THC, THCA, and THC Activation

Tetrahydrocannabinolic Acid (THCA) is found in abundance in growing and harvested cannabis and is a biosynthetic precursor of Tetrahydrocannabinol (THC). THCA is considered to be non-psychoactive, while THC is psychoactive. The difference between the two molecules is the presence of a carboxylic acid group found on THCA, which is not present on THC as seen in Figures 1 and 2. This process of removing this carboxylic acid group, known as "de-carboxylation," (or activation) is a naturally occurring chemical reaction (see Figure 3), the rate of which is greatly increased at higher temperatures (see Figures 5-7). The released carboxylic acid group is converted to CO_2 gas during the process.

Typically, in live plants and fresh plant tissue, the plant synthesizes and stores large amounts THCA. Therefore, fresh plant material has very small trace amounts of THC, usually due to natural chemical breakdown processes and the resulting ratio of THCA/THC molecules is very high in plant tissue (see Figure 4; Turner & Mahlberg 1982; Fetterman et. al. 1971; Kimura & Okamoto 1970). This isn't a problem when smoking or vaping medicine, because hot temperatures will naturally decarboxylate THCA into THC. However, this is not the case with edible medicine. Edible medicine should be decarboxylated, or "activated," before ingesting for maximum potency.

THC activation is a mathematical calculation to determine what percentage of the combined THCA & THC molecules is in the activated THC form. To do this, we use the following equation (Eq.1):

$$THC\ Activation = \frac{THC\ value}{(THC\ value + THCA\ value)}\ X\ 100\%$$

(Eq. 1)

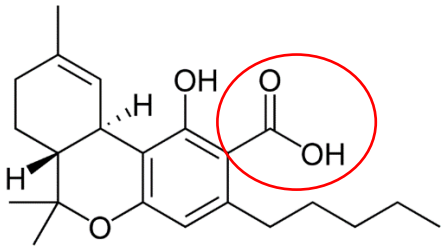

Figure 1: Molecular structure of Tetrahydrocannabinolic Acid (THCA). The carboxylic acid group is circled.

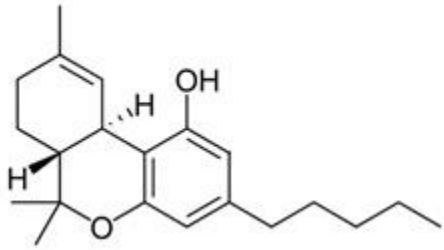

Figure 2: Molecular structure of Tetrahydrocannabinol (THC). Lacking a carboxylic acid group, THC has a different structure than THCA.

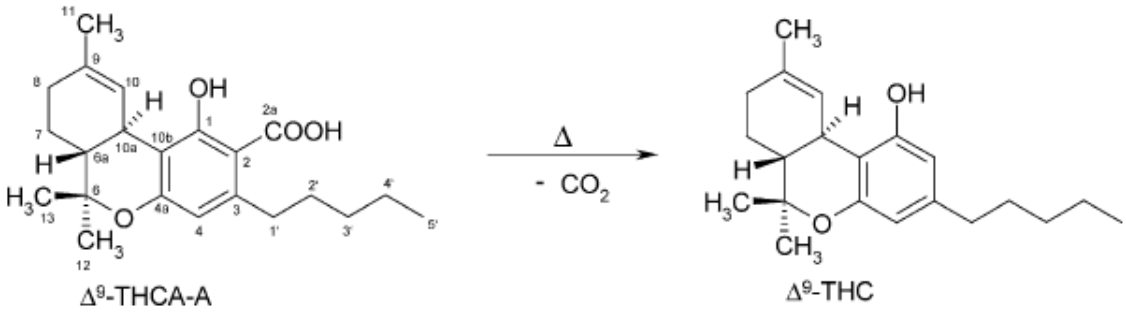

Figure 3: Chemical conversion of THCA into THC (Dussy et al 2005)

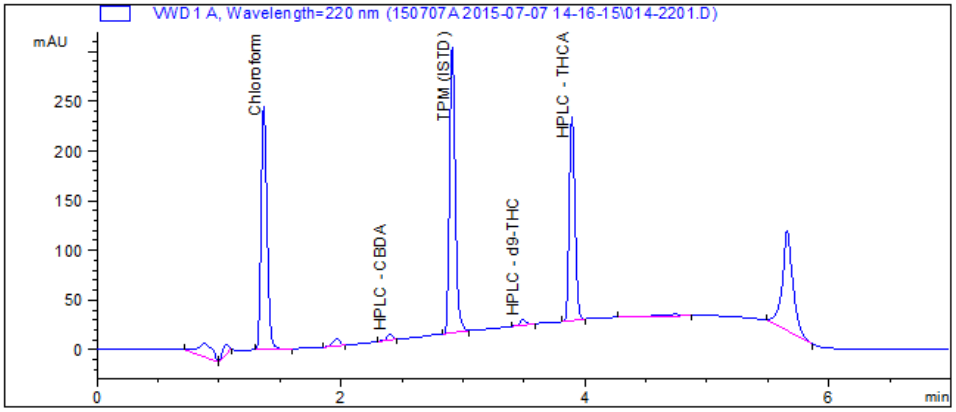

Figure 4: HPLC chromatogram of an unheated flower sample. THCA for this particular flower sample was quantified at 31.5 % (by weight), while THC was 0.98%. The ratio (by weight) of THCA-to-THC is greater than 30-to-1. Data was collected in house at Iron Laboratories.

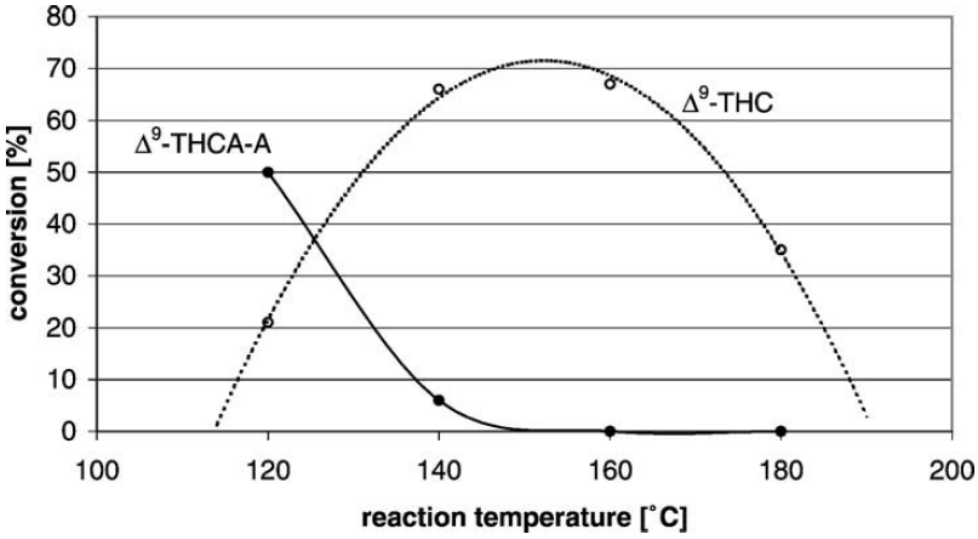

Figure 5: Conversion of THCA into THC (Dussey et al 2005) at varying temperatures.

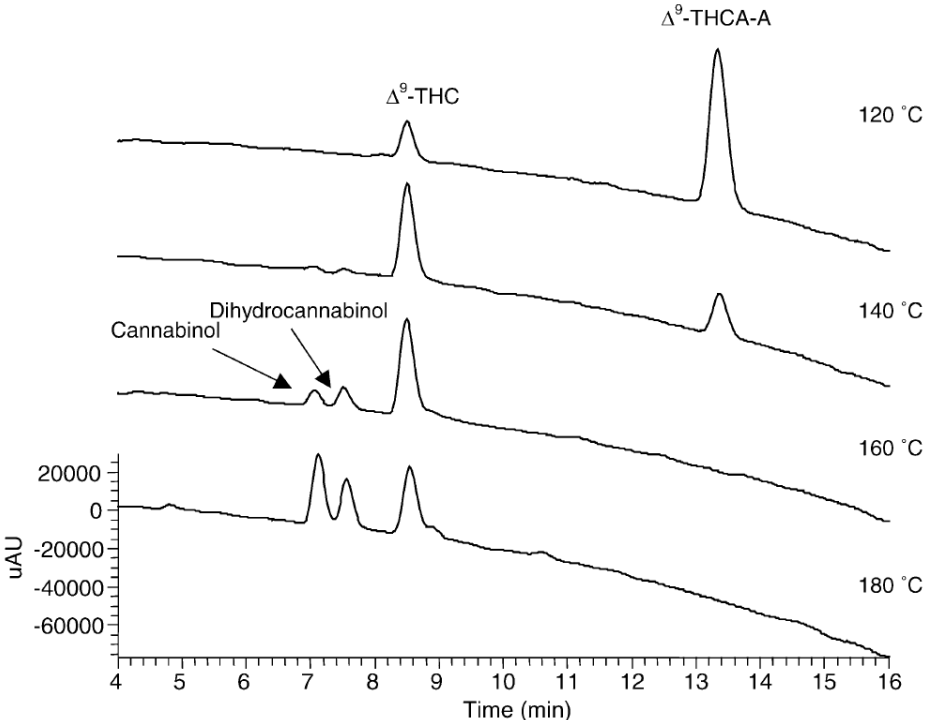

Figure 6: HPLC chromatograms for the conversion of THCA into THC at different temperatures prior to analysis. Each sample was subject to the corresponding temperature for 15 minutes (Dussy et al 2005); the optimum decarboxylation rate in order to limit formation breakdown products (cannabinol = CBN) is reached at around 150 °C in this study.

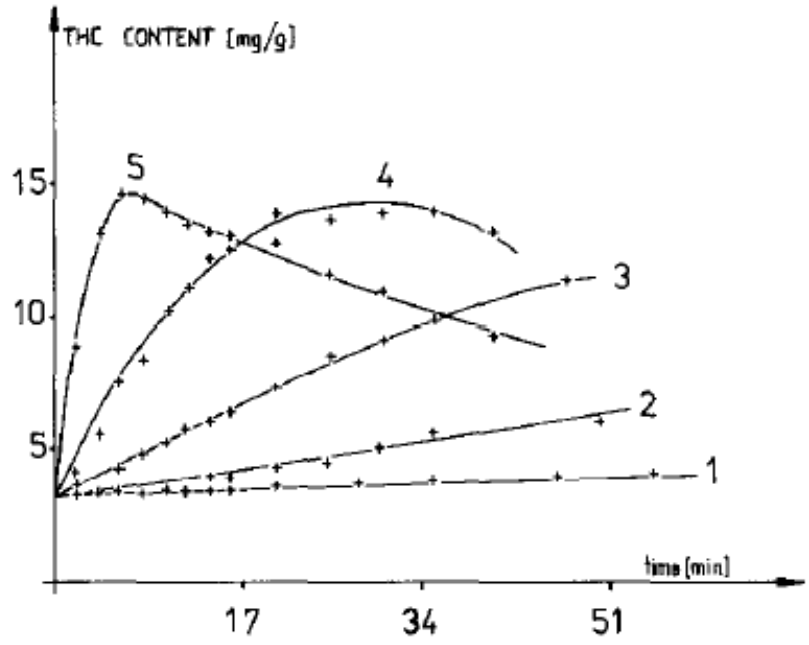

Figure 7: Effect of heating time an temperature on the THC content of an n-hexane extract after heating on a glass surface in an open reactor. Curves: 1 = 80 °C; 2 = 94 °C; 3 = 106 °C; 4 = 122 °C; 5 = 145 °C (Veress et al 1990).

References:

Dussy, F. E., Hamberg, C., Luginbühl, M., Schwerzmann, T., & Briellmann, T. A. (2005). Isolation of Δ9-THCA-A from hemp and analytical aspects concerning the determination of Δ9-THC in cannabis products. *Forensic Science International*, *149*(1), 3–10.

Fetterman, P. S., Doorenbos, N. J., Keith, E. S., & Quimby, M. W. (1971). A simple gas liquid chromatography procedure for determination of cannabinoidic acids in Cannabis sativa L. Experientia, 27(8), 988–990.

Kimura, M., & Okamoto, K. (1970). Distribution of tetrahydrocannabinolic acid in fresh wild cannabis. Experientia, 26(8), 819–820.

Turner, J. C., & Mahlberg, P. G. (1982). Simple high-performance liquid chromatographic method for separating acidic and neutral cannabinoids in cannabis sativa L. Journal of Chromatography A, 253, 295–303.

Veress, T., Szanto, J. I., & Leisztner, L. (1990). Determination of cannabinoid acids by high-performance liquid chromatography of their neutral derivatives formed by thermal decarboxylation: I. Study of the decarboxylation process in open reactors. *Journal of Chromatography A, 520*, 339–347.