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# FLEMINONE, A FLAVANONE FROM THE STEMS OF *FLEMINGIA MACROPHYLLA*

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**Key Word Index**—*Flemingia macrophylla*; Leguminosae; stems flavanone; 5,2'-dihydroxy-4'-methoxy-6-(3-methylbut-2-enyl)-6″,6″-dimethylpyrano(2″,3″: 7,8) flavanone; fleminone.

**Abstract**—A new flavanone, designated fleminone, was isolated from the petrol extract of the stems of *Flemingia macrophylla*. Its structure was established as 5,2'-dihydroxy-4'-methoxy-6-(3-methylbut-2-enyl)-6″,6″-dimethylpyrano (2″,3″: 7,8) flavanone on the basis of physical and chemical evidence.

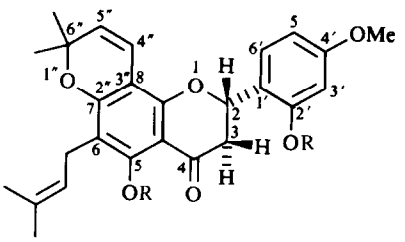
## INTRODUCTION

The genus *Flemingia* (Leguminosae) elaborates several types of flavonoid compounds [1–3]. Chemical investigation of *Flemingia macrophylla* (syn. *F. congesta*) does not seem to have been reported. It is a small shrub occuring at lower elevations throughout India and in the Andaman Islands. It is one of the minor host plants of the Indian Lac insect and the pods yield *warrus*. The roots of the plant are used by hill tribes as an external application to ulcers and swellings [4]. In the present communication the isolation and structural elucidation of a new flavanone designated as fleminone (**1**) from the stems of *F. macrophylla*, is presented.

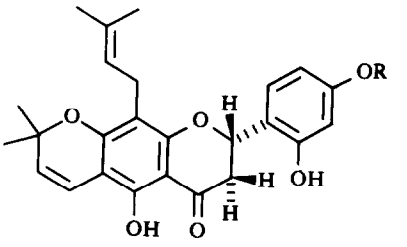
## RESULTS AND DISCUSSION

Fleminone (**1**), mp 106–108°, $C_{26}H_{28}O_6$, $[M]^+$ 436 gave a green colour with alcoholic ferric chloride solution indicating the presence of a chelated hydroxyl group. It is also soluble in alkali indicating its phenolic nature. Furthermore **1** gave a positive Shinoda test [5] suggesting it to be a flavone or flavanone. The IR spectrum indicated a chelated hydroxyl 3300 $cm^{-1}$ and a carbonyl group 1640 $cm^{-1}$. Its UV spectral data $\lambda_{max}^{MeOH}$ nm (log ε) 272 (4.63), 310 (4.08; sh), 361 (3.51) suggest a flavanone [6] skeleton. Fleminone did not show a UV shift with sodium acetate indicating alkylation of the 7-hydroxyl.

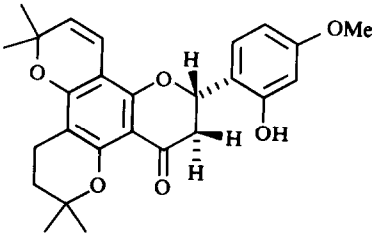
In the $^1H$ NMR spectrum (270 MHz, $CDCl_3$), flemi-



**1** R=H
**2** R=COMe



**3a** R=Me
**3b** R=H



**4**

none revealed a set of peaks ($\delta$3.21, *d*, $J$ = 7 Hz, 2H, =C–$\underline{CH_2}$; $\delta$5.91, *t*, $J$ = 7 Hz, 1H, =$\underline{CH}$ and $\delta$1.45, *s*, 3H, and $\delta$1.44, *s*, 3H, =C$\underline{\overset{Me}{\underset{Me}{}}}$) characteristic of a C-3-methylbut-2-enyl group [7]. The spectrum also showed a set of peaks ($\delta$5.27, *d*, $J$ = 10 Hz. C-5″–H; $\delta$6.64, *d*, $J$ = 10 Hz, C-4″–H; $\delta$1.66, *s*, 6H, –C$\underline{\overset{Me}{\underset{Me}{}}}$) characteristic of 2,2-dimethyl chromene [8]. In the NMR, the flavanone ring protons [9] [$\delta$5.54, *dd*, $J_{2H_{ax},3H_{ax}}$ = 12 Hz, $J_{2H_{ax},3H_{eq}}$ = 3 Hz, C – 2 $H_{ax}$; $\delta$3.16, *dd*, $J_{3H_{ax},2H_{ax}}$ = 12 Hz, $J_{3H_{ax},3H_{eq}}$ = 17 Hz, C – $3H_{ax}$; $\delta$2.826, $J_{3H_{eq},3H_{ax}}$ = 17 Hz, $J_{3H_{eq},2H_{ax}}$ = 3 Hz, C – $3H_{eq}$] could readily be discernible. The spectrum also revealed the presence of methoxyl protons ($\delta$3.80, *s*, 3H), a phenolic hydroxyl ($\delta$6.26, *s*, 1H, $D_2O$ exchangeable) and a chelated phenolic hydroxyl ($\delta$12.28, *s*, 1H, $D_2O$ exchangeable). In the aromatic region of the NMR a low field doublet ($\delta$7.134, *d*, $J_{6'H,5'H}$ = 10.0 Hz, C – 6′H); a relatively upfield quartet ($\delta$6.509, *q*, $J_{C5'H,C6'H}$ = 10.0 Hz, $J_{5'H,3'H}$ = 2.2 Hz, C – 5′H) and another upfield doublet ($\delta$6.519, *d*, $J_{3'H,5'H}$ = 2.2 Hz, C – 3′H) are observed. In flavanones, the C-2′ and C-6′ positions of the side phenyl nucleus approach close to the pyranone ring oxygen in the half chair conformation, which is the most favoured conformation in flavonones. Therefore, protons at these positions suffer a deshielding effect and resonate in the low field region ($\sim \delta$7.0). Thus in 3′,4′-dioxygenated flavanones $C_{2'H}$, $C_{6'H}$ and $C_{5'H}$ resonate as complex multiplets, usually two peaks in the low field region ($\delta$6.7–7.1) [10]. In the NMR of fleminone only one low field proton ($\delta$7.134, *d*, C-6′H) is observed. Therefore it is concluded that one of the *O*-positions of the side phenyl nucleus is oxygenated, i.e. the C-2′ position. Furthermore, fleminone gave a positive Gibbs test [11] suggesting a phenolic hydroxyl at the 2′-position since the position *para* to the 2′-position is unsubstituted. Thus one methoxyl group is placed at the 4′-position. Hence a 2′-hydroxy-4′-methoxy substituted 2-phenyl group is considered to be present in fleminone.

Fleminone formed a diacetate (**2**), mp 70–72°, $C_{30}H_{32}O_6$, $[M]^+$ 520, indicating the presence of two phenolic hydroxyl groups. *Ortho-C*-(3-methylbut-2-enyl) phenol systems undergo cyclisation in the presence of acids to furnish chromans [12]. Fleminone ($R_f$ 0.32) on treatment with a mixture of formic acid and sulphuric acid underwent facile acid catalysed cyclisation to furnish a chroman (**4**), $C_{26}H_{28}O_6$, mp > 300°, ($R_f$ 0.60) which did not give any colour with alcoholic ferric chloride and its IR (KBr) spectrum showed the absence of the chelated hydroxyl. The compound is formed by the cyclisation of the 6-*C*-(3-methylbut-2-enyl) group with the 5-hydroxyl group. Furthermore in the UV spectrum of fleminone there is no shift with $AlCl_3$–HCl which is in agreement with a recent observation [13] that 6-*C*-(3-methylbut-2-enyl)-5-hydroxy flavonoids do not show this shift due to steric hindrance. Hence, the *C*-3-methylbut-2-enyl group is allocated to the 6-position and the 2,2-dimethyl chromene ring system is placed at an angular position. Therefore, structure **1** is assigned to fleminone and the alternate structure **3a** can be eliminated.

From the roots of *Flemingia wallichii* W. and A., flemichin-D (**3b**) isomeric to **1** but with a 4′-hydroxyl has been isolated [14]. The UV data of **1** are similar to those of **3b**. It is observed that if a 3-methylbut-2-enyl group is adjacent to a hydroxyl, fragmentation should occur with a loss of 56 mu ($C_4H_8$) [15]. In the mass spectrum of flemichin-D [14] loss of 56 mu was not observed from any ions but only losses of 55 mu ($C_4H_7$) to form benzyl cations; in fact this was given as evidence to place the 3-methylbut-2-enyl group at the 8-position. On the other hand in the mass spectrum of fleminone (**1**) there is a loss of 56 mu from the ion *m/z* 271 (Scheme 1) confirming the presence of the 3-methylbut-2-enyl group at position-6, adjacent to the 5-hydroxyl. The remainder of the mass spectrum is in agreement with the assigned structure **1**.

The CD spectrum of fleminone exhibited a positive Cotton effect in the region 310–330 nm due to $n$–$\pi^*$ transition and a negative Cotton effect in the region (290–300 nm) due to $\pi$–$\pi^*$ transition which is characteristic of 2*S* flavanones [16]. Furthermore the large coupling constant ($J_{2H_{ax},3H_{ax}}$ = 12 Hz) between $C_2H$ and $C_3H$ protons suggest that the 2-phenyl ring exists in the equatorial position which is thermodynamically favourable [17].

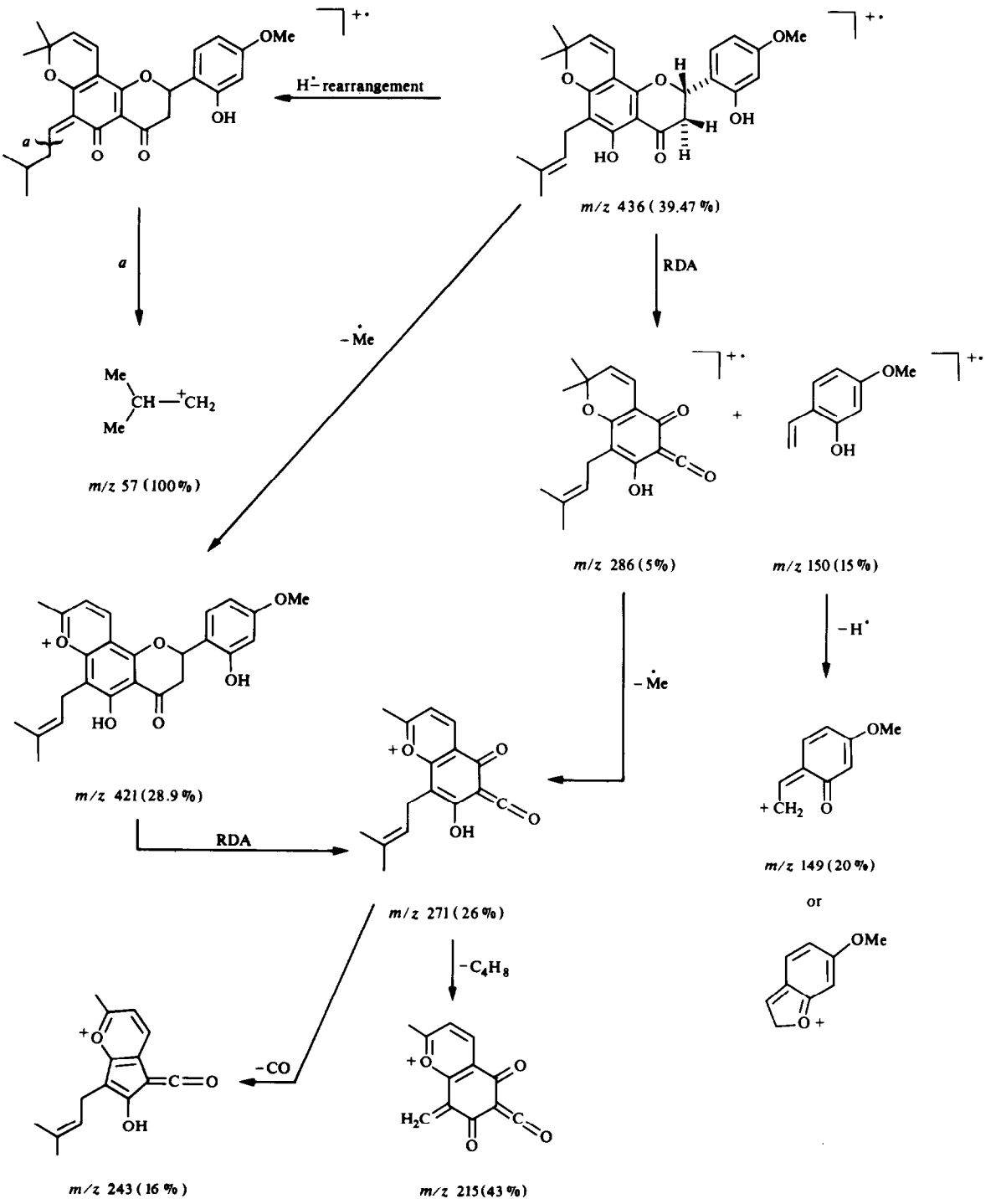
## EXPERIMENTAL

Plant material was procured from United Chemical and Allied Products, Calcutta. The stems were separated from other plant parts and powdered. The stem powder (4 kg) was extracted successively with petrol (60–80°), $CHCl_3$ and MeOH in a Soxhlet extractor. The petrol extract on concn under red. pres. furnished a green semi-solid (15 g) which was subjected to CC on silica gel (200 mesh). Fractions 200 ml each were collected. The column was successively eluted with petrol (Fractions 1–33); petrol–$C_6H_6$ (1:1) (Fractions 34–74); $C_6H_6$ (Fractions 75–125); $CHCl_3$ (Fractions 126–155); $CHCl_3$–EtOAc (9:1) (Fractions 156–168); $CHCl_3$–EtOAc (4:1) (Fractions 169–181); $CHCl_3$–EtOAc (7:3) (Fractions 182–210); $CHCl_3$–EtOAc (1:1) (Fractions 211–224); EtOAc (Fractions 225–226).

Each fraction was monitored by TLC and similar fractions were combined. Fractions 1–33 yielded waxes and aliphatic esters (3.5 g). Fractions 34–60 yielded a phenolic product (15 mg), whose structural elucidation is in progress. Fractions 61–73 yielded a steroid fraction (5.0 g) (positive Liebermann–Buchard test). Fractions 79–147 gave a flavanoid bearing greenish semi-solid material (0.5 g). Fractions 148–226 yielded only resinous material (4.0 g).

The flavonoid bearing material (0.5 g) was rechromatographed over Si gel (200 mesh). The column was eluted with petrol (Fractions 1–4); petrol–$C_6H_6$ (1:1) (Fractions 5–6); petrol–$C_6H_6$ (1:3) (Fractions 17–35) and finally with $C_6H_6$ (Fractions 36–60). Fractions 1–21 and 40–60 yielded negligible amounts of material and were not further investigated. Fractions 22–39 were combined, on the basis of identical TLC behaviour, and on concn furnished a light green semi-solid (300 mg). This was further subjected to CC on silica gel. The column was eluted with petrol–$C_6H_6$ (1:1) (Fractions 1–5); petrol–$C_6H_6$ (1:2) (Fractions 6–34). Fractions 1–10 yielded negligible amounts of waxy material. Fractions 11–21 yielded aliphatic esters (50 mg). Fractions 22–34 furnished an yellow enriched flavonoid material (150 mg) still associated with minor fluorescent impurities having a similar $R_f$ value. Further purification was done by prep. TLC (silica gel G) using $CHCl_3$–EtOAc (19:1). The band at $R_f$ 0.32 was located under UV, scraped off and extracted with $CHCl_3$. The product crystallized from $CHCl_3$–petrol to yield fleminone as light yellow granules (50 mg), mp 106–108°. (Found: C, 71.53; H, 6.44. $C_{26}H_{28}O_6$ requires C, 71.57; H, 6.42%. $[M]^+$ 436.) The compound gave a blue colour with the Gibbs test [11] and a pink colour with the Shinoda test [5].

CD spectra were recorded in $CHCl_3$ on a spectropolarimeter using constant $N_2$ flushing at 25°. 0.1 cm stoppered cuvettes were




Scheme 1. Mass spectral fragmentation of fleminone (**1**).

employed. Data were plotted as $\Delta\varepsilon$ against wavelength. $\Delta\varepsilon_{365}$ +1.45, $\Delta\varepsilon_{330}$ +1.22, $\Delta\varepsilon_{327}$ +1.5, $\Delta\varepsilon_{321}$ +1.75, $\Delta\varepsilon_{315}$ 0, $\Delta\varepsilon_{300}$ −9.24, $\Delta\varepsilon_{275}$ 0, $\Delta\varepsilon_{245}$ +3.56.

*Fleminone diacetate* (**2**). To fleminone (10 mg) dissolved in 1 ml of $Ac_2O$, pyridine (3 drops) was added, and the mixture allowed to stand at room temp. for 48 hr. The diacetate was purified by prep. TLC ($CHCl_3$–petrol, 9:1) and the product crystallized from petrol–$CHCl_3$, mp 70–72° ($R_f$ 0.57). (Found: C, 69.13; H, 6.19. $C_{30}H_{32}O_8$ requires C, 69.23; H, 6.15%. $[M]^+$ 520.)

*Cyclisation to chroman* (**4**). Fleminone (10 mg) was taken up in 2 ml of $HCO_2H$ and a few drops of conc $H_2SO_4$ added. The mixture was warmed for 5 min whilst shaking. The clear acid soln was allowed to stand at room temp. for 24 hr. The material was then poured over crushed ice (50 g) and gently shaken. After 1 hr

the material obtained was filtered, washed thoroughly with $H_2O$, dried in a vacuum desiccator and crystallized from $CHCl_3$–petrol. The cyclised product had mp > 300°. Found: C, 71.529; H, 6.44. $C_{26}H_{28}O_6$ requires C, 71.57; H, 6.42%. TLC on silica gel G gave $R_f$ 0.6, which is different from that of fleminone ($R_f$ 0.32) in $CHCl_3$–EtOAc (19:1).

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