# CHIRAL ANALYSIS OF THUJONE IN ESSENTIAL OIL SAMPLES

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Thujone is a natural product present in several common plants, such as sage, cedar leaf, and wormwood.[1] Thujone is a neurotoxin that can cause serious health complications in high concentrations, with different stereoisomers having different levels of toxicity.[1] This work extends on previous work to analyze thujone by molecular spectroscopy,[2-3] and presents new efforts to determine the enantiomeric excess (ee) of the alpha- and beta-thujone in several essential oil (EO) samples by chiral tagging. There are four stereoisomers of thujone which arise from the different orientation of the methyl and isopropyl group on the bicyclo[3,1,0]hexan-3-one structure. Alpha-thujone has the methyl and isopropyl group trans and beta-thujone has the two groups cis. Each of these diastereomers have three conformers from the rotational of the isopropyl group. Of the three conformers, all three of alpha-thujone and the lowest two of beta-thujone were observed experimentally. In order to determine the enantiomeric excess of alpha- and beta-thujone in various samples, the homochiral and heterochiral complexes with propylene oxide were assigned using quantum chemistry calculations at the B3LYP D3BJ / def2tzvp level of theory. There was $^{13}$C-level sensitivity to determine carbon framework structures of the strongest homochiral and heterochiral complex of alpha-thujone. Several sage and cedar leaf essential oils were analyzed. There was high enantiopurity of alpha- and beta-thujone in all samples. Additionally, we were able to determine the ee of fenchone, which is present in in cedar leaf EO samples, and camphor, which is present in opposite enantiopurity in sage and cedar leaf.[4]

[1] Williams, J. D. et al. (2016). Detection of the Previously Unobserved Stereoisomers of Thujone in the Essential Oil and Consumable Products of Sage (Salvia officinalis L.) Using Headspace Solid-Phase Microextraction-Gas Chromatography-Mass Spectrometry. Journal of Agricultural and Food Chemistry, 64(21), 4319-4326. [2] Kisiel, Z.; Legon, A.C. (1978). Conformations of Some Bicyclic Monoterpenes Based on Bicyclo[3.1.0]hexane from Their Low-Resolution Microwave Spectra. Journal of the American Chemical Society, 100, 8166-8169. [3] Kisiel, Z. Chirped pulse rotational spectroscopy of a single thujone+water sample. In International Symposium of Molecular Spectroscopy, http://hdl.handle.net/2142/91165: 2016. [4] Tateo, F. et al. (1999). Update on enantiomeric composition of (1R)-(+)- and (1S)-(-)-camphor in essential oils by enantioselective gas chromatography. Anal. Commun., 36, 149-151.