GemmaCert

Analyzing with GemmaCert

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1. Introduction

This paper outlines cannabis analysis using GemmaCert best practices and limitations. This paper does not brief on GemmaCert App use; for that please refer to GemmaCert Quick Reference. Readers are also advised to refer to Customer Portal for troubleshooting instructions.

Limitations are gradually reduced as GemmaCert continues enhancing its database and algorithms. Readers are advised to check Customer Portal for newer document versions.

2. Applicability

GemmaCert applicability is defined along 3 sample characteristics:

- Type
- Maturity
- Moisture

2.1 Sample type

GemmaCert presently analyses 3 sample types:

- Intact flower
- Ground matter
- Extract produced using Ethanol extraction

GemmaCert users have experimented analyses of concentrates produced by other than Ethanol extraction methods. Some have reported satisfactory results, e.g. for hashish. GemmaCert appreciates customer creativity and is glad to engage with inquisitive users to explore applicability. However, performance for concentrates produced by other methods is not warranted at this time.

2.2 Sample maturity

Sample maturity here refers to inflorescence age. Therefore, this characteristic applies to Intact flower and Ground matter only.

GemmaCert presently analyses THC and CBD only. Both cannabinoids are products of CBG conversion, commencing at the beginning of flowering, about 2 weeks after flower induction. GemmaCert does not yet analyse CBG. Therefore, analysis of younger plants is likely to produce erroneous results.

Growers cultivating products under legal THC content regulations may seek appraisal of potential THC content at maturity. To this end GemmaCert recommends starting analyses at the beginning of the flowering stage, usually about 10-14 days after flower induction. Note that at this stage, in which trichomes are developed and cannabinoid synthesis begins, there is a high turnover of CBG into THC and CBD and all concentrations are very low. Therefore, THC reading at this stage may represent also CBG results, causing inaccurate THC appraisal. CBD reading at this stage is accurate.

THC to CBD content ratio depends on plant genetics and varies little over plant maturation. Hence growers may rely on CBD reading to appraise expected THC content, provided they know cultivars' THC to CBD ratio.

THC reading inaccuracy occurs only in the early stage of flowering and is resolved few weeks after flowering and before harvest.

2.3 Sample moisture

High water content obstructs analysis accuracy. Very high water content of undried material will pollute the device and might result in irreversible damage.

For accurate results GemmaCert recommends analysing safe-to-store samples, i.e. samples with water content below 12%.

GemmaCert is validating Moisture and Water Activity analyses. Relying on those your app will soon be able to alert on excessive water content, causing the sample to be unsafe to store and to be susceptible to mold contaminations.

3. Batch & Representation

Discussion below does not address regulatory obligations. Regulators in various geographies have specified sampling procedures and number of mandatory samples per lot or weight. GemmaCert users subject to regulatory obligations should refer to these sampling procedures.

GemmaCert may be used to appraise a particular flower. More likely GemmaCert is used to characterize a cannabis batch along the supply chain. Batch characterization comprises estimation of batch attributes' average and optionally variance; presently those apply to Total THC and Total CBD. Thus, it is worth discussing what constitutes a batch and how many samples need to be analysed to characterize a batch.

Batch dimensions are driven upwards by effort & cost of maintaining many batches and driven downwards by average turning meaningless when batch comprises very heterogeneous specimen.

With GemmaCert one may analyse many more samples than relying on analytical/chemical lab. This allows segmenting harvest into multiple batches, thus achieving more homogeneous batches and consequently more representative average appraisal. Yet the logistics effort of maintaining multiple batches and recording their respective results would turn a burden.

At the other extreme, turning entire harvest into a single batch would turn batch average values meaningless, unable to predict what will a regulator or a business counterpart find randomly selecting specimen for analysis.

Neither A nor B in figure above are absolute. B is subject to operators' costs structure, while A is product of crop variability and average accuracy targets. Operators' objective is segmentation in batches satisfying average accuracy requirements with sustainable effort, i.e. number of batches between A & B in the chart above.

This discourse may not evade statistics any longer, so here it is in brief. Number of samples to estimate average at required confidence level, appraising population with certain variability is expressed in formula below.

$$n = \left(\frac{(z_{\alpha/2})(\sigma)}{E}\right)^2$$

Where:

- n denotes number of samples
- Z expresses required confidence level, e.g. 1.96 for 95% confidence
- σ denotes standard deviation of the sampled material, e.g. prior experience showing that 95% of analyzed samples are within 12% to 20% THC means σ=2
- E denotes margin of error

Reader need not apply this formula. There are printed and online sources providing number of samples tables, which one may refer to instead. The formula helps explaining the rationale of segmentation into batches. Consider this example:

- Grower desires to appraise crop average at 95% confidence with margin of error 1
- Analyses in past seasons have produced THC values of 8% to 24%, likely attributing to differences between bottom, middle and top of plant, i.e. σ=4 (95% of normally distributed samples are with ±2σ)
- Using the formula above, analyzing the entire crop as a single batch would mandate 64 samples.
- Alternatively, grower could attempt segmenting crop into bottom, middle and top of plant batches. That wouldn't be perfect, yet would yield far more homogeneous batches, possibly with σ=2
- With these 3 batches in mind number of samples for each would turn 16, hence 48 samples in total.

The example above shows that in some cases segmenting into more batches provides economies – 48 analyzed samples instead of 64, while achieving equivalent accuracy.

Segmentation into more batches is driven also by another rationale – that of avoiding embarrassment and potentially adverse effects on one's business by regulator or a business counterpart finding specimen far-off the declared average.

Segmentation into batches is a learning process. One should start specifying as many batches as one can handle. Batch could be determined by cultivar variety, location in the lot, height on the plant, cultivation protocol or any combination of these. Some growers using GemmaCert are already identifying their samples by height on the plant. Good start, yet possibly not adequate.

Initial segmentation into batches need not be followed through harvest. Analyses made pre-harvest may show that some batches are similar, hence may be merged.

Batch attributes learned in one season will serve segmentation in next season, particularly where location in the lot comes into play. Thus, one may expect number of analyzed samples decrease from season to season, as experience accumulates. Alternatively, one may exploit experience to boost accuracy, e.g. starting with 90% confidence and improving to 95% in next season.

GemmaCert Customer Portal offers batch analysis tools. Users may also rearrange batches through Customer Portal, e.g. merge similar batches.

4. Sample Preparation

Good result depends on sample preparation done by the following steps-

- Drying
- Trimming
- Grinding

4.1 Drying Sample

Drying sample distinguishes between the two- before and harvest.

Before harvesting you are advised to use our wet flower testing protocol. In case it is after harvest we recommend proper curing, process both resulting in a dried sample with under than 12% moisture.

A whole plant dries within 24 hours to reach about 15% moisture when spread evenly to a depth of approximately 6 inches (15 cm) at 105˚F (40˚C). If hung to dry at 86˚F (30˚C), 15% moisture is achieved in 36 hours. Fresh flowers, stored in paper bags at 70˚F (21˚C) and 40% humidity, will reach about 11% moisture in 5 days.

Therefore, we recommend a semi-air-drying protocol for reliable and quick results:

1. Cut flower buds into a few chunks (do not shred!) and place or wrap in a paper bag.
2. Place the paper bag in a relatively warm place with a temperature of about 86˚F (about 30˚C).
3. If an incubator is unavailable, place the paper bag next to a heater on low temperature or even on top of low heat dissipating appliance such as a TV.
4. The buds should be dry in 24 hours and ready for potency analysis by GemmaCert.

Warnings:

1. Avoid exposing the flowers during the drying process to temperatures which exceed 150F° (65˚C), as it may cause decarboxylation of cannabinoid acids and lead to an inaccurate measurement.
2. Avoid humidity of the surrounding exceeding 50%, as it may harm the drying process.

4.2 Trimming Sample

Leaves should be trimmed as much as possible from the stem prior to GemmaCert analysis. Trimming the flower prior to analyzing in device can result in better identification of the trichomes on the flower that later will translated to spectra of the same flower.

4.3 Grinding Sample

Best way to grind flower is manually with a simple grinder like ‘volcano grinder’ from “storz-bickel” manufacturer.

GemmaCert does not recommend use of electrical grinders, as these are likely to break trichomes, spreading their sticky contents on grinder walls. The likely outcome is reduced cannabinoid contents readings.

Figure 1 – Manual Grinders

When grinding the flower make sure to remove branches and seeds, as these will effect in erroneous results.

Do not grind into powder, three rotations with the grinder are enough for optimal mass.

Note that aging commences following grinding, resulting in cannabinoids decomposition. Therefore, analysis shortly after grinding is recommended.

5. Analysis

For optimal analysis condition we should make sure to follow these guidelines-

- Environment
- Sample identification, usefulness of optional fields
- Repetitions

5.1 Environment

Device must be placed on a stable horizontal surface with no environmental interference. Device sensitivity to vibrations mandate placing device with no other equipment nearby. Device proximity to compressors, air-conditioners and other vibrating machinery must be avoided. Device placed on table or counter standing on a wooden floor may experience shock produced by steps on the floor.

5.2 Sample Identification

GemmaCert recommends practicing a consistent sample identification and description procedure. To this end smartphone app allows optional entry of Supplier, Variety, Batch and Comments. GemmaCert does not mandate any specific syntax or notation of these fields; users are free to choose any.

Users practicing repeated analyses of same sample, comparison between GemmaCert and some lab results or serving analyses to other parties will do best implementing unique sample identification, independent of FlowerID maintained by GemmaCert. Comments field could serve sample identification.

GemmaCert recommends placing every flower in a dedicated container and attaching a barcode bearing that flower identification to the container. Installing barcode reader software on the smartphone will allow error-free feeding sample identification into the app.

Batch identification is prerequisite to any statistical analysis using Customer Portal. Supplier and Variety fields may serve input for aftermath modification sample belonging to a Batch. Growers may use Supplier field for any other purpose, e.g. to identify lot.

GemmaCert analysis does not use any of these fields. They are there entirely to serve users in any customized manner they favor.

5.3 Analysis Repetitions

Averaging across repeated analyses of a sample will produce superior accuracy. Users pursuing superior accuracy need to conduct five analysis repetitions at least, rotating the analyzed flower between repetitions.

Spectrometer embedded in GemmaCert device illuminates samples to measure their light absorbance and subsequently derive composition attributes from measured absorbance. This illumination does not decarboxylate the samples and does not produce any other irreversible effects. Illumination does warm-up the samples slightly and this temperature increase affects spectra.

Therefore, conducting repeated analyses of the same sample, as recommended above, one must let the sample cool for about 10 minutes between consecutive analyses.

6. Results Interpretation

6.1 Results

GemmaCert presently produces Total THC and Total CBD results. These totals represent expected THC & CBD contents upon consumption, i.e. in fully decarboxylated product. Results assume 0.877 conversion ratio from the acid from of THCA and CBDA into the active form of THCΔ9 and CBD, respectively. Accordingly, totals are calculated as percentages of total weight using formula below.

%Total THC =0.877× (%THCA) + (%Δ9THC)

%Total CBD=0.877× (%CBDA) + (%CBD)

Note that some cannabis products on the market misstate totals as plain summation, disregarding conversion ratio.

GemmaCert results rely on Reference data produced by HPLC analyses. To this end GemmaCert maintains an in-house ISO-certified analytical lab.

Note that GemmaCert results are percentages of total weight whereas HPLC results are percentages of dry weight, details in chapter below.

GemmaCert is presently validating Moisture model. Upon completion percentage of dry weight will become available as well.

6.2 Dry weight versus Total weight

Labs serving the cannabis industry mostly use HPLC, producing results as percentages of dry weight. GemmaCert produces results as percentages of total weight. Total weight has value in commercial transactions, where buyer is interested in THC and CBD content in the material procured. Dry weight would be of interest as well, providing base for comparison with lab results.

GemmaCert will soon deliver both. In the meantime, rule of thumb for comparing dry and total weight results could be useful.

Moisture content of properly dried cannabis flowers ranges from 4% to 12%. Below 4% cannabis flowers are too fragile, breaking into small pieces. Above 12% cannabis flowers eventually develop mold. For the sake of this discussion let us assume moisture content at the median value of 8%. Under this assumption GemmaCert results should be divided by 0.92 for comparison with lab results produced by HPLC.

Users in possession of moisture analyzers can apply more accurate scaling for comparison of GemmaCert results with dry weight results. Moisture analyzers destroy analyzed samples; devices implementing LOD (Loss On Drying) and implementing Karl Fischer method do not differ in this respect – both make analyzed samples not available for any further analysis. Consequently, user willing to apply the scaling will measure moisture of one sample and apply it to another sample. Caution must be practiced here – the two flowers may not contain identical moisture. Flowers kept for many days in same closed container, not exposed to sunlight or any heat source, may be assumed to contain practically identical moisture. Flowers dried using rapid procedure and analyzed shortly after drying may differ in moisture content substantially.

6.3 Batch analysis in Customer Portal

GemmaCert Customer Portal provides several functions for batch statistical analysis and graphical display. These functions can be used to track batch growth progress, analyze plant maturity, and determine batch homogeneity and assist in planning towards next season.

Results, listed in Customer Portal, may be exported to excel for further analysis using tools of user's choice.

Results may be filtered by Batch and analysed in Batch Details form providing statistical data for both THC and CBD values. Figure below depicts batch statistics display.

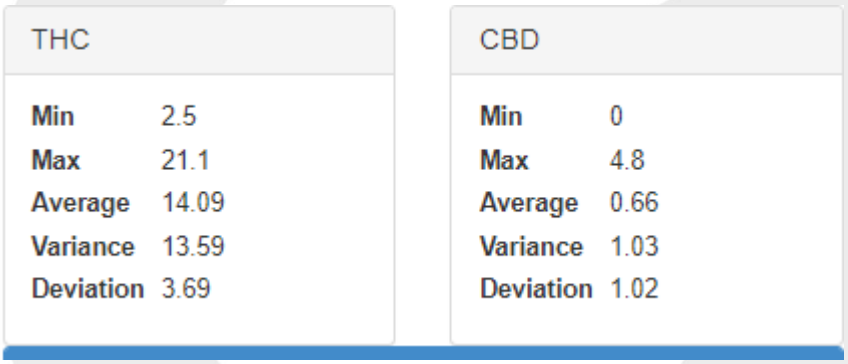

Figure 2 – Batch Statistics in Customer Portal

High variance and deviation in figure above indicate a heterogenous batch, worth segmenting into few batches. Conversely, low variance and deviation indicate homogeneous batches, worth merging.

Batches may be segmented or merged as desired by editing the "Batch" field. To this end it is advisable to type in additional information about analysed at Supplier, Variety & Comments sample description fields of the app. Detail entered at these field will help segmenting batch as an aftermath action.

Batch details analysis also produces a graphical plot of CBD/THC ratio providing further insight to the batch heterogeneity.

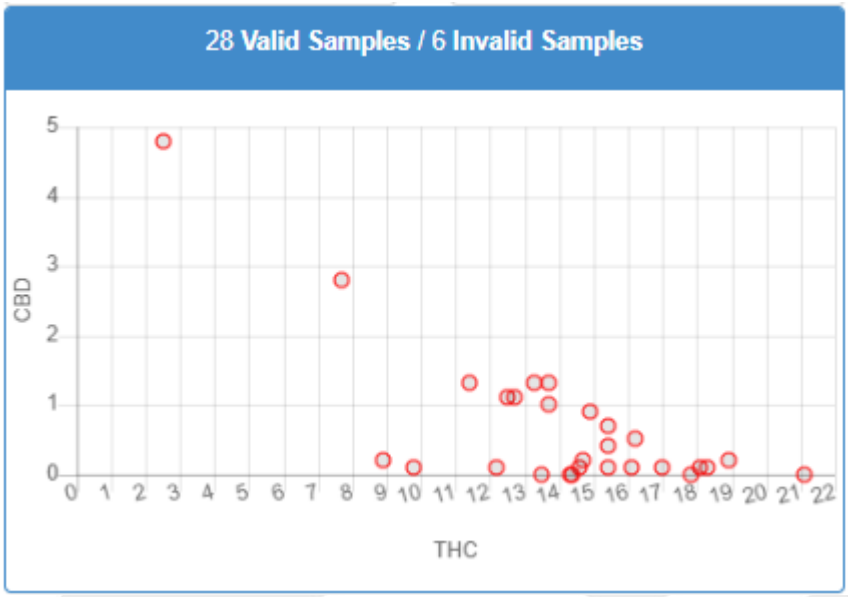

Figure 3 – Batch Composition in Customer Portal

GemmaCert Customer Portal also provides batch Progress Growth Chart that can assist in the analysis of plant maturation; see figure below.

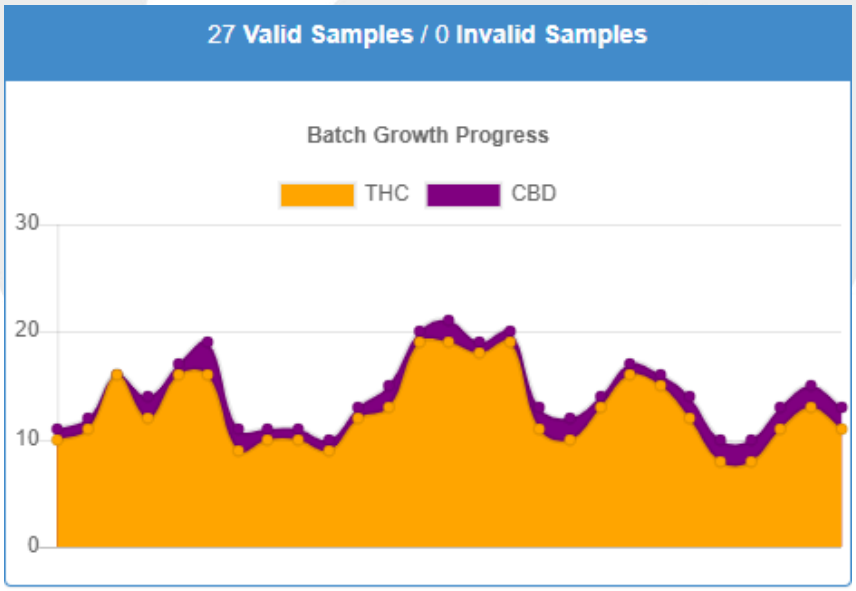

Figure 4 – Batch Evolution in Customer Portal

Figure above is an example of incorrect batch segmentation. Evidently, such increase and subsequent decrease of cannabinoid content can be explained only by analysing very different samples as one batch.