Communications to the Editor

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DETERMINATION OF C-6 OR C-8 SUBSTITUTED FLAVANONE USING ^{13}C-^{1}H LONG RANGE COUPLING AND THE REVISED STRUCTURES OF SOME FLAVANONES

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C-6 or C-8 substituted flavanones were determined by methods of chemical and/or ^{1}H-NMR spectral analysis. We report a very convenient method for determining the substituted position of these flavanones using ^{13}C-^{1}H long range coupling. In connection with this study, we revised some structures of flavanones using this technique.

KEYWORDS —— ^{13}C-NMR; gated decoupling with NOE; ^{13}C-^{1}H long range coupling; long range selective proton decoupling (LSPD); sophoraflavanone A; sophoraflavanone B; euchrestaflavanone A; euchrestaflavanone B; euchrestaflavanone C

There are many 5,7-dihydroxyflavanones having 3,3-dimethylallyl (prenyl) or (E)-3,7-dimethyl-2,6-octadienyl (geranyl) side chains at C-6 or C-8. Some techniques have been reported to determine the substituted positions, for instance Gibbs test,[1] anomalous $AlCl_3$ induced UV shift,[2] cyclized reaction,[3] chemical shift of C_5-OH,[4] or vinyl methyl proton signals in the 3,3-dimethylallyl group[5] in the ^{1}H-NMR spectra, and upfield shift of the ^{1}H-NMR spectra about benzyl protons[6] or chromene protons[7] after acetylation of C_5-OH. We also reported the chemical shift in ^{13}C-NMR spectra.[8] But these are not complete techniques, because the position of C-6 and C-8 may be interconverted during the chemical reaction by a Wessely-Moser rearrangement and the chemical reactions require large samples. In the NMR spectrum, the signals of C_6-H and C_8-H or C-6 and C-8 are very close together in 5,7-dihydroxyflavanones.

The signals of C_6-H and C_8-H in naringenin appear at about δ 6.0 ppm in the ^{1}H-NMR spectrum overlapping each other, and in the ^{13}C-NMR spectrum, C-6 appears at about δ 97 ppm and C-8 at about δ 96 ppm (in CD_3COCD_3), very near each other. So it is very difficult to determine the position of the side chain located at C-6 or C-8 in 5,7-dihydroxyflavanones by comparing them with naringenin in the ^{1}H-NMR spectra or by complete decoupling or off-resonance decoupling in the ^{13}C-NMR spectra.

Recently, ^{13}C-^{1}H long range coupling and a technique of long range selective proton decoupling (LSPD) have been reported.[9] These are very useful in determining the substitution pattern of polysubstituted aromatic compounds. Here we describe the structural determination of C-6 or C-8 substituted flavanone using ^{13}C-^{1}H long range coupling, and revise the structures of sophoraflavanone A, B, and euchrestaflavanone A, B and C.

We studied the ^{13}C-^{1}H long range coupling of C-6 and C-8 with C_6-H, C_8-H and

Table I. ^{13}C-NMR Spectral Data and LSPD Experiments for Flavanones (in CD_3COCD_3)

Compounds No.	1		3		5 a)		4 a)		7		9		11		10 b)	
Formula	$C_{15}H_{12}O_5$		$C_{25}H_{28}O_5$		$C_{20}H_{20}O_5$		$C_{20}H_{20}O_5$		$C_{25}H_{28}O_5$		$C_{25}H_{28}O_6$		$C_{25}H_{26}O_6$		$C_{25}H_{26}O_6$	
mp (°C)	248-251		144-145		193-195		209-210		145-147		188-190		198-200		194	
Carbons	6	8	6	8	6	8	6	8	6	8	6	8	6	8	6	8
δ (ppm)	96.8	95.8	96.3	108.3	96.2	108.2	109.0	95.3	96.3	108.2	96.4	108.4	96.3	108.2	109.0	95.3
M	ddd	dd	dd	m	dd	m	m	d	dd	m	dd	m	dd	m	m	d
J (Hz)	161.9 (H_6) 7.3 (C_5-O<u>H</u>) 4.2 (H_8)	164.0 (H_8) 4.2 (H_6)	160.9 (H_6) 7.3 (C_5-O<u>H</u>)		160.9 (H_6) 7.3 (C_5-O<u>H</u>)			163.0 (H_8)	160.9 (H_6) 7.2 (C_5-O<u>H</u>)		159.8 (H_6) 7.3 (C_5-O<u>H</u>)		160.8 (H_6) 7.2 (C_5-O<u>H</u>)			161.9 (H_8)
LSPD of C_5-O<u>H</u>																
M	dd	dd	d	m	d	m	m	d	d	m	d	m	d	m	m	d
J (Hz)	161.9 (H_6) 4.2 (H_8)	164.0 (H_8) 4.2 (H_6)	157.9 (H_6)		160.9 (H_6)			162.5 (H_8)	161.9 (H_6)		159.8 (H_6)		161.9 (H_6)			159.9 (H_8)

a) See ref. 10.
b) See ref. 11.

^1H- and ^{13}C-NMR spectra were obtained on a JEOL JNM GX-270 FT instrument at 25°C, spectral width 4.5 (^1H) and 16 kHz (^{13}C), data points 16 kW, repetition time 6 (^1H) and 2.0-5.0 s (^{13}C), pulse width 10 (^1H) and 4.5 μs (^{13}C) (both 45° pulse), power level for LSPD 5.9 kHz, -35 dB with power attenuator.

δ : downfield from TMS, M : multiplicity, m : unresolved multiplet.

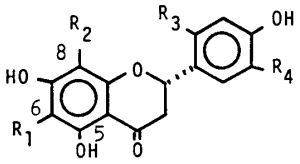
C_5-OH using the techniques of gated decoupling with NOE and LSPD of naringenin (1).

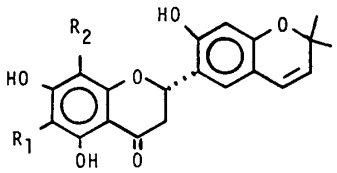
The signal of C-6 at δ 96.8 ppm was a split double double doublet (J=161.9, 7.3, 4.2 Hz) and C-8 at δ 95.8 ppm was a split double doublet (J=164.0, 4.2 Hz). The signal of C-6 was changed into a double doublet (J=161.9, 4.2 Hz) and that of C-8 was not changed after LSPD of C_5-OH. Next, the signal of C-6 was changed into a doublet (J=7.3 Hz) and that of C-8 was changed into a singlet after LSPD of $C_{6,8}$-H.

This means that C-6 is coupled with C_6-H (J=161.9 Hz), C_8-H (J=4.2 Hz) and C_5-OH (J=7.3 Hz), and C-8 is coupled with C_8-H (J=164.0 Hz) and C_6-H (J=4.2 Hz).

Consequently, in flavanones having a side chain at C-6, the signal of C-8 is only a doublet (J=164.0 Hz) coupled with C_8-H at about δ 95 ppm and is not changed after LSPD of C_5-OH. In another case, having a side chain at C-8, the C-6 signal is a double doublet (J=161.9, 7.3 Hz) coupled with C_6-H and C_5-OH at about δ 96 ppm and changed to a doublet (J=161.9 Hz) coupled with only C_6-H after LSPD of C_5-OH.

We have reported that the structures of sophoraflavanone A (2),[8] B (4),[12] euchrestaflavanone A (6),[13] B (8)[14] and C (10),[14] have a side chain at C-6, as determined by Gibbs test[15] and the chemical shifts of ^{13}C-NMR spectra. But the present investigation (Table I) lead to a revision to a C-8 substitution of the side chains (3,5,7,9 and 11) (Fig. 1).





	R_1	R_2	R_3	R_4
1)	H	H	H	H
2)	geranyl	H	H	H
3)	H	geranyl	H	H
4)	prenyl	H	H	H
5)	H	prenyl	H	H
6)	prenyl	H	H	prenyl
7)	H	prenyl	H	prenyl
8)	prenyl	H	OH	prenyl
9)	H	prenyl	OH	prenyl

	R_1	R_2
10)	prenyl	H
11)	H	prenyl

prenyl = 

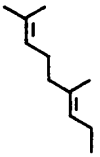
geranyl = 

Fig. 1

Earlier, Byrne et al.[16] used the long range coupling technique without LSPD for the structural elucidation of (±)-cryptostrobin, (±)-stropopinin, (±)-lawinal, unonal, 7-O-methylunonal and isounonal. We have applied the LSPD technique widely to prenyl and geranyl side chains, and have established the usefulness of this technique. Since the structures of C_6 or C_8 substituted flavanones have been so confusing, the ^{13}C-^{1}H long range coupling and LSPD methods should be very useful in their analysis.

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