

(D/H) Isotopic Fractionation by Anisotropic NAD 2D-NMR Spectroscopy: Exploiting the Analytical Wealth of Oriented Solvents to Investigate Molecules of Interest

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The deuterium/hydrogen (D/H); ratio measurement by quantitative $^2\text{H}\{-^1\text{H}\}$ NMR spectroscopy is a method of choice in numerous analytical fields such as the study of biosynthetic pathway or kinetic isotopic effects associated with enzyme-catalyzed reaction, the determination of botanical or geographical origin of biocompounds, and last but not least, the authentication of molecules in the frame of the fight against counterfeiting[1,2].

As the solvent used in the « SNIF-NMR » protocol is both isotropic (liquid) and achiral, the efficiency of the current protocols is basically limited for two reasons : i) the small ^2H chemical shift dispersion of deuterium nuclei (expressed in Hz); ii) the impossibility of spectrally discriminating enantiotopic sites (methylene pro stereogenic sites) in prochiral molecules or enantiomers of chiral molecules, hence precluding the quantification of isotopic fractionation on methylene pro stereogenic sites or mirror-image isomers[3].

To overcome these drawbacks, the natural abundance deuterium bidimensional NMR (NAD 2D-NMR) using chiral oriented phases is a powerful way to separate deuterium signals of monodeutero-isotopomers on the basis of the quadrupolar interaction, not longer averaged to zero as in isotropic NMR. The distribution of quadrupolar doublets on the 2D maps significantly facilitates the analysis of overcrowded NAD 1D-NMR spectra obtained in liquid state, thus providing a real original and robust approach to classical tool[2-5].

To illustrate the analytical potential of the method, various illustrative examples of (pro)chiral molecules of interest are presented. Among them, the case of miliacin of a triterpenic chiral molecular biomarker found in sedimentary archives is examined[6,7]. Among perspectives, this approach has the potential to permit predicting isotopic natural fractionations during pentacyclic triterpene diagenesis.

References:

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