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Determination of Cannabis Extract Potency Degradation Mechanism and Rate by Infrared Spectroscopy

Cannabis extracts lose potency over time with a half-life of 7.9 months, which can lead to mislabeled products that may put consumers at risk.

Introduction

Cannabis extracts are medicine and should be tested like medicine. The United States Food and Drug Administration (USFDA) has long required stability testing of potential new drugs [1]. This testing insures that drug products meets potency label claims and are safe for consumers to use.

We know that tetrahydrocannabinolic acid (THCA) is thermally unstable since cannabis buds and extracts are heated to generate tetrahydrocannabinol (THC). It has been stated in the literature that cannabis extracts lose potency over time[2]. However, to date it appears no work has been published on that determines the stability of cannabis extract potency.

We have investigated the rate and mechanism of cannabis extract potency loss using a novel mid-infrared spectrometer. We have discovered that cannabis extracts lose potency via a “first order” rate mechanism. First order reactions are characterized by a half-life- the amount of time it takes half the sample to degrade. For total THC in cannabis extracts the half-life is 7.9 months. The implications of this for the manufacture and sale of cannabis extracts and consumer safety are discussed.

Experimental

7 samples of cannabis extracts were purchased from a local dispensary. Their weight percent total THC values (potencies) were measured using High Pressure Liquid Chromatography (HPLC) by SC Labs of Santa Cruz CA. Total THC was monitored instead of THCA or THC by themselves since both cannabinoids contribute to the potency of extracts. Mid-infrared spectra of the extracts were measured in triplicate using the BSS 2000 Cannabis Analyzer from Big Sur Scientific of Capitola CA. The BSS 2000 is a small, lightweight mid-infrared spectrometer capable of measuring the spectra of solids and liquids non-destructively., including cannabis buds and extracts. Analysis time is about 2 minutes per sample.

The spectra and measured potencies were used to construct a predictive multivariate mathematical model using the Partial Least Squares (PLS) algorithm[3]. The model was built using The Unscrambler software V10.4.1 from CAMO Software of Oslo, Norway. The samples were stored in their original packaging in a cool, dark, dry place for 6.9 months. After this their infrared spectra were measured again.

Results and Discussion

The first step was to calibrate the BSS 2000 to measure total THC in extracts. This was done by taking the spectra of the seven fresh extract samples in triplicate, the total THC values as determined by HPLC, and creating a predictive multivariate PLS model. A measure of the predictive ability of these models is the linearity of the actual versus predicted plot[3]. Such a plot of total THC as measured by HPLC on the x-axis versus as predicted by the BSS 2000 on the y-axis is seen in Figure 1. This plot is for a cross-validation, where the sample being predicted is left out of the calibration.

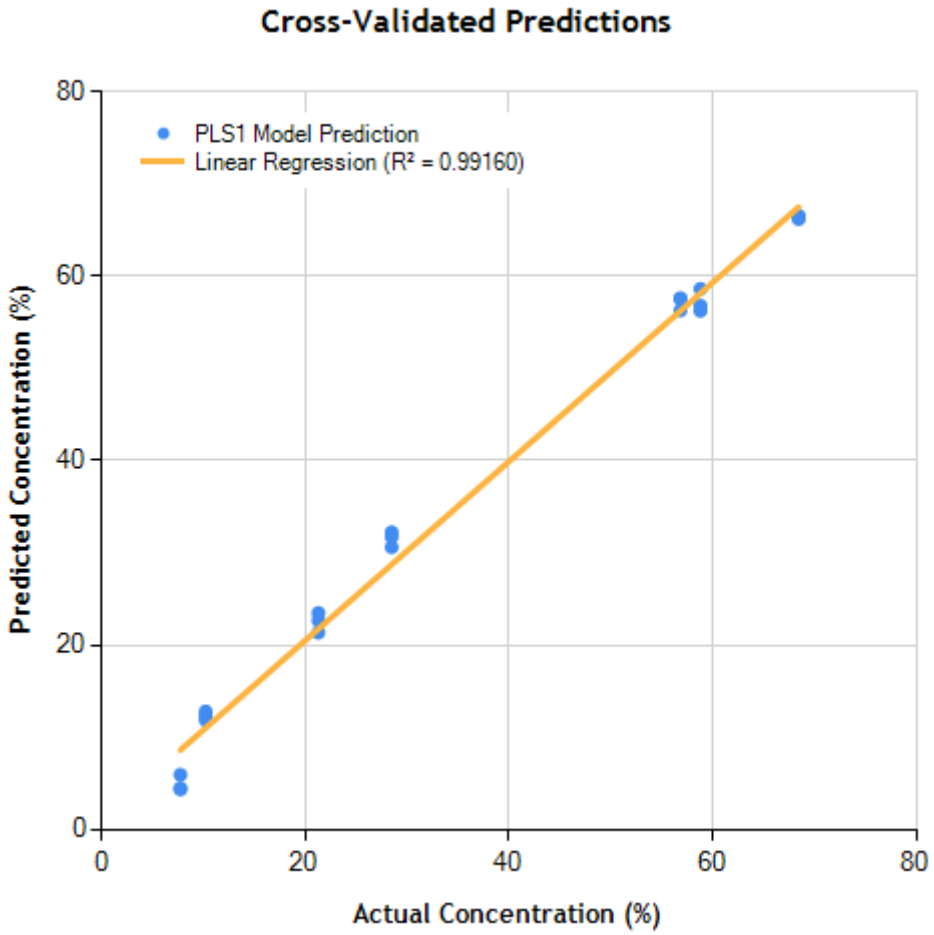

Figure 1 A plot of total THC as determined by HPLC on the x-axis versus as predicted by the BSS 2000 Cannabis Analyzer on the y-axis.

The correlation coefficient in Figure 1 is better than 0.99, indicating an excellent model. The cross-validation standard error of prediction[3], a measure of the model's predictive accuracy, is ±2 weight percent total THC, indicating the BSS 2000 is useful for predicting total THC values in extracts. After the cannabis extract samples were aged for 6.9 months their spectra were remeasured, the PLS model was applied to the spectra, the total THC weight percent was predicted, and the potency degradation rate was calculated.

In the field of chemical kinetics, for what is known as a first order chemical reaction a plot of the rate of degradation versus initial concentration produces a straight line[4]. Such a plot for cannabis extract potency is seen in Figure 2.

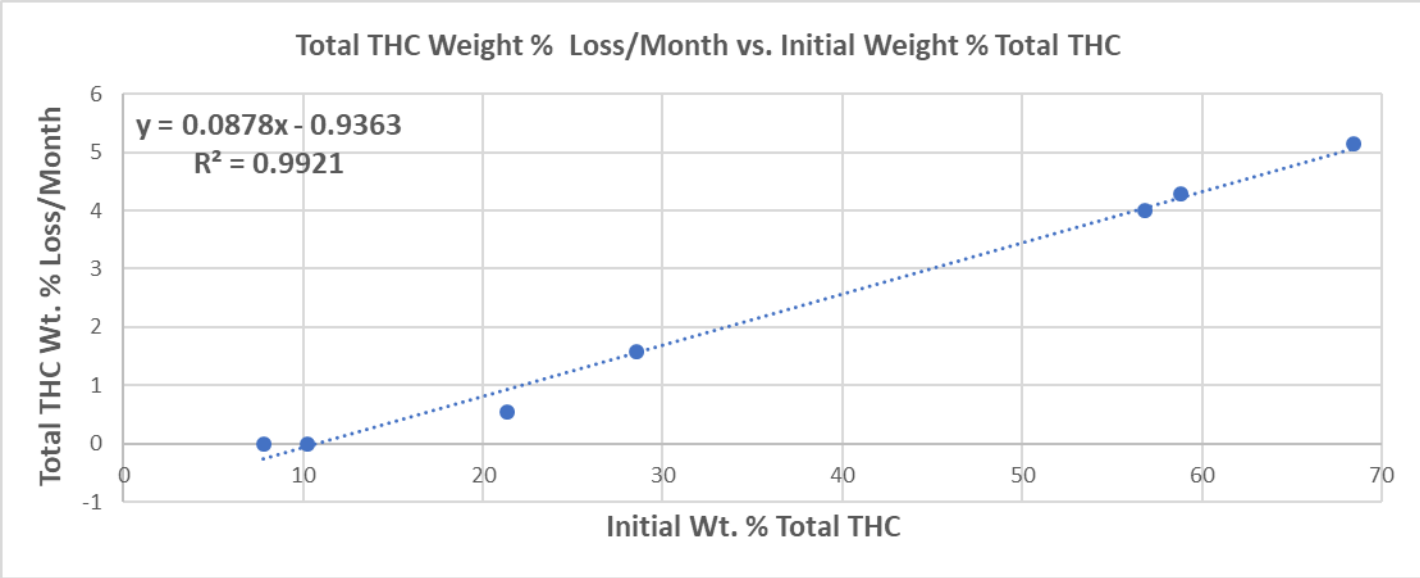

Figure 2 A plot of total THC degradation rate versus initial total THC concentration for a collection of 7 cannabis extract samples.

Note in Figure 2 that the correlation coefficient for this plot is 0.992, indicating the cannabis extract potency degradation mechanism is first order and thus follows this reaction mechanism[4].

Total THC **=>** Reaction Products

Many processes, including radioactive decay, follow a first order mechanism.

First order reactions are characterized by a half-life, which is the amount of time it takes for half the material to decay. Note from Figure 2 that the slope of the line is 0.0878, which is called the reaction rate constant, k. It is known[4] that he half-life of a reactant, $T_{1/2}$, can be determined from the rate constant using this equation:

$$T_{1/2} = 0.693/k \qquad (1)$$

Thus, the half-life of total THC in cannabis extracts is 7.6 months. This means that any given cannabis extract sample will lose half its potency in this time.

It is also known[4] that the rate constant can be used to calculate the percent of reactant left at any given point in time using this equation:

$$\% \text{ left} = 100(e^{-kt}) \qquad (2)$$

Where

e = the base of natural logarithms

k = rate constant

t = time

A graph showing how the Total THC in an extract with a starting potency of 60% changes over time is seen in Figure 3.

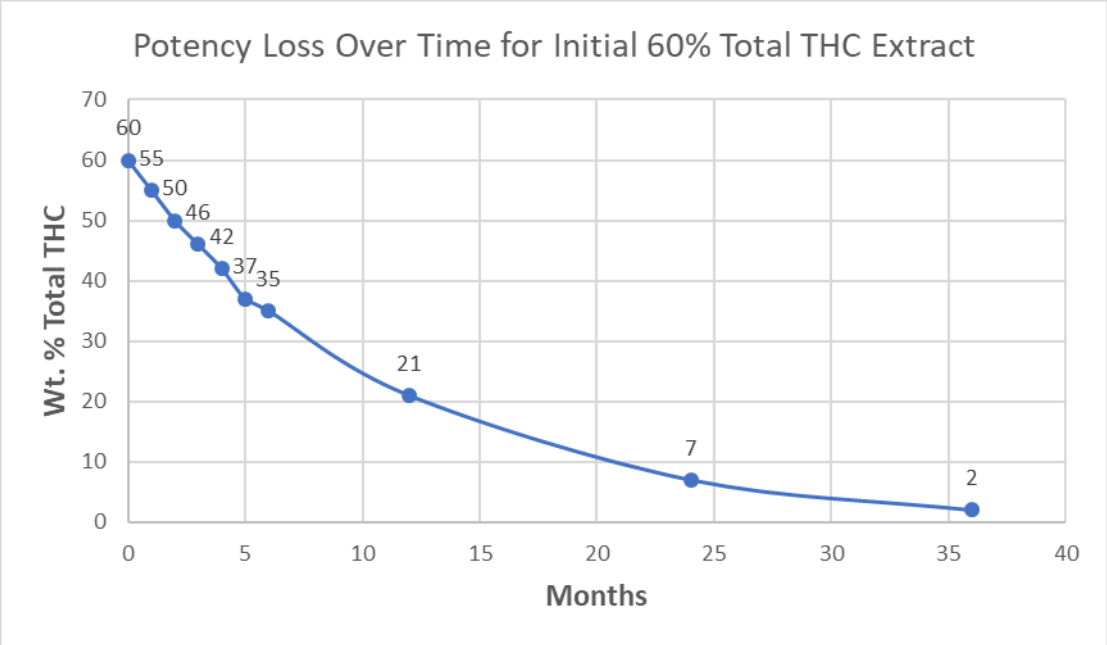

Figure 3 Weight % Total THC left versus time for a 60% starting potency extract.

Figure 3 shows that the potency for an initially 60% potent extract decreases to 55% after 1 month, 46% after 3 months, 35% after 6 months, and 21% after a year.

Conclusions

These results indicate that cannabis extracts lose potency rapidly over time. It is possible that the labels on many cannabis extract products that have been sold or will be sold are incorrect, making it difficult for patients to get the proper dosage of their medicine, and perhaps leading to negative user experiences. To prevent this problem cannabis extracts should be tested for potency at regular intervals from the time they are made until they are sold to an end user. Additionally, sell by and use by dates should be added to cannabis extracts to insure consumer safety.

References

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