



Ministry of
Public Safety and
Solicitor General

Chemical Analysis of Illicit Cannabis

**Prepared by the BC Cannabis Secretariat
Ministry of Public Safety and Solicitor General
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Introduction

In contrast to legal and regulated cannabis products, illicit cannabis products are sold to consumers without any apparent quality or safety oversight. Cannabis products sold in the regulated market are produced in accordance with Health Canada's Good Production Practices¹ and are subject to testing for contaminants and the concentration or amount of cannabinoids.

Although most people in Canada who use cannabis purchase it from legal sources, data shows that a considerable proportion of spending on cannabis in Canada (35% in Q4 2021) goes towards purchasing cannabis products from unlicensed sources². This is concerning given that several recent Canadian studies have identified widespread contamination and misrepresentation in illicit cannabis samples:

- 'Unregulated cannabis: Risky production practices raise concern for consumers'³, drafted by the National Collaborating Center for Environmental Health reported pesticide, heavy metal, and microbial contamination in illicit dried cannabis in B.C.;
- 'Ontario cannabis study shows illegal cannabis fails to deliver the goods'⁴ reported overstated cannabinoid concentrations and pesticide contamination in illicit edibles in Ontario;
- 'Why You Need to Drop Your Dealer'⁵, also from Ontario, reported overstated cannabinoid concentrations and pesticide contamination in illicit vape liquids and dried cannabis; and
- 'Analysis of Illicit and Legal Cannabis Products for a Suite of Chemical and Microbial Contaminants'⁶, a study from New Brunswick, reported overstated cannabinoid concentrations and microbial and chemical contamination in illicit dried cannabis and edible samples.

This report assesses illicit cannabis products seized in January and April of 2020 from several illicit storefronts located in the Lower Mainland and on Vancouver Island. Testing for this project was conducted through a provincial–federal partnership between the Province of British Columbia's Cannabis Secretariat and Community Safety Unit (CSU) along with Health Canada and the National Research Council of Canada (NRC).

It is important for consumers to understand that using illicit cannabis products can result in exposure to potentially harmful contaminants. The objectives of this project were to test for contaminants in illicit cannabis, and to share the information to help inform consumer decision-making. This report is an extension of B.C.'s previous illicit cannabis testing pilot project where dried cannabis samples were tested for chemical and microbial contaminants.

Project Approach and Testing Logistics

Samples of illicit cannabis products were collected by the CSU and transferred to the federal agencies for testing, specifically, to Health Canada's Drug Analysis Service (DAS) laboratory and the NRC lab. The following analyses were completed by each laboratory:

- The DAS lab tested for the presence and quantification of vitamin E acetate in 25 illicit cannabis vape cartridges.
- The NRC lab tested the concentration of THC and pesticides in 25 illicit cannabis vape cartridges and 25 illicit dried cannabis samples.

Vape cartridges were tested by the DAS Lab for vitamin E acetate, which is a synthetic compound typically used in cosmetics. Vitamin E acetate has been identified in illicit cannabis vape cartridges in the USA where it is assumed to have been used as a diluent or thickening agent. There is a strong association between vitamin E acetate and e-cigarette, or vaping product use-associated lung injury (E/VALI)⁷. As per Health Canada's Cannabis Regulations⁸, legal and regulated cannabis extracts such as those used in vape cartridges may not contain anything (e.g. vitamin E acetate) that may cause injury to the health of the user when the product is used as reasonably intended.

The majority of the products tested lacked product information and THC amounts. All dried cannabis and vape cartridge samples were tested for Delta-9-tetrahydrocannabinol (THC) content, the main psychoactive cannabinoid found in cannabis. Analysis of other cannabinoids, like cannabidiol (CBD), was not completed as part of this project.

Both the dried cannabis and the vape cartridges were tested for pesticides. In the legal, regulated market, cannabis must be tested for an extensive list of pesticides provided by Health Canada¹⁰. Licensed producers manufacturing cannabis products may forego pesticide testing on finished products, like vape cartridges, if there was prior testing on the cannabis inputs (e.g., dried cannabis).

To ensure that any potential pesticide contamination is reported accurately, Health Canada has established limits of quantification (LoQs)¹¹ for pesticides found in dried cannabis and cannabis oil. The LoQ represents the minimum concentration at which a compound can be expected to be reliably detected using currently accepted methods. Licensed cannabis products must be tested using methods that can detect pesticides at the LoQ; and if no pesticide is detected it may mean that the sample is free of the pesticide or that the concentration is so low that it cannot be detected with the specified methods. In this study, the illicit dried cannabis samples were assessed for the 96 pesticides identified by Health Canada¹⁰. The vape cartridge samples were assessed against 64 pesticides for which Health Canada has determined LoQs for cannabis oil¹⁰.

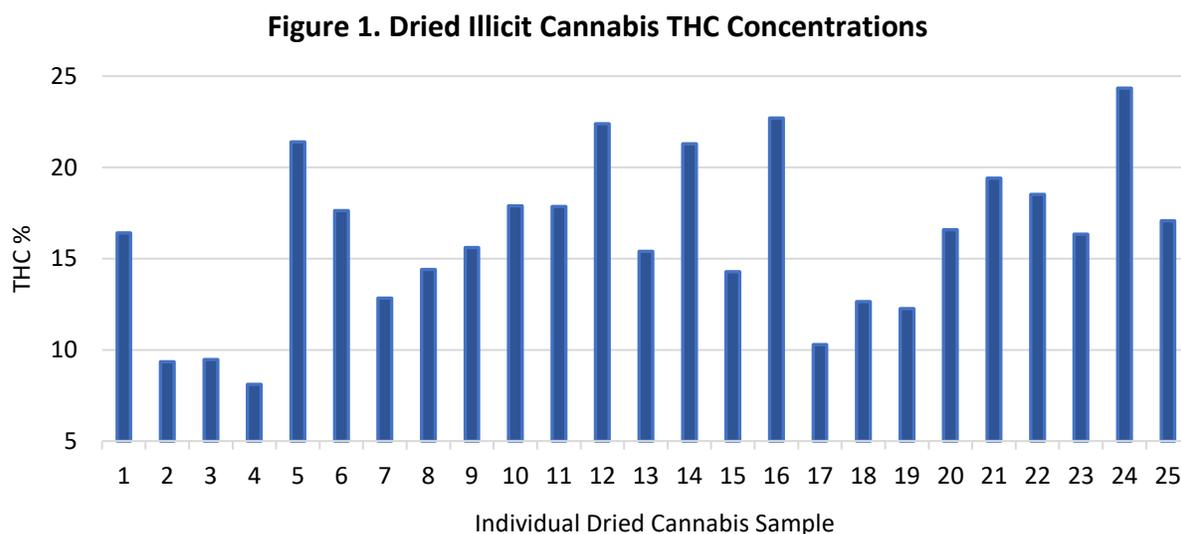
It is important to emphasize that the LoQ for a given pesticide does not represent an acceptable or unacceptable level of the compound. Rather, as mentioned earlier, the LoQ represents the minimum concentration at which a compound can be expected to be reliably detected using currently accepted methods. While no amount of unauthorized pesticide product is technically permitted within a cannabis product, pesticides are widely found within the environment and very small amounts can inadvertently contaminate crops, including cannabis.

In the legal, regulated system, there is a process that must be followed if pesticides are detected at any amount in legal cannabis, and a root cause analysis must be completed to identify where and how the contamination occurred. A product may still be suitable for sale if it is found that the pesticide was unintentionally introduced, that Good Production Practices were being followed (as outlined in Part 5 of the federal Cannabis Regulations¹), and it is assessed that there is no health risk associated with the low level of pesticide contamination.

What was found

THC Concentrations: Dried Cannabis

Twenty-five individual three-gram samples of illicit dried cannabis were submitted for analysis. The testing results displayed a range of THC concentrations from 8.1% up to 24.3%. The following figure displays the results for each individual sample.



While there was no information about advertised amounts of THC, 20 of the 25 illicit cannabis samples displayed THC concentration below 20%, with an average of 16.2%. In comparison to

dried cannabis products available from legal retailers, recent data from over 500 products advertised an average THC concentration of 22%ⁱ.

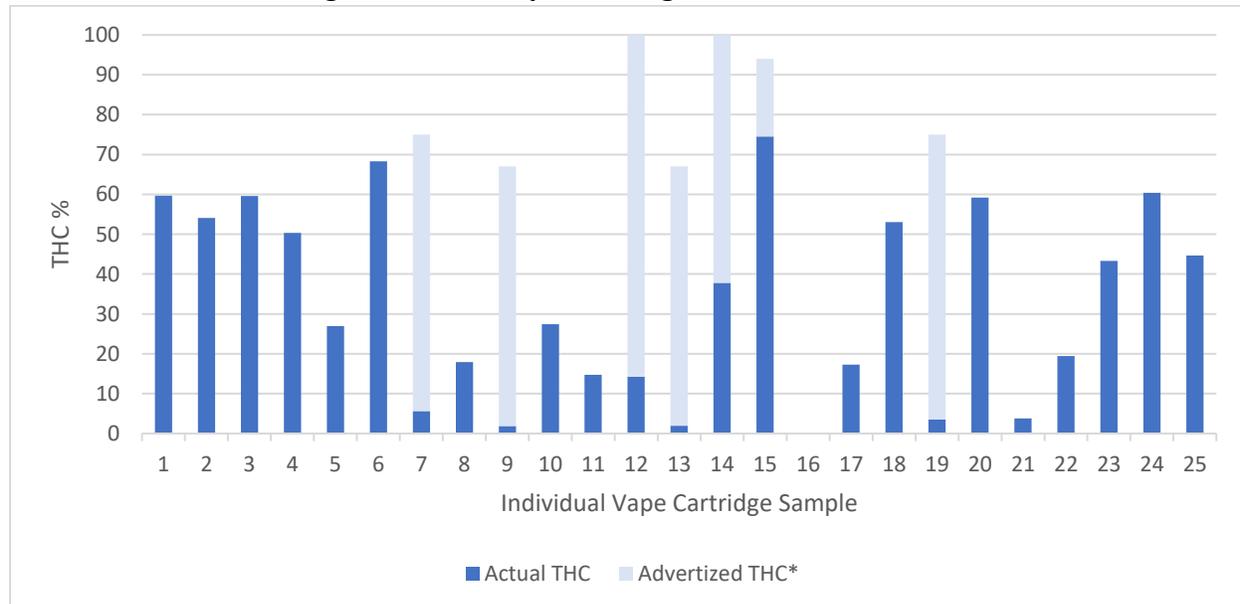
Vitamin E Acetate and THC Concentrations: Vape Cartridges

Twenty-five pairs of illicit cannabis vape cartridges were used for the vape cartridge analysis. The pairs were divided, and one of each set was submitted for analysis at either the DAS laboratory or the NRC laboratory. Each pair appeared to contain identical vape cartridges based on the product packaging.

The DAS laboratory didn't identify the presence of vitamin E acetate in any of the 25 illicit vape cartridge samples.

Analysis of THC concentrations in the vape cartridges was completed by the NRC. The results ranged from below the detection limit in one sample to 74.5% THC. The average concentration in the 24 samples where THC was detected was 34.2%. The chart below displays the results for THC concentrations in each individual sample as well as the advertised THC concentration in the seven vape cartridges where it was available. The remaining illicit cannabis vape cartridges had no information available on THC concentration.

Figure 2. Illicit Vape Cartridge THC Concentrations



*Only 7 samples displayed an advertised THC concentration, see commentary in the last paragraph of this section.

ⁱ Data collected by the BC Cannabis Secretariat in December 2021 by downloading details of cannabis products available through BC Cannabis Stores and a sample of licensed private retailers.

The THC concentrations in illicit vape cartridges had a much larger range than the dried cannabis samples. There is the potential that other cannabinoids like CBD may be present within the cannabis extract in the vape cartridges, but they were not tested for in this analysis. For example, sample 16 in Figure 2 was labelled as a ‘pure CBD cartridge’ so the corresponding result could potentially reflect this, but further testing at the NRC lab was not completed beyond pesticide and THC concentrations.

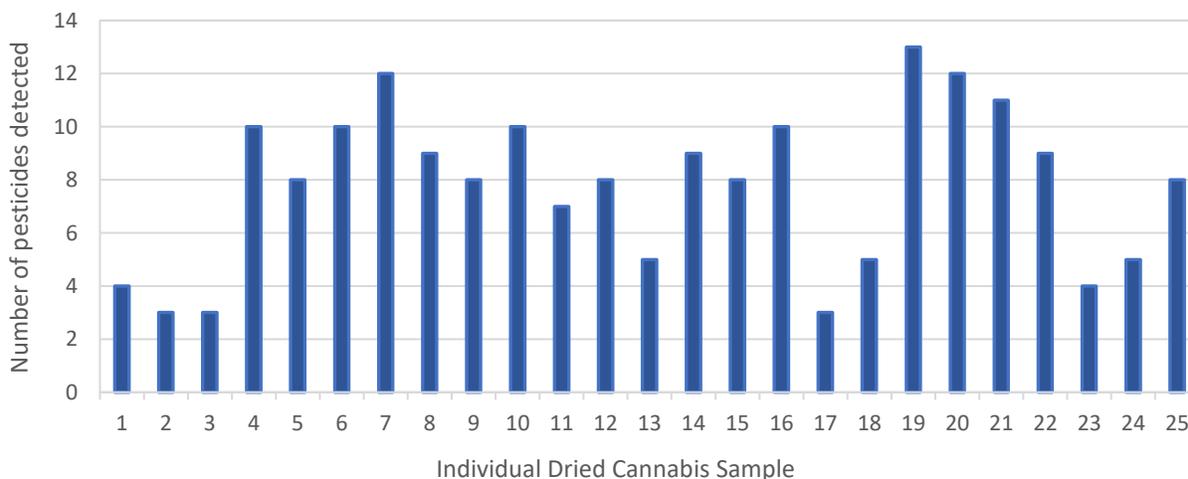
Most of the samples analyzed displayed concentrations of THC below what would be expected for THC dominant vape cartridges. In April 2022 a review of close to 100 vape cartridges listed on the BC Cannabis Stores website found an average THC concentration of 75.2%.

THC concentrations advertised on the illicit cannabis products in this study were unreliable and misleading. Only seven of the 25 samples had a THC concentration displayed on the packaging. The average advertised THC concentration for these seven vape cartridges was 83%, but the average THC concentration for these was actually found to be 19.9% (see Figure 2). The considerably lower than advertised THC concentrations in this study are consistent with the findings of other testing reports^{4,5}.

Pesticides: Dried Cannabis

Every illicit dried cannabis sample tested had detectable concentrations of pesticides unauthorized for use on cannabis. The following chart displays the number of pesticides found in the 25 samples. One dried cannabis sample contained 13 unique pesticides, while the average sample contained approximately eight different pesticides.

Figure 3. Discrete Pesticides Identified in 25 Illicit Dried Cannabis Samples



The most prevalent pesticides in the dried cannabis samples are summarized in the following table. Although the LoQ does not represent an allowable limit as explained above, the presence

of pesticides at concentrations an order of magnitude or 10 times greater than the LoQ was looked at as a reference indicator to estimate if pesticides were deliberately applied. Table 1 displays the number of samples that had concentrations high enough to indicate deliberate pesticide use.

Table 1. Most Prevalent Pesticides in Illicit Dried Cannabis Samples

Pesticide unauthorized for use on cannabis	Reference indicator for deliberate application* (ppm)	No. of samples above reference indicator	Mean concentration where pesticide was detected - above reference indicator (ppm)	Maximum concentration observed (ppm)
Myclobutanil	0.2	5	2.52	9.8
Paclobutrazol	0.2	5	2.07	7.0
Piperonyl Butoxide	0.2	6	7.73	33
Pyrethrins	0.5	3	2.08	5.0

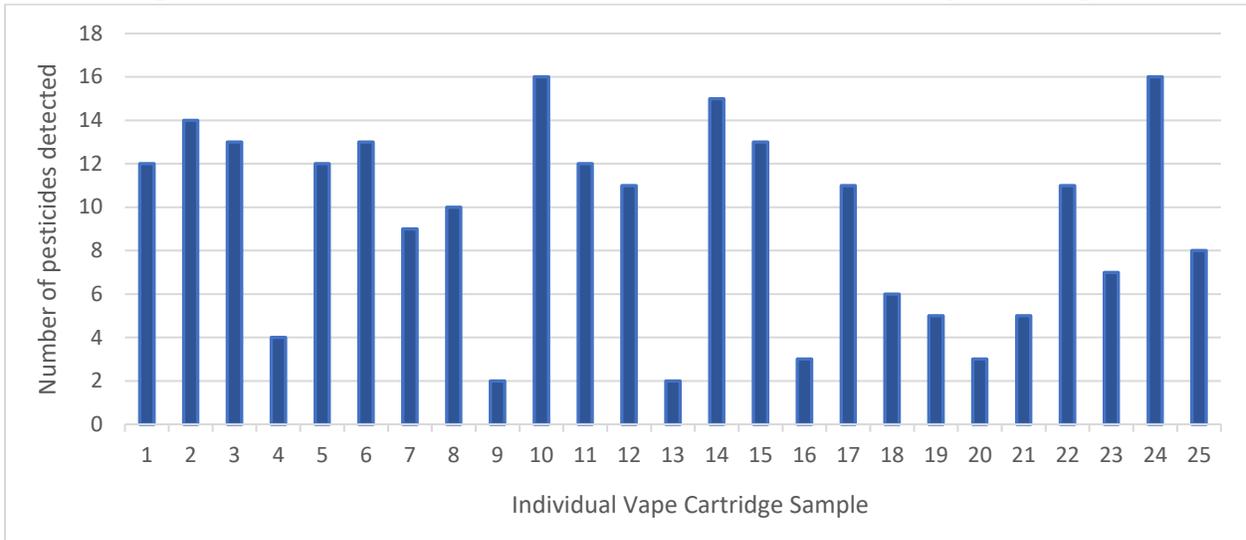
*- Reference indicator is ten times the LoQ for the respective pesticide in dried cannabis

The pesticide concentrations observed indicate it is very likely that there is widespread use of pesticides not authorized for use on cannabis in illicit cannabis production. For example, both piperonyl butoxide and myclobutanil were identified in 24 of the 25 dried cannabis samples tested. Piperonyl butoxide was present in six samples and myclobutanil was present in five samples at concentrations strongly suggesting deliberate application. Piperonyl butoxide is not used on its own as a pesticide but in conjunction with other pesticides to increase effectiveness. Myclobutanil is a fungicide used on food crops that are susceptible to powdery mildew and is commonly used in the agricultural sector. Neither piperonyl butoxide or myclobutanil are currently approved for use on cannabis in Canada.

Pesticides: Vape Cartridges

Every illicit vape cartridge tested contained detectable concentrations of pesticides. The following figure displays the number of pesticides found in each of the 25 illicit samples. Two samples contained only two pesticides, while another two samples contained 16 different pesticides. An average of nine different pesticides were found in each sample.

Figure 4. Discrete Pesticides Identified in 25 Illicit Cannabis Vape Cartridges



A summary of the concentrations of the most prevalent pesticides in the illicit vape cartridge samples is provided in the following table. Five of the most frequently found pesticides in the illicit vape cartridges are present at concentrations many times above the reference indicator. This indicates that the presence was likely not inadvertent, and that the unauthorized pesticides were deliberately applied to the illicit cannabis.

Table 2. Most Prevalent Pesticides in Illicit Vape Cartridge Samples

Pesticide unauthorized for use on cannabis	Reference indicator for deliberate application* (ppm)	No. of samples at, or above reference indicator	Mean concentration where pesticide was detected at, or above reference indicator (ppm)	Maximum concentration observed (ppm)
Fluopyram	0.1	17	5.8	82.1
Metalaxyl	0.1	18	2.1	11.4
Myclobutanil	0.1	24	268.2	1,503.9
Paclobutrazol	0.1	16	6.8	22.4
Piperonyl Butoxide	12.5	9	691.5	2,808.1

*- Reference indicator is ten times the LoQ for the respective pesticide in cannabis oil

It is also notable that a variety of pesticides were detected in the illicit vape cartridges, and that they were generally found at much higher concentrations when compared to the dried cannabis samples. The higher concentrations of pesticides in vape cartridges suggest the pesticides in the base material (dried cannabis flower) become concentrated during processing.

Refer to Appendix 1 for a complete list of pesticides detected in both the illicit dried cannabis and illicit vape cartridges, including the number of samples where the respective pesticide was detected. The B.C. testing project conducted previously and referenced earlier in this report provides further context (in the blog's Table 2³) for risks associated with select pesticides (such as myclobutanol, piperonyl butoxide, and paclobutrazol) that have been found in illicit cannabis samples.

Closing

The testing results show that the use of pesticides is a common practice in illicit cannabis production. Pesticides not authorized for use on cannabis were detected in all 50 samples. Fifteen of the 25 dried cannabis samples (60%) and all but one of the vape cartridge samples (96%) had concentrations high enough to suggest pesticides were deliberately applied.

It is likely that customers who buy illicit vape cartridges are not getting the THC concentrations that they are expecting. For the vape cartridges with advertised THC concentrations, the actual THC concentrations were much lower than what was displayed on the packaging, and many were lower than comparable products available in the regulated market.

Fortunately, no vitamin E acetate, a chemical implicated as a causative agent of E/VALI, was detected in the illicit cannabis extract samples for vaping.

This study's findings are compelling and concerning but there are limitations to consider. The samples represent a limited selection of the products available in the illicit cannabis market in British Columbia. Seizing products from illicit retailers does not allow for identifying the producer(s), the production methods, or environmental factors. Similarly, only specific contaminants were tested for, not the full suite of testing required in the legal and regulated system, so the findings do not reflect all potential contaminants that could be found in illicit cannabis.

However, the findings highlight the value of testing. Without product testing, a consumer cannot be sure of the concentration of their cannabis' active ingredients or if their cannabis contains contaminants. Cannabis products within the legal, regulated system must be tested and pass quality specifications, and if contaminants are found licensed producers are required to address the issue.

The general conclusion of these testing results is consistent with previous reports; that is, unless a consumer is purchasing from a legal and regulated source there is no mechanism or oversight protecting the consumer from false and misleading product claims and potentially harmful contaminants.

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Appendix I – Summary Table of Pesticide Findings in Illicit Cannabis

Pesticide	Number of illicit dried cannabis samples with pesticide identified	Number of illicit cannabis extract in vape cartridge samples with pesticide identified
1. Myclobutanil	23	24
2. Piperonyl Butoxide	24	19
3. Imidacloprid	15	2
4. Bifenazate	12	15
5. Endosulfan-alpha	16	1
6. Pyrethrins	9	-
7. Spiromesifen	8	3
8. Chlorphenapyr	7	7
9. Fluopyram	8	17
10. Paclobutrazol	7	16
11. Tetramethrin Group	5	2
12. Chlorpyrifos	5	14
13. Bifenthrin	5	6
14. Permethrins Group	5	8
15. Metalaxyl	5	18
16. Daminozide	5	-
17. Buprofezin	4	9
18. Abamectin B1a	3	1
19. Spinosad Group	3	-
20. Spinetoram Group	3	-
21. MGK 264	3	-
22. Acephate	2	-
23. Pyraclostrobin	2	1
24. Pyridaben	2	17
25. Clothianidin	1	-
26. Thiacloprid	1	-
27. Dichlorvos	1	1
28. Thiophanate Methyl	1	-
29. Azadirachtin	1	-
30. Carbaryl	1	-
31. Azoxystrobin	1	1
32. Malathion	1	-
33. Boscalid	1	4
34. Propiconazole	1	4
35. Acequinocyl	1	1
36. Etridiazole	1	-
37. Kinoprene	1	-
38. Dodemorph	-	16
39. Etoxazole	-	4

Pesticide	Number of illicit dried cannabis samples with pesticide identified	Number of illicit cannabis extract in vape cartridge samples with pesticide identified
40. Cyprodinil	-	6
41. Fludioxonil	-	3
42. Etofenprox	-	7
43. Allethrin	-	2
44. Etofenprox	-	7
45. Phenothrin	-	2
46. Kresoxim Methyl	-	1
47. Fenpyroximate	-	1