LOQ	0.10	0.4	Pass	
Thiacloprid	< LOQ	0.10	0.2	Pass		Thiamethoxam	< LOQ	0.10	0.2	Pass	
Trifloxystrobin	< LOQ	0.10	0.2	Pass							

You May be Wondering

Why did we do this? How did we achieve these results? More importantly, how can you achieve these results?

General Objective

To eliminate toxic contaminants (pesticides, herbicides, fungicides, synergists) from contaminated Cannabis Extracts with simple procedures in a cost-effective manner.

Background

Though it's an agricultural product, the level of contamination of cannabis and cannabis extracts is effectively not covered by current federal regulations. The reason is simple. It's illegal to possess cannabis in the first place.

However, FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act of 1910) is still the Federal law in the United States to protect applicators, consumers, and the environment in ALL products of ALL types.

Toxic contaminants—factors to consider:

- Pesticides, herbicides, fungicides, synergists are used by growers to improve crop quality, and increase crop yield profitability
- They're commonly found at the 1 to 50 ppm level per contaminant in plant material
- The extraction processes for removing and concentrating cannabinoids also remove and concentrate the toxic contaminants.
- A concentration increase—by a factor of ten of the toxic contaminants—in the extracts by comparison with the starting plant material is the usual case

Oregon—First to Go Green

The state of Oregon decriminalized cannabis in 1973 and was, effectively, “First In” with serious regulations of cannabis extracts and has the most experience in regulating cannabis and cannabis extracts. It appears that most states are following, or will follow, Oregon’s lead.

As of 2018, Oregon requires testing of cannabis products BEFORE they are sold and is one of the only state to require testing.

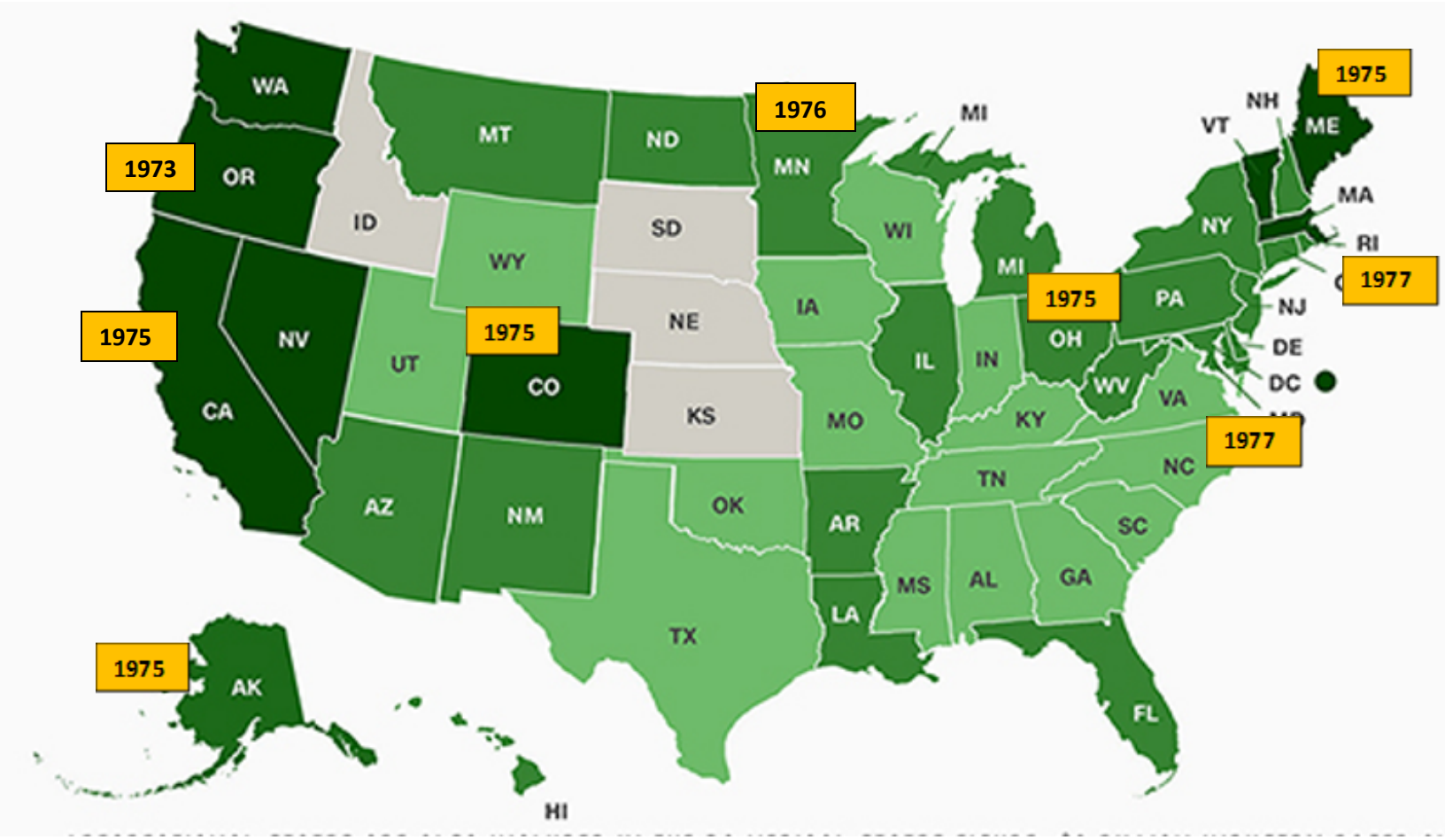
The **Total Contaminant Load** (all pesticides, herbicides, fungicides, and synergists added together) in cannabis extracts is frequently 50 to 500ppm or more. But according to Oregon law, there must be a maximum of 25 ppm. These levels are clearly health risks to users, and Oregon state health authorities have already begun to mandate action levels for specific pesticides.

There is something else.

The “safe” concentration of pesticides in food products (edibles in cannabis lingo) is established, well-known, and relatively high. However, the “safe” concentration of pesticides in the smoke of cannabis cigarettes or the vapor of vape products is not known.

Pyrolysis occurs during partial combustion and numerous products can be (are) generated. Many of these products are toxic, for example, Myclobutanil will surely generate a Cyanide radical, which is definitely toxic.

Decriminalization – 1973 to 2001



- 1973: Oregon
- 1975: California, Colorado, Maine and Ohio
- 1976: Minnesota
- 1977: North Carolina and Rhode Island

THE REST OF THE STATES HAVE FOLLOWED SINCE 2001.

Current Status

31	20
Medical Marijuana Laws	Operating Dispensaries
9	4
Recreational Marijuana Laws	Operating Retail Stores

What is Being Regulated

In the Oregon Health Authorities Technical Report 8964, easily obtainable online, approximately **59 contaminants** (pesticides, fungicides and synergists) must be tested in cannabis and cannabis-containing products.

(Note: synergists are NOT toxic by themselves)

This testing must occur **BEFORE THE PRODUCTS CAN BE SOLD IN OREGON.**

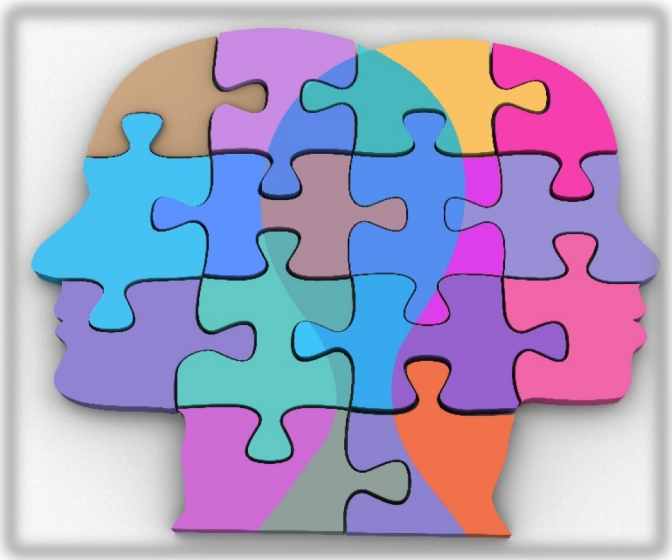
Action Levels of individual contaminants range from 0.2 to 2 ppm depending on the contaminant. Note that thousands of pesticides are registered at the US-EPA under FIFRA, but only 59 are required to be tested in Oregon. It's likely that other states will follow Oregon's lead.

Additionally, the usual residual solvents (Class 1, 2, and 3) must be tested.

Let's Take a Closer Look

#	Analyte	Chemical Abstract Services(CAS) Registry number	Action level (ppm)
1	Abamectin	71751-41-2	0.5
2	Acephate	30560-19-1	0.4
3	Acequinocyl	57960-19-7	2
4	Acetamiprid	135410-20-7	0.2
5	Aldicarb	116-06-3	0.4
6	Azoxystrobin	131860-33-8	0.2
7	Bifenazate	149877-41-8	0.2
8	Bifenthrin	82657-04-3	0.2
9	Boscalid	188425-85-6	0.4
10	Carbaryl	63-25-2	0.2
11	Carbofuran	1563-66-2	0.2
12	Chlorantraniliprole	500008-45-7	0.2
13	Chlorfenapyr	122453-73-0	1
14	Chlorpyrifos	2921-88-2	0.2
15	Clofentezine	74115-24-5	0.2
16	Cyfluthrin	68359-37-5	1
17	Cypermethrin	52315-07-8	1
18	Daminozide	1596-84-5	1
19	DDVP (Dichlorvos)	62-73-7	0.1
20	Diazinon	333-41-5	0.2
21	Dimethoate	60-51-5	0.2
22	Ethoprophos	13194-48-4	0.2
23	Etofenprox	80844-07-1	0.4
24	Etoxazole	153233-91-1	0.2
25	Fenoxycarb	72490-01-8	0.2
26	Fenpyroximate	134098-61-6	0.4
27	Fipronil	120068-37-3	0.4
28	Flonicamid	158062-67-0	1
29	Fludioxonil	131341-86-1	0.4
30	Hexythiazox	78587-05-0	1
31	Imazalil	35554-44-0	0.2
32	Imidacloprid	138261-41-3	0.4
33	Kresoxim-methyl	143390-89-0	0.4
34	Malathion	121-75-5	0.2
35	Metalaxyl	57837-19-1	0.2
36	Methiocarb	2032-65-7	0.2
37	Methomyl	16752-77-5	0.4
38	Methyl parathion	298-00-0	0.2
39	MGK-264	113-48-4	0.2
40	Myclobutanil	88671-89-0	0.2
41	Naled	300-76-5	0.5
42	Oxamyl	23135-22-0	1
43	Paclobutrazol	76738-62-0	0.4
44	Permethrins*	52645-53-1	0.2
45	Phosmet	732-11-6	0.2
46	Piperonyl_butoxide	51-03-6	2
47	Prallethrin	23031-36-9	0.2
48	Propiconazole	60207-90-1	0.4
49	Propoxur	114-26-1	0.2
50	Pyrethrins†	8003-34-7	1
51	Pyridaben	96489-71-3	0.2
52	Spinosad	168316-95-8	0.2
53	Spiromesifen	283594-90-1	0.2
54	Spirotetramat	203313-25-1	0.2
55	Spiroxamine	118134-30-8	0.4
56	Tebuconazole	80443-41-0	0.4
57	Thiacloprid	111988-49-9	0.2
58	Thiamethoxam	153719-23-4	0.2
59	Trifloxystrobin	141517-21-7	0.2

QUESTION: Is this a **REAL** problem?



Garden Variety Pesticides Versus Cannabis

Comparing the average pesticide consumers purchase and use in their homes and gardens with the concentration of pesticides in cannabis extracts, the numbers are virtually the same.

Percent	Parts	PPM
10%	1/10	100,000
1%	1/100	10,000
0.5%	1/500	5,000
0.1%	1/1,000	1,000
0.05%	1/5,000	500
0.01%	1/10,000	100
0.005%	1/50,000	50
0.001%	1/100,000	10
0.0005%	1/500,000	5
0.0001%	1/1,000,000	1

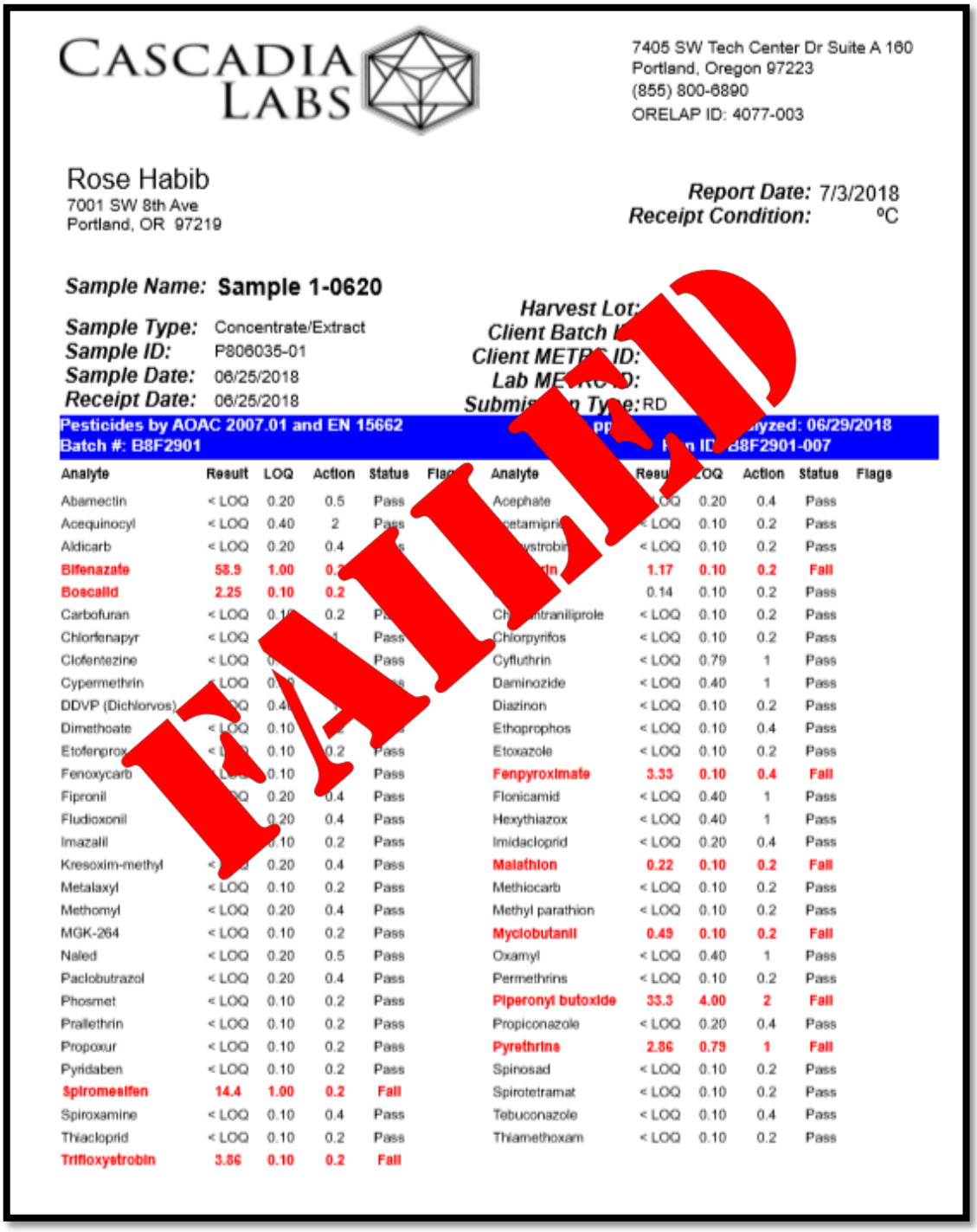
Concentration of Pesticides at the Grocery Store, Home Depot, and Garden Centers.

Percent	Parts	PPM
10%	1/10	100,000
1%	1/100	10,000
0.5%	1/500	5,000
0.1%	1/1,000	1,000
0.05%	1/5,000	500
0.01%	1/10,000	100
0.005%	1/50,000	50
0.001%	1/100,000	10
0.0005%	1/500,000	5
0.0001%	/1,000,000	1

Concentration of Pesticides at Cannabis Extracts.

The Batch Failed

Here are the initial test results from a test lot of ~7kg that we were working with and decontaminated. **Note that the Total Contaminant Level is ~100ppm.**



CASCADIA LABS

7405 SW Tech Center Dr Suite A 160
Portland, Oregon 97223
(855) 800-6890
ORELAP ID: 4077-003

Rose Habib
7001 SW 8th Ave
Portland, OR 97219

Report Date: 7/3/2018
Receipt Condition: °C

Sample Name: **Sample 1-0620**

Sample Type: Concentrate/Extract
Sample ID: P806035-01
Sample Date: 06/25/2018
Receipt Date: 06/25/2018

Harvest Lot:
Client Batch ID:
Client METRC ID:
Lab METRC ID:
Submission Type: RD

FAILED

Pesticides by AOAC 2007.01 and EN 15662 — Analyzed: 06/29/2018
Batch #: B8F2901 — Item ID: B8F2901-007

Analyte	Result	LOQ	Action	Status	Flags	Analyte	Result	LOQ	Action	Status	Flags
Abamectin	< LOQ	0.20	0.5	Pass		Acephate	< LOQ	0.20	0.4	Pass	
Acequinocyl	< LOQ	0.40	2	Pass		Acetamiprid	< LOQ	0.10	0.2	Pass	
Aldicarb	< LOQ	0.20	0.4	Pass		Azoxystrobin	< LOQ	0.10	0.2	Pass	
Bifenazate	**58.9**	**1.00**	**0.2**	**Fail**		**Bifenthrin**	**1.17**	**0.10**	**0.2**	**Fail**	
Boscalid	**2.25**	**0.10**	**0.2**	**Fail**		Cyantraniliprole	0.14	0.10	0.2	Pass	
Carbofuran	< LOQ	0.10	0.2	Pass		Chlorantraniliprole	< LOQ	0.10	0.2	Pass	
Chlorfenapyr	< LOQ	0.40	1	Pass		Chlorpyrifos	< LOQ	0.10	0.2	Pass	
Clofentezine	< LOQ	0.10	0.2	Pass		Cyfluthrin	< LOQ	0.79	1	Pass	
Cypermethrin	< LOQ	0.79	1	Pass		Daminozide	< LOQ	0.40	1	Pass	
DDVP (Dichlorvos)	< LOQ	0.40	1	Pass		Diazinon	< LOQ	0.10	0.2	Pass	
Dimethoate	< LOQ	0.10	0.2	Pass		Ethoprophos	< LOQ	0.10	0.4	Pass	
Etofenprox	< LOQ	0.10	0.2	Pass		Etoxazole	< LOQ	0.10	0.2	Pass	
Fenoxycarb	< LOQ	0.10	0.2	Pass		**Fenpyroximate**	**3.33**	**0.10**	**0.4**	**Fail**	
Fipronil	< LOQ	0.20	0.4	Pass		Flonicamid	< LOQ	0.40	1	Pass	
Fludioxonil	< LOQ	0.20	0.4	Pass		Hexythiazox	< LOQ	0.40	1	Pass	
Imazalil	< LOQ	0.10	0.2	Pass		Imidacloprid	< LOQ	0.20	0.4	Pass	
Kresoxim-methyl	< LOQ	0.20	0.4	Pass		**Malathion**	**0.22**	**0.10**	**0.2**	**Fail**	
Metalaxyl	< LOQ	0.10	0.2	Pass		Methiocarb	< LOQ	0.10	0.2	Pass	
Methomyl	< LOQ	0.20	0.4	Pass		Methyl parathion	< LOQ	0.10	0.2	Pass	
MGK-264	< LOQ	0.10	0.2	Pass		**Myclobutanil**	**0.49**	**0.10**	**0.2**	**Fail**	
Naled	< LOQ	0.20	0.5	Pass		Oxamyl	< LOQ	0.40	1	Pass	
Paclobutrazol	< LOQ	0.20	0.4	Pass		Permethrins	< LOQ	0.10	0.2	Pass	
Phosmet	< LOQ	0.10	0.2	Pass		**Piperonyl butoxide**	**33.3**	**4.00**	**2**	**Fail**	
Prallethrin	< LOQ	0.10	0.2	Pass		Propiconazole	< LOQ	0.20	0.4	Pass	
Propoxur	< LOQ	0.10	0.2	Pass		**Pyrethrins**	**2.86**	**0.79**	**1**	**Fail**	
Pyridaben	< LOQ	0.10	0.2	Pass		Spinosad	< LOQ	0.10	0.2	Pass	
Spiromesifen	**14.4**	**1.00**	**0.2**	**Fail**		Spirotetramat	< LOQ	0.10	0.2	Pass	
Spiroxamine	< LOQ	0.10	0.4	Pass		Tebuconazole	< LOQ	0.10	0.4	Pass	
Thiacloprid	< LOQ	0.10	0.2	Pass		Thiamethoxam	< LOQ	0.10	0.2	Pass	
Trifloxystrobin	**3.86**	**0.10**	**0.2**	**Fail**							

Question:

Is this a real problem?

Answer:

Yes!

Another "Little" Problem

As of 2016, Oregon had:

- 420 dispensaries
- 50,000 growers
- 36,000 sites
- 34 labs

This is a Major Bottleneck.

Insufficient number of testing laboratories.

*Source: Oregon.gov

What can be done about this?

Let's evaluate potential methods to eliminate contaminants from cannabis.

1. **Pesticide-Free Crop Growth**
   - Right, sounds easy enough—just don't use pesticides
   - But it's not as easy as it sounds due to persistence of contaminants in the soil and contaminants applied to adjacent fields
   - Also, contaminant free water must be used, which requires a significant capital expenditure on equipment and high cost of production in the required volumes

2. **Selective Extraction**
   - **All** solvents extract a relatively broad range of substances, and substances with similar characteristics are always extracted together
   - If your initial cannabis plant material has toxic contaminants—No Matter What Solvent You Use—then your extract will have the same toxic contaminants at a higher level than in the original plant material
   - The reason for this is that contaminants and cannabinoids have the same properties

3. **Selective Adsorption**
   - There are selective adsorbents—we'll explore this in detail

4. **Destruction of Contaminants by Chemical Reaction**
   - This is not as difficult or painful as it sounds
   - This involves transformation of functional groups required for biological activities, such that the biological activity (pesticide action) is gone
   - The reaction must transform the substance into a non-toxic entity
   - This is fairly easy to accomplish, but the chemical reaction must also leave intact the substance(s) of interest (cannabinoids in our case)
   - This can be done, we did it—and this will be discussed in this eBook

Selective Adsorption

There are numerous available adsorbents—from A to Z.

- Activated Alumina
- Bonded Phase Silica
- Calcium Carbonate
- Carbon Nanotubes
- Cellulose
- Charcoal (Activated Carbon)
- Florisil (Magnesium Silicate)
- Graphitized Silica
- Ion Exchange Resins
- Iron Oxide
- Lignin clays
- Magnesium Oxide
- Modified Cellulose
- Polymeric Adsorbents
- (non-ionic Reversed Phase Resins)
- Silica (Silicon Dioxide)
- Sorption clays
- Titania (Titanium Dioxide)
- Zeolites
- Zinc Oxide
- Zirconia (Zirconium Dioxide)

Adsorbent Selection Criteria

1. **Cost**—must be sufficiently inexpensive or it's too cost prohibitive
2. **Availability**—must be able to obtain the material
3. **Disposable**—must be able to safely dispose of spent material
4. **Efficient**—must be sufficiently efficient that it's economically viable
5. **Reusable or regenerable**—preferably, should be regenerable or reusable
6. **Selective**—must either selectively retain either the contaminants or the substances of interest
7. **Capacity**--must have sufficient capacity to be useful

Potentially Viable Adsorbents

The following adsorbents pass all the criteria:

- Florisil (Magnesium Silicate)
- Activated Alumina
- Silica (Silicon Dioxide)
- Bonded Phase Silica
- Polymeric Adsorbents (non-ionic Reversed Phase Resins)

All the other potential adsorbents fail one or more criteria.

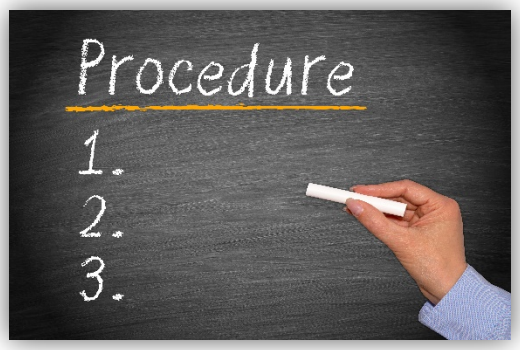
Sorbtech's research explores results using Florisil. However, additional studies with other adsorbents are on-going and will be the subject of future presentations, white papers, and eBooks.

In the future, we'll discuss research findings using:

- Silica Gel
- Bonded Phase Silica Gel (Reversed Phase, Ion Exchange, and so on)
- Polymeric Adsorbents (non-ionic Reversed Phase Resins, Ion Exchange)
- Activated Alumina

Procedure for Selective Adsorption Using Florisil (Magnesium Silicate)

1. Dissolve the extract (distillate) in an alkane solvent (such as butane, pentane, hexane, heptane, isooctane, and so on)
2. Pass the mixture through a column filled with Florisil
3. Pass more solvent through (about 5CV) to recover all the extract
4. Evaporate the solvent



Which Alkane to Use

The FDA, USP, EPA, EP, BP, and just about every regulatory agency in the human universe recognizes three (3) classes of solvents to assay in residual solvent testing:

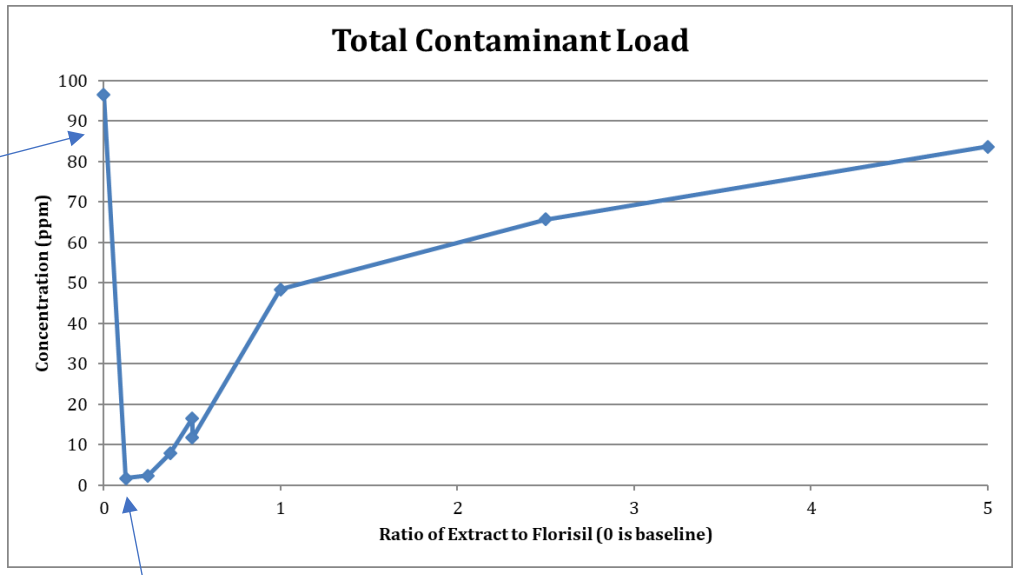
- **Class One Solvents.** "To be avoided". Includes Benzene, Carbon Tetrachloride, and the like. Usually very toxic solvents and sometimes carcinogenic. Acceptable limits usually in the 2 to 100ppm range.
- **Class Two Solvents.** "To be limited". Includes Hexane (290 ppm, or 0.02%), Chloroform (60 ppm), Acetonitrile (410 ppm).

- **Class Three Solvents.** "Regarded as less toxic and of lower risk to human health." Acceptable limits are usually pretty high. Heptane is a Class Three Solvent with a limit of 5,000 ppm or 0.5%.

For this reason, *and only this reason*, Heptane is the preferred solvent for Cannabinoid extraction.

Results of Selective Adsorption with Florisil

Initial Sample (no treatment)



125g of Cannabis Extract to 1000g of Florisil

Note: The dilution ratio (extract: Heptane) used to generate these results was 1:1.

Example:

- 1kg of Extract to 1kg of Heptane

We tested higher dilutions:

- 1kg of Extract to 2kg of Heptane
- 1kg of Extract to 3kg of Heptane
- 1kg of Extract to 4kg of Heptane—and so on

The results were superimposable

Ratio of Cannabis Extract to Florisil	ppm	Percent Contaminants Eliminated	Weight of Cannabis Extract (g) Per kg of Florisil
0	96.49	0.0%	UNTREATED
0.125	1.71	98.2%	125
0.25	2.36	97.6%	250
0.375	7.78	91.9%	375
0.5	16.51	82.9%	500
0.5	11.73	87.8%	500
1	48.36	49.9%	1,000
2.5	65.73	31.9%	2,500
5	83.66	13.3%	5,000
10	89.9	6.8%	10,000
15	91.56	5.1%	15,000

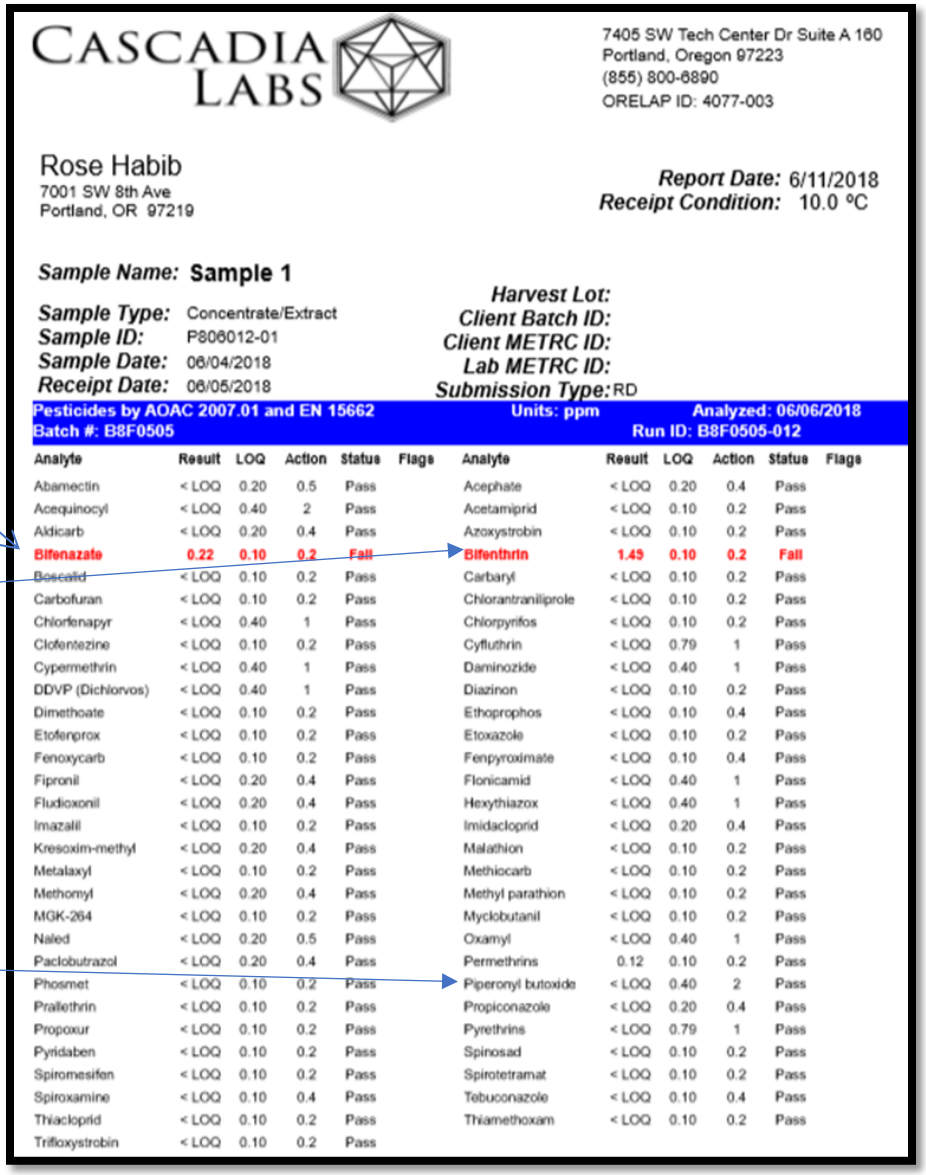
Results of Selective Adsorption with Florisil

Bifenzenate is highly reduced but doesn't pass

Bifenthrin is slightly reduced and doesn't pass

All other contaminants are completely eliminated

NOTE: Piperonyl Butoxide is completely eliminated



CASCADIA LABS

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Portland, Oregon 97223
(855) 800-6890
ORELAP ID: 4077-003

Rose Habib
7001 SW 8th Ave
Portland, OR 97219

Report Date: 6/11/2018
Receipt Condition: 10.0 °C

Sample Name: **Sample 1**

Sample Type: Concentrate/Extract
Sample ID: P806012-01
Sample Date: 06/04/2018
Receipt Date: 06/05/2018

Harvest Lot:
Client Batch ID:
Client METRC ID:
Lab METRC ID:
Submission Type: RD

Pesticides by AOAC 2007.01 and EN 15662 — **Units: ppm** — **Analyzed: 06/06/2018**
Batch #: B8F0505 — **Run ID: B8F0505-012**

Analyte	Result	LOQ	Action	Status	Flags	Analyte	Result	LOQ	Action	Status	Flags
Abamectin	< LOQ	0.20	0.5	Pass		Acephate	< LOQ	0.20	0.4	Pass	
Acequinocyl	< LOQ	0.40	2	Pass		Acetamiprid	< LOQ	0.10	0.2	Pass	
Aldicarb	< LOQ	0.20	0.4	Pass		Azoxystrobin	< LOQ	0.10	0.2	Pass	
Bifenazate	0.22	0.10	0.2	Fail		Bifenthrin	1.49	0.10	0.2	Fail	
Boscalid	< LOQ	0.10	0.2	Pass		Carbaryl	< LOQ	0.10	0.2	Pass	
Carbofuran	< LOQ	0.10	0.2	Pass		Chlorantraniliprole	< LOQ	0.10	0.2	Pass	
Chlorfenapyr	< LOQ	0.40	1	Pass		Chlorpyrifos	< LOQ	0.10	0.2	Pass	
Clofentezine	< LOQ	0.10	0.2	Pass		Cyfluthrin	< LOQ	0.79	1	Pass	
Cypermethrin	< LOQ	0.40	1	Pass		Daminozide	< LOQ	0.40	1	Pass	
DDVP (Dichlorvos)	< LOQ	0.40	1	Pass		Diazinon	< LOQ	0.10	0.2	Pass	
Dimethoate	< LOQ	0.10	0.2	Pass		Ethoprophos	< LOQ	0.10	0.4	Pass	
Etofenprox	< LOQ	0.10	0.2	Pass		Etoxazole	< LOQ	0.10	0.2	Pass	
Fenoxycarb	< LOQ	0.10	0.2	Pass		Fenpyroximate	< LOQ	0.10	0.4	Pass	
Fipronil	< LOQ	0.20	0.4	Pass		Flonicamid	< LOQ	0.40	1	Pass	
Fludioxonil	< LOQ	0.20	0.4	Pass		Hexythiazox	< LOQ	0.40	1	Pass	
Imazalil	< LOQ	0.10	0.2	Pass		Imidacloprid	< LOQ	0.20	0.4	Pass	
Kresoxim-methyl	< LOQ	0.20	0.4	Pass		Malathion	< LOQ	0.10	0.2	Pass	
Metalaxyl	< LOQ	0.10	0.2	Pass		Methiocarb	< LOQ	0.10	0.2	Pass	
Methomyl	< LOQ	0.20	0.4	Pass		Methyl parathion	< LOQ	0.10	0.2	Pass	
MGK-264	< LOQ	0.10	0.2	Pass		Myclobutanil	< LOQ	0.10	0.2	Pass	
Naled	< LOQ	0.20	0.5	Pass		Oxamyl	< LOQ	0.40	1	Pass	
Paclobutrazol	< LOQ	0.20	0.4	Pass		Permethrins	0.12	0.10	0.2	Pass	
Phosmet	< LOQ	0.10	0.2	Pass		Piperonyl butoxide	< LOQ	0.40	2	Pass	
Prallethrin	< LOQ	0.10	0.2	Pass		Propiconazole	< LOQ	0.20	0.4	Pass	
Propoxur	< LOQ	0.10	0.2	Pass		Pyrethrins	< LOQ	0.79	1	Pass	
Pyridaben	< LOQ	0.10	0.2	Pass		Spinosad	< LOQ	0.10	0.2	Pass	
Spiromesifen	< LOQ	0.10	0.2	Pass		Spirotetramat	< LOQ	0.10	0.2	Pass	
Spiroxamine	< LOQ	0.10	0.4	Pass		Tebuconazole	< LOQ	0.10	0.4	Pass	
Thiacloprid	< LOQ	0.10	0.2	Pass		Thiamethoxam	< LOQ	0.10	0.2	Pass	
Trifloxystrobin	< LOQ	0.10	0.2	Pass							

Destruction of Contaminants by Chemical Reaction

Which Functional Groups to Attack

Common functional groups of contaminants:

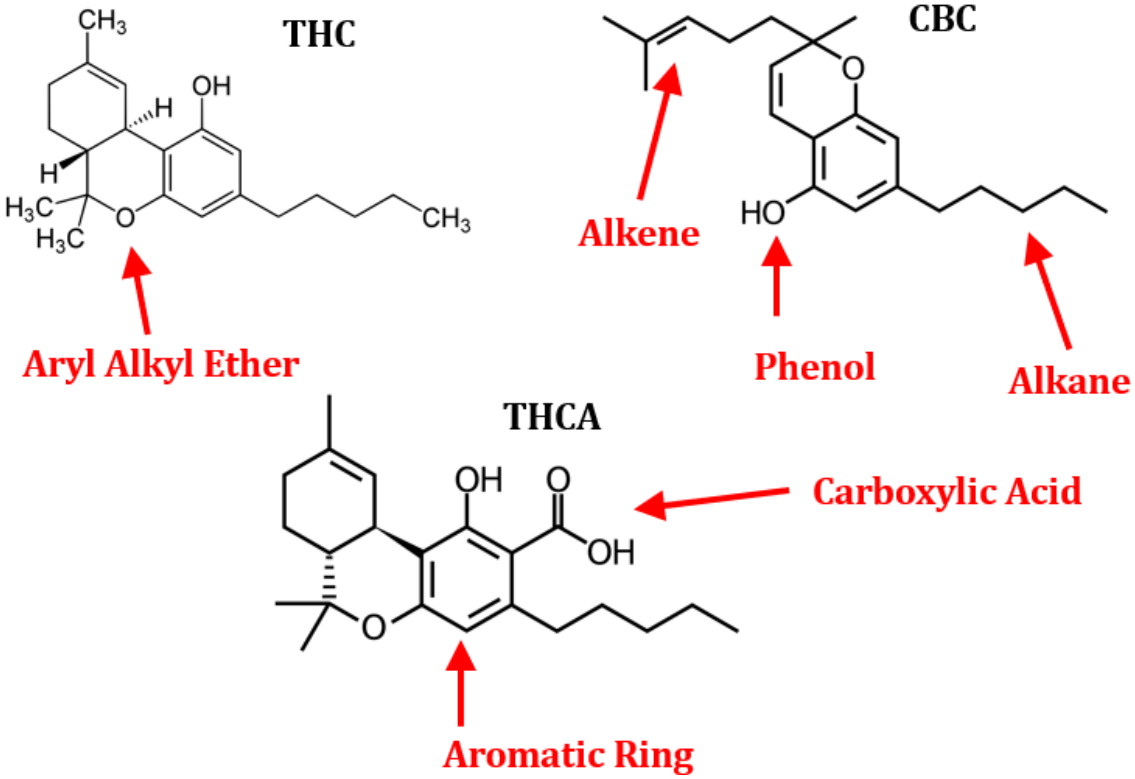
- Carbamates
- Carboxylate Esters
- Nitriles
- Organophosphates
- Oximes
- Phosphoryl Acetamide
- Other Groups

Note: All these groups are highly polar and easily attacked by a variety of agents, including reagents.

Functional Groups of Cannabinoids of Interest

The only functional groups in Cannabinoids are:

- Phenol(s)
- Alkane
- Aryl Alkyl ether
- Alkenes
- Aromatic ring
- Carboxylic Acid



General Properties of Cannabinoids

Cannabinoids are:

- very stable substances
- very lipophilic—non-polar
- most are not soluble in water (some are)
- possess functional groups that are not easily attacked by most common reagents

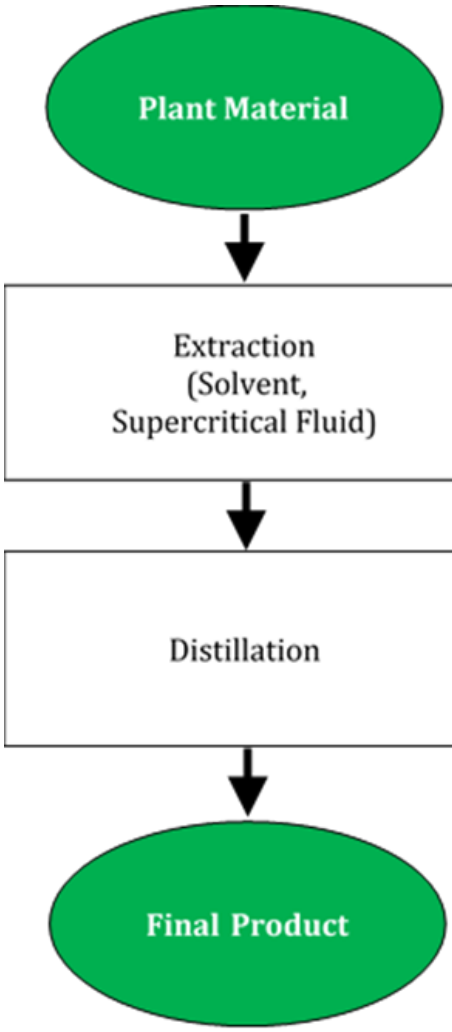
Selective Chemical Destruction of Contaminants in Cannabis Extracts

- We have developed a Proprietary Procedure that is easy to perform without expensive equipment
- The approximate cost is $200 per kilogram of starting cannabis extract with 99+% recovery of cannabinoids
- This cost includes the labor, reagents and solvents (purchased in bulk), and adsorbent-based cleanup
- It does not include building costs or equipment costs

For more details and licensing please contact Sorbent Technologies.

Ignorance is Bliss

In the past, there were not regulations or testing. Plat material looked fine, and after extraction and distillation, the final product looked acceptable as well.



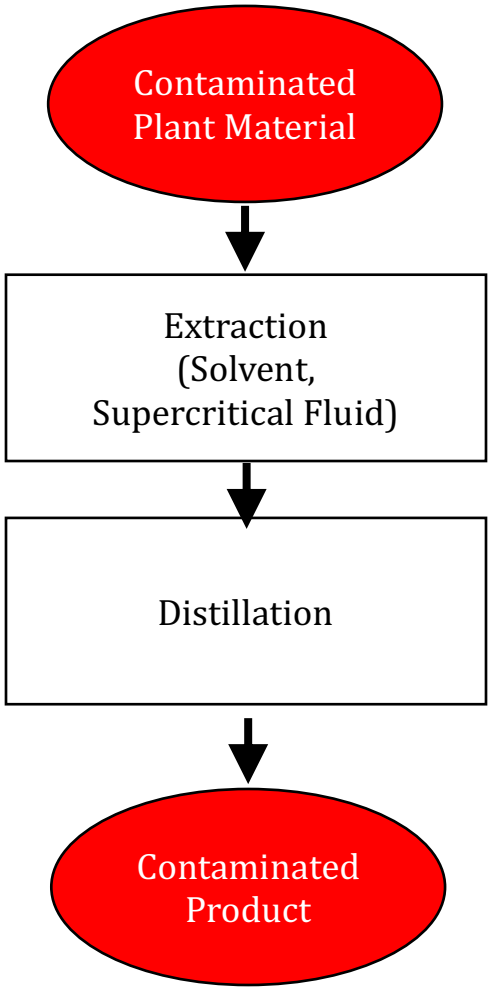
Looked good

Looked good

Unfortunately, they were not good.
You just thought they were.

Reality Bites

More and more often today, with regulations either here or on the way, cannabis products are tested and found to be…



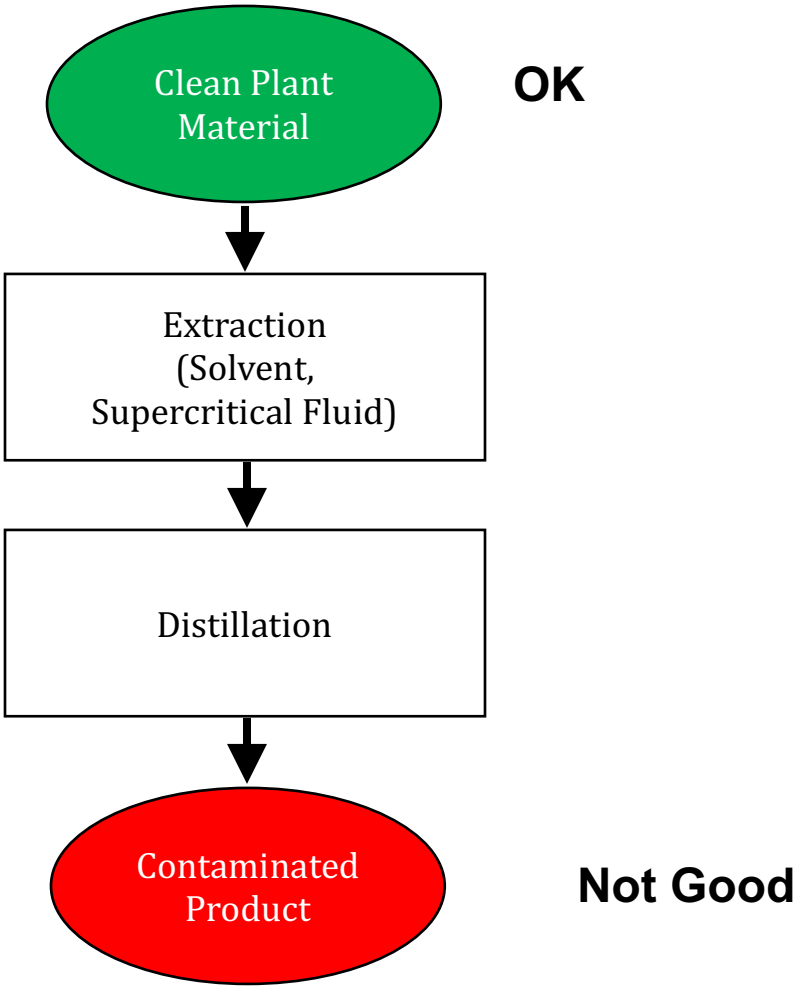
Not Good

Even Worse

…contaminated with toxic agents.

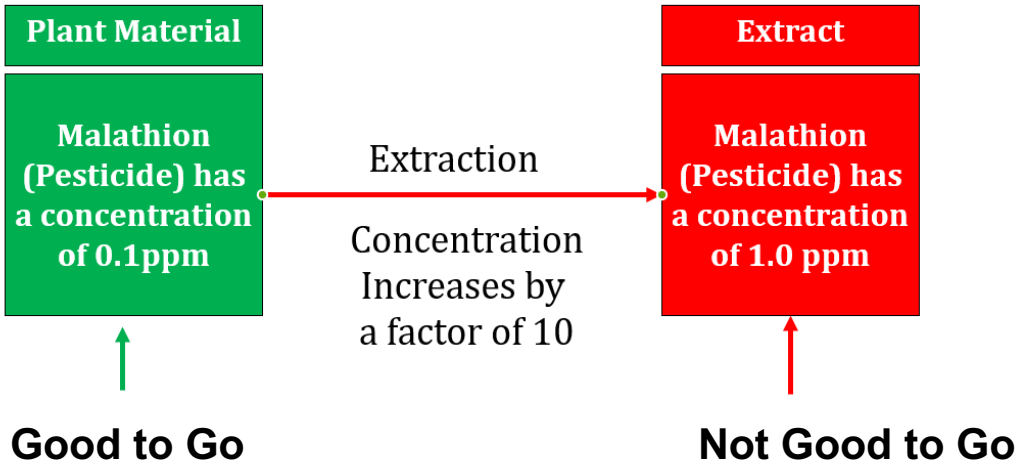
Sometimes this Happens

Plant material is tested and found to be OK, but the extract is found to be…



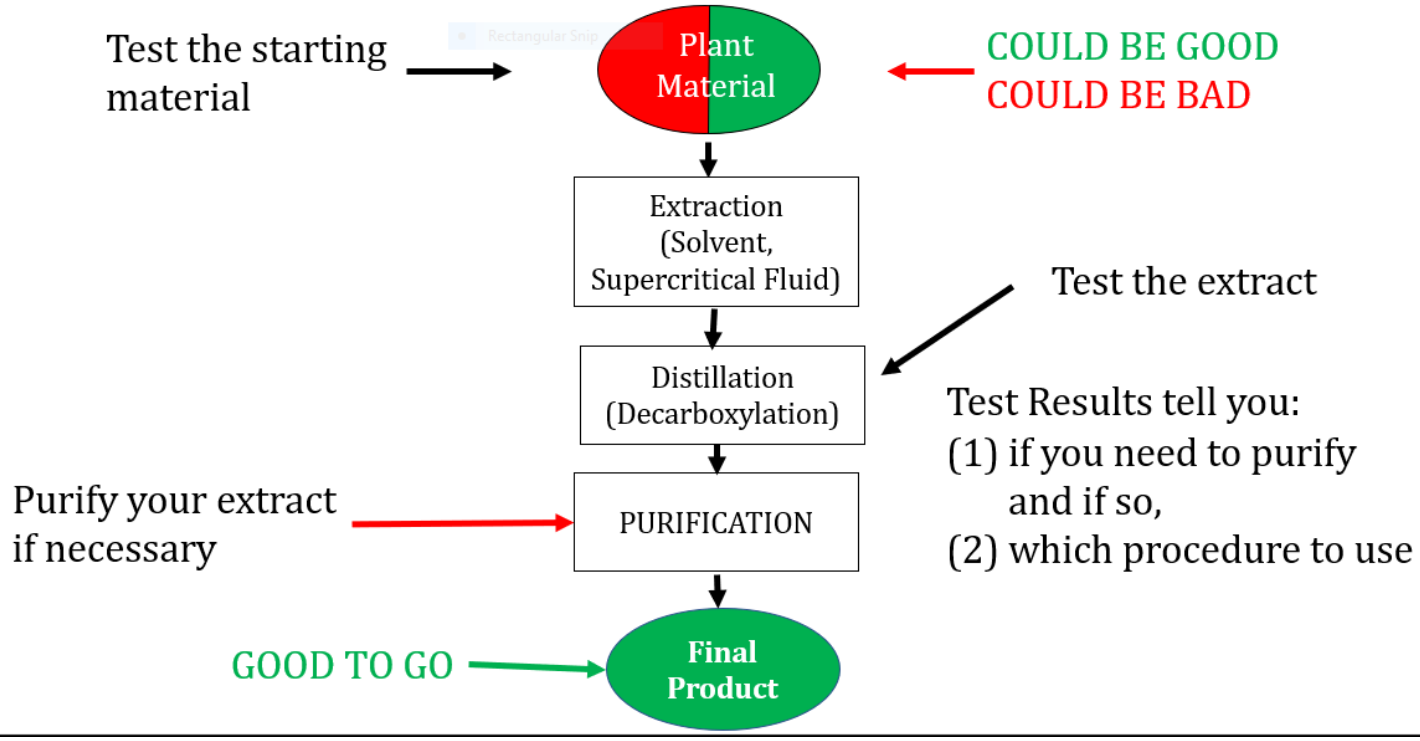
…contaminated with toxic agents.

For Example



Researchers require a better way to move their cannabis research forward, whether or not their plant material is good from the start of the extraction process. The good news is, Sorbtech has a way to move the research forward.

The Way Forward

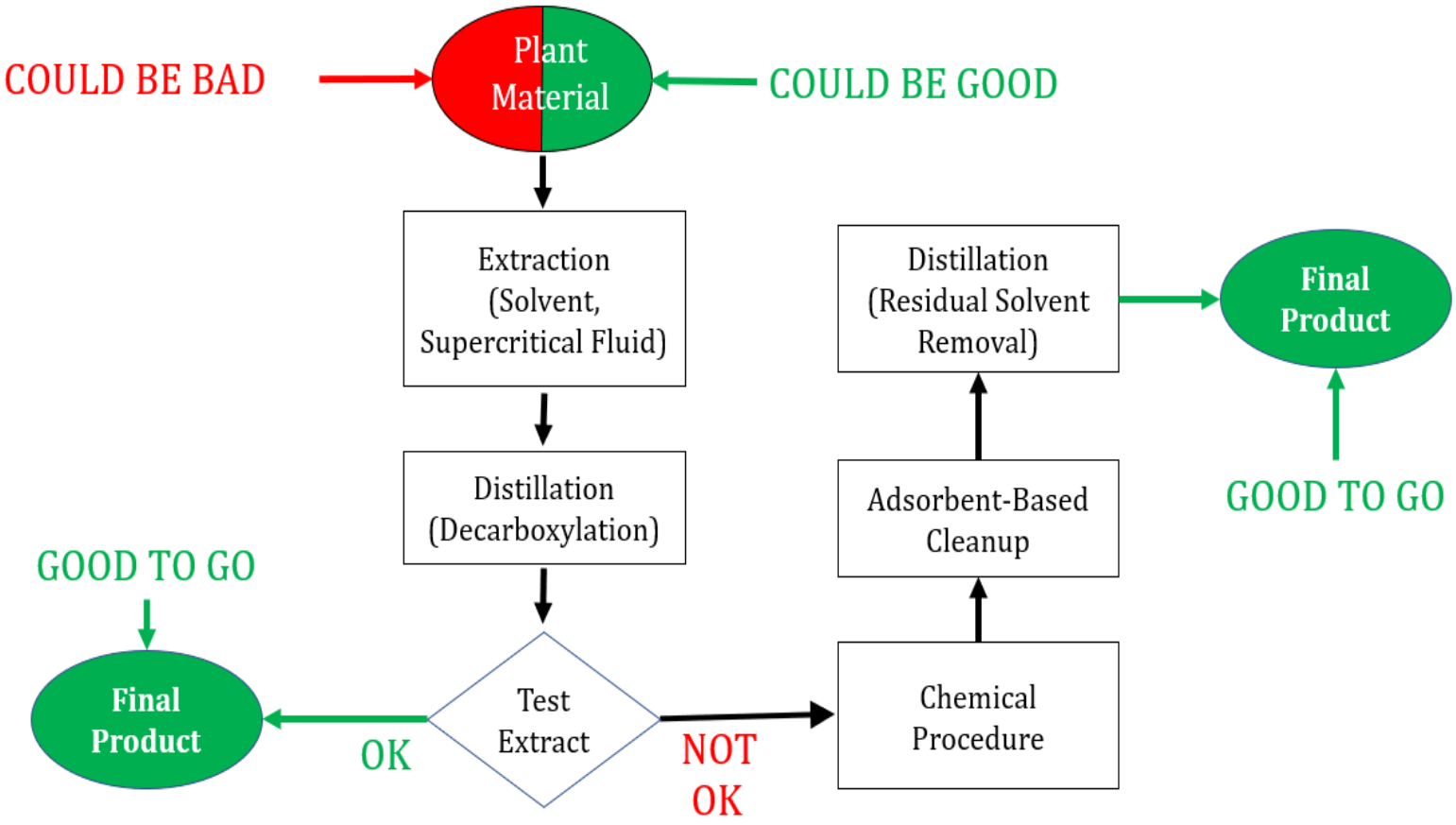


The Way Forward with Details

Here's more detailed information on how to proceed in decontaminating cannabis. As you begin, your plant material may be bad or good to begin with.

Either way, conduct the extraction process, move to distillation, then test the extract. If it's free of contaminants, you're done and have a final product.

If the test extract shows that it's not okay, move forward with the chemical procedure, the adsorbent-based clean-up process, then distillation to removed residual solvents. At this point, you should have achieved a final product and are good to go.



Coming to a Theatre Near You

Based on our experimental results, in the future we will construct a diagram with which a cannabis producer can take the analytical test results and know which procedure, or combination of procedures, to use to eliminate all pesticide residues in cannabis products to meet state regulations to produce a safe product.

Stay tuned for future developments

For Additional Information

Or, if you would like to discuss your research, please contact Sorbent Technologies, Inc. at:

Tel: 770-936-0323

cannabis@sorbtech.com