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SHORT COMMUNICATION

A GENERAL NMR PROCEDURE FOR LOCATING METHOXYL GROUPS IN ALL FLAVONE AND FLAVONOL AGLYCONES AND SOME GLYCOSIDES UTILIZING TRIMETHYLSILYL ETHERS AND BENZENE-INDUCED SHIFTS

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Abstract—All flavonoids are readily converted to their trimethylsilyl ethers and in this form their NMR spectra can be recorded in both CCl_4 and benzene Both methoxyl and trimethylsilyl groups at certain positions show diagnostic benzene-induced resonance shifts

ALTHOUGH it is well established[1-3] that benzene-induced shifts (relative to an inert solvent such as CCl_4) of methoxyl resonances in methoxylated flavones and flavonol aglycones are diagnostic for methoxyl groups at certain positions, the method has not found widespread application among natural flavonoids, since most occur as glycosides which are insoluble in CCl_4 and benzene. Indeed, some workers[4] have noted that the benzene-induced shifts could not even be employed for some aglycones because of solubility problems. We[5,6] and others[7] have previously emphasized the value of preparing trimethylsilyl ethers of both flavonoid aglycones and glycosides for NMR analyses in CCl_4 These same ethers are also ideal derivatives for locating certain methoxyl groups in all flavone and flavonol aglycones and glycosides* utilizing benzene-induced shifts. In addition, when an *O*-trimethylsilyl group is at C_5, it also exhibits a diagnostic benzene-induced shift and, furthermore, in benzene all the signals for the *O*-trimethylsilyl groups are well separated thus permitting the determination of the number of hydroxyl groups present in the flavonoid before trimethylsilylation.

The data below summarize the benzene shifts observed in the present study for some 20 trimethylsilylated-methoxylated flavones and flavonols·

Positions of methoxyl groups	Ranges of Δ value (δ CCl_4–δC_6D_6 ppm)
3′, 4′, 2′, 7*	+0·35 to +0·70 ppm
3, 6, 8	0 0 to +0·18 ppm

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* For trimethylsilylated 3-*O*-glycosides, B-ring methoxyl groups (checked only for a series of 3′-methoxylated compounds) do not exhibit shifts, thus, in these compounds, distinguishing B-ring methoxylation from 7-methoxyl groups

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[3] D L DREYER, *J Org Chem* **33**, 3577 (1968)

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[6] T J MABRY, K R MARKHAM and M B THOMAS, *The Systematic Identification of Flavonoids*, Springer Verlag, New York-Heidelberg (1970)

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Positions of O-trimethylsilyl groups

5	−0·14 to −0 20 ppm
3, 6, 7, 8, 2′, 3′, 4′	−0 05 to +0 12 ppm
glycosyl	0 00 to +0 10 ppm

Detailed shifts for four representative examples are presented in Fig 1

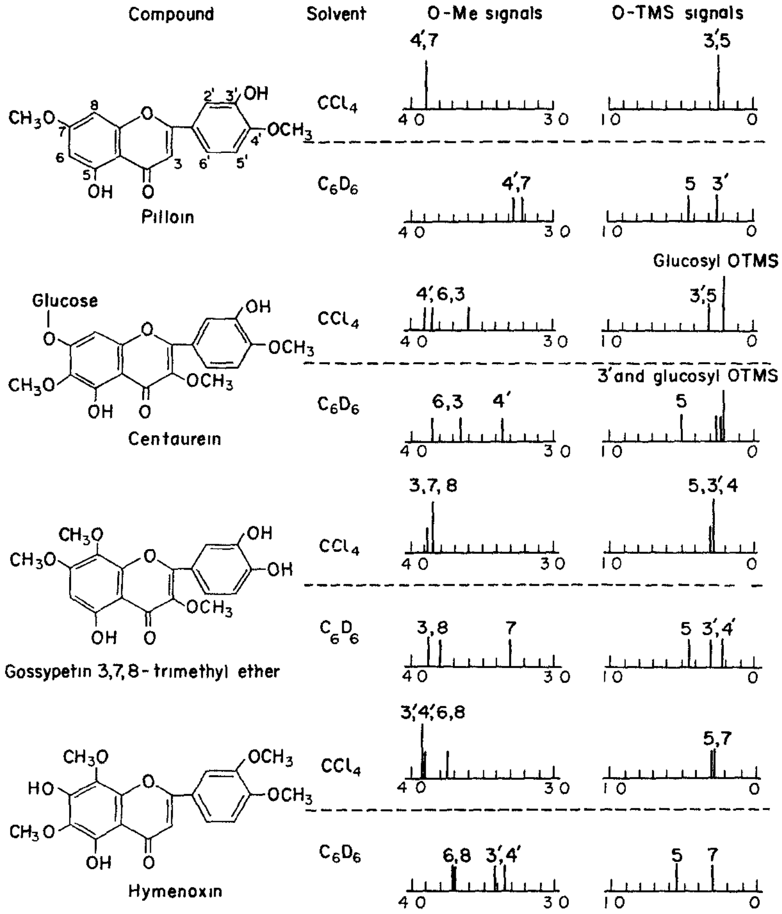

FIG 1 BENZENE-INDUCED NMR RESONANCE SHIFTS (RELATIVE TO CCl_4) OF METHOXYL AND TRIMETHYLSILYL GROUPS IN FOUR REPRESENTATIVE TRIMETHYLSILYLATED METHOXYLATED FLAVONES AND FLAVONOLS

EXPERIMENTAL

All spectra were recorded on a Varian A-60 Spectrometer, and values are given ppm relative to internal tetramethylsilane as reference The preparation of all the trimethylsilyl ethers were carried out by standard procedures [6]

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Key Word Index—Flavones, flavonols, methoxyl group location, NMR, benzene shifts