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FLAVONOIDS FROM *TEPHROSIA*—VI[1]
THE STRUCTURE OF SEMIGLABRIN AND SEMIGLABRINOL

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Abstract—Two new flavones, semiglabrinol and semiglabrin, have been isolated from *Tephrosia semiglabra* Sond. and their structures have been established as 2‴,2‴-dimethyl-3‴-hydroxy-tetrahydrofurano-[5‴, 4‴-b]-dihydrofurano[5″, 4″-h]flavone and the 3‴-O-acetate derivative, respectively by means of spectral evidence and chemical degradation reactions.

Tephrosia semiglabra Sond. (Leguminosae) is widely distributed throughout South Africa.[2] The genus *Tephrosia* is invariably used medicinally as as well as a fish poison[3] and is known to yield rotenoids[3] and flavonoids.[4,5] In continuation of our work on plants belonging to *Tephrosia* species we undertook the chemical investigation of *T. semiglabra*.

The dichloromethane extract of the aerial parts and roots, on chromatographic separation gave two new flavones which we have named semiglabrin and semiglabrinol.

Semiglabrin, $C_{23}H_{20}O_6$, $[\alpha]_D^{24}$ −369·3° (*c*, 1·04 $CHCl_3$ (*l*) is assigned structure (1) (2‴,2‴-dimethyl-3‴-acetoxy-tetrahydrofurano[5‴, 4‴-b]-dihydrofurano[5″,4″-h]flavone) on the basis of spectral and chemical evidence.

Semiglabrin gives a positive Shinoda test for a flavone.[6] Absorption in the OH region of the IR spectrum was absent and the fact that its UV spectrum was unchanged on addition of base suggested that phenolic OH groups were absent. The IR spectrum showed features characteristic of the flavone system with a band at 1640 cm^{-1} attributable to the γ-pyrone moiety.[7] The band at 1730 cm^{-1} is to be expected for the acetate CO group.

The nature of the groups present in the semiglabrin structure was indicated by its NMR spectrum (Table 1). The two high field singlets at τ 8·91(3H) and τ 8·68(3H) were assigned to the *gem*-Me_2 group adjacent to an oxygen function.[8] The geminal relation was also evident from the bands at 1380 cm^{-1} and 1370 cm^{-1} in the IR spectrum. The protons of the OAc group appear as a singlet at τ 7·78(3H). The singlet at τ 3·24(1H) is highly characteristic of the C_3 proton of a flavone.[9–11] In the aromatic region a pair of doublets is discernible at τ 3·08 (J = 8·5 Hz) and τ 1·85 (J = 8·5 Hz) which are ascribed to the two *ortho*-coupled protons at C_6 and C_5, respectively. The low chemical shift of the C_5 proton (τ 1·85), due to the deshielding effect of the *peri* situated CO group,[12] confirms the angular structure as indicated in **1** for semiglabrin. The multiplets centered at τ 2·48(3H) and τ 2·10(2H) are assigned to the B-ring protons. The doublet at τ 5·72 ($J_{2‴,3‴}$ = 6·5 Hz) is assigned to the benzylic proton at $C_{3‴}$ while the doublet at τ 3·38 ($J_{2‴,3‴}$ = 6·5 Hz) is due to the $C_{2‴}$ proton.[13,14] The *cis* configuration is assigned to the $C_{2‴}$ and $C_{3‴}$ protons on the basis of the coupling constant[13] ($J_{2‴,3‴}$ = 6·5 Hz) and by analogy with the absolute configuration of the bisfurano moiety present in the aflatoxins[15–17] and sterigmatocystin.[18] The slightly broadened singlet at τ 4·36 (1H, $J_{3‴,3‴'} \simeq 0$ Hz) is due to the $C_{3‴}$ methine proton. The lack of any discernible coupling between the $C_{3‴}$ and $C_{3‴'}$ protons, through application of the Karplus equation,[19] leads to a dihedral angle of ~ 90° for these protons. Although semiglabrin (1) has three chiral centres, the stereochemical requirement of *cis* fusion of the two 5-membered rings and the dihedral angle of ~ 90° for the $C_{3‴}$ and $C_{3‴'}$ protons, limits the number of stereoisomers to two. The relative configuration as indicated in 1 is therefore assigned to semiglabrin. Only one enantiomer is shown.

Chemical evidence for the presence of an O-acetate group in semiglabrin was provided by mild alkaline hydrolysis to give semiglabrinol (2). This alcohol was identical in all respects with the 'natural' semiglabrinol isolated from *T. semiglabra*. Acetylation of the natural semiglabrinol gave semiglabrin (1).

Alkaline hydrolysis of semiglabrin yielded acetophenone and two carboxylic acids, which were characterized as their methyl esters *viz* methyl semiglabrinate (3) and methyl pseudosemiglabrinate (4). The mass spectra of 3 and 4 showed the molecular ion peak at *m/e* 280 and both compounds analyzed for the molecular formula $C_{14}H_{16}O_6$. Methyl semiglabrinate (3) gave a strong coloration with ethanolic ferric chloride and its IR spectrum indicated a chelated aromatic ester (ν_{max} 1655 cm^{-1}).[20] The chelated nature of this ester was

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Table 1. Chemical shifts (τ) for the indicated protons in the NMR spectra of semiglabrin and related compounds

	B-ring H	3-H	5-H	6-H	2″-H	3″-H	2‴-*gem*-Me_2	3‴-H	3‴-OAc
Semiglabrin (**1**)	2·10 m (2H) 2·48 m (3H)	3·24	1·85 d $J_{5,6}$ = 8·5	3·08 d $J_{5,6}$ = 8·5	3·38 d $J_{2'',3''}$ = 6·5	5·72 d $J_{2'',3''}$ = 6·5	8·91 8·68	4·36	7·78
Semiglabrinol (**2**)*	1·87 m (2H) 2·57 m (3H)	3·10	1·68 d $J_{5,6}$ = 8·5	3·03 d $J_{5,6}$ = 8·5	3·33 d $J_{2'',3''}$ = 6·5	5·37 d $J_{2'',3''}$ = 6·5	8·62 8·56	5·32	
Semiglabrinone (**7**)	1·84 m (2H) 2·42 m (3H)	3·18	1·78 d $J_{5,6}$ = 8·5	2·99 d $J_{5,6}$ = 8·5	3·19 d $J_{2'',3''}$ = 6·5	5·43 d $J_{2'',3''}$ = 6·5	8·70 8·52		

*Pyridine-d_5 as solvent

Multiplicity of signals. Where there is no other indication the signal is a singlet, d = doublet, m = multiplet. J values in Hz.

Table 2. Chemical shifts (τ) for indicated protons in the NMR spectra of semiglabrin degradation products

	1-CO_2Me	2-OH	2-OAc	5-H	6-H	2′-H	3′-H	3″-OH	3″-OAc	3″-H	2″-*gem*-Me_2
Methyl semiglabrinate (**3**)	6·12	−1·21		3·63 d $J_{5,6}$ = 8·5	2·26 d $J_{5,6}$ = 8·5	3·52 d $J_{2',3'}$ = 6·5	6·03 d $J_{2',3'}$ = 6·5	7·72		5·74	8·65 9·00
Methyl pseudosemiglabrinate (**4**)	6·12	−1·51		3·59 d $J_{5,6}$ = 8·5	2·25 d $J_{5,6}$ = 8·5	3·71 d $J_{2',3'}$ = 6·5	5·73 m*	6·80		5·73 m*	8·68 9·00
Methyl semiglabrinate diacetate (**5**)	6·15		7·55	3·27 d $J_{5,6}$ = 8·5	2·03 d $J_{5,6}$ = 8·5	3·53 d $J_{2',3'}$ = 6·5	6·08 d $J_{2',3'}$ = 6·5		7·86	4·77	8·68 8·98
Methyl pseudosemiglabrinate diacetate (**6**)	6·21		7·72	3·29 d $J_{5,6}$ = 8·5	2·06 d $J_{5,6}$ = 8·5	3·64 d $J_{2',3'}$ = 6·5	5·80 dd $J_{2',3'}$ = 6·5 $J_{3',3''}$ = 8·5		7·95	4·76 d $J_{3',3''}$ = 8·5	8·69 8·91

*Signals overlap to give a unresolved multiplet.

Multiplicity of signals. Where there is no other indication the signal is a singlet, d = doublet, dd = double doublet, m = multiplet. J values in Hz.

shown by the low field position ($\tau - 1{\cdot}21$) of the phenolic proton resonance in the NMR spectrum (Table 2). The chelated phenolic proton in methyl pseudosemiglabrinate appeared at $\tau - 1{\cdot}51$. Both compounds are thus *o*-hydroxy-esters.

The major difference in the NMR spectra of compounds **3** and **4** is the chemical shift value and multiplicity of the benzylic proton at $C_{3'}$ and the methine proton at $C_{3''}$. As a result of the overlap of the $C_{3'}$ and $C_{3''}$ proton resonances at *ca* τ 5·73 in the NMR spectrum of **4** the diacetate derivatives, *viz* **5** and **6** were prepared from compounds **3** and **4**, respectively to facilitate the analysis of the $C_{3'}$ proton signal. The NMR spectrum of **5** shows a singlet at τ 4·77 ($J_{3',3''} \simeq 0$ Hz), assigned to the $C_{3''}$ proton while the $C_{3'}$ proton appears as a doublet at τ 6·08 ($J_{2',3'} = 6{\cdot}5$ Hz). The NMR spectrum of **6** however shows a doublet at τ 4·76 ($J_{3',3''} = 8{\cdot}5$ Hz) due to the $C_{3''}$ proton while the $C_{3'}$ proton now appears as a double doublet at τ 5·80 ($J_{2',3'} = 6{\cdot}5$ Hz, $J_{3',3''} = 8{\cdot}5$ Hz).

The two methyl esters, methyl semiglabrinate (**3**) and methyl pseudosemiglabrinate (**4**) are thus diastereomers and this implies that isomerism occurred during the alkaline hydrolysis of semiglabrin. The formation of the two diastereomers is rationalized in terms of a ring-opened intermediate as shown in Fig 1. Attack of the phenolate anion on either the α- or β-face of the double bond would lead to the formation of two diastereomers.

Alkaline H_2O_2 oxidation of semiglabrin (**1**) gave benzoic acid, derived from the B-ring and two phenolic acids which were characterized, by esterification with diazomethane, as methyl semiglabrinate (**3**) and methyl pseudosemiglabrinate (**4**).

The formulation of the alkaline isomerism of semiglabrinol *via* a ring-opened intermediate (Fig 1) held far-reaching results. Through utilization of the acidic benzylic proton the otherwise stable bisfurano moiety could be stepwise degraded.

The acidity of the benzylic proton at $C_{3''}$ in semiglabrinol (**2**) was enhanced by chromic acid oxidation of the OH group to give the ketone, semiglabrinone (**7**). The IR spectrum showed strong CO absorption at 1750 cm^{-1}.

The reaction of semiglabrinone (**7**) with MeI using K_2CO_3 as base, resulted in cleavage of the bisfurano system with concomitant methylation of the intermediate phenolate anion to give tephroglabrin (**8**). The band at 1690 cm^{-1} in the IR spectrum was assigned to the newly-formed α,β-unsaturated CO group.[5,21] The protons of the *gem*-Me_2 group appeared as a singlet at τ 8·40(6 H) in the NMR spectrum.[5] The protons of the OMe group were represented by the singlet at τ 6·06. The singlet at τ 1·62(1H) was highly characteristic of the $C_{5''}$ olefinic proton.[5,22]

Mild alkaline hydrolysis of tephroglabrin (**8**) gave an alcohol, tephroglabrinol (**9**). The compound exhibited strong OH absorption in the IR spectrum at 3300 cm^{-1}. The bands at 1705 cm^{-1} and 1635 cm^{-1} were ascribed to the side-chain aliphatic CO[5] and the flavone CO group,[7] respectively. The NMR spectrum showed a two-proton singlet at τ 5·16 due to the protons of the newly-formed benzylic methylene group.[5] The flavone character of tephroglabrinol was evident from the characteristic signal of the C_3 proton at τ 2·98.[9-11] The formation of tephroglabrinol (**9**) from tephroglabrin (**8**) is consistent with the behaviour of 4-substituted 2,3-dihydro-3-furanones towards alkali.[5,23]

Proof of the flavone structure of tephroglabrin (**8**) and thus of semiglabrin was provided by alkaline fission of the compound to give acetophenone and benzoic acid, derived from the B-ring, and a phenol and a phenolic carboxylic acid derived from the A-ring.

The phenol, $C_{14}H_{18}O_5$, was an *o*-hydroxyketone and was assigned structure **10**. It gave a strong coloration with ethanolic ferric chloride and its IR spectrum indicated the presence of a chelated aromatic CO (ν_{max} 1625 cm^{-1})[20] and an aliphatic CO (ν_{max} 1700 cm^{-1}).[5] The NMR spectrum showed the intramolecular H-bonded phenolic proton at $\tau - 2{\cdot}83$. The benzylic methylene protons of the aliphatic side-chain appeared as a singlet at τ 6·01. The three-proton singlet at τ 7·39 was assigned to the MeCO-group.

The phenolic acid was characterized as the methyl ester (**11**), which clearly contained a chelated ester grouping. It showed an ester CO band at 1665 cm^{-1} in the IR spectrum and its NMR spectrum was fully compatible with the structure **11** in particular the phenolic proton which appeared at very low field ($\tau - 1{\cdot}14$) due to internal H-bonding.

The isolation of semiglabrin and semiglabrinol from *T. semiglabra* is the first recorded case of

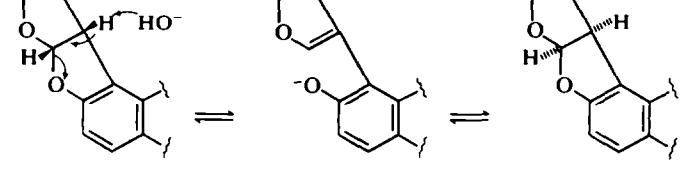
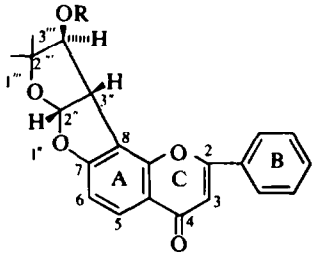
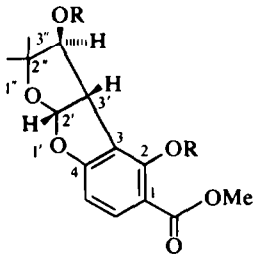


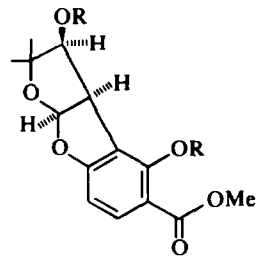
Fig 1.



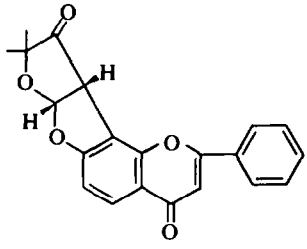
1: R = $COCH_3$
2: R = H



3: R = H
5: R = $COCH_3$



4: R = H
6: R = $COCH_3$



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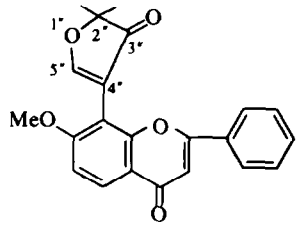

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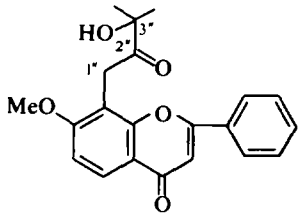

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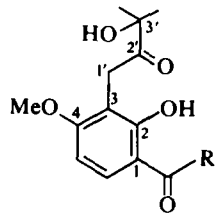

10: R = Me
11: R = OMe

natural flavones containing the bisfurano moiety. The bisfurano moiety in both these compounds is probably derived from a 8-γ,γ-dimethylallylflavone precursor by secondary modifications.

The structural elucidation of a minor component, called glabratephrin isolated from *T. semiglabra* (Experimental) is in progress.

EXPERIMENTAL

M.ps were determined with a Kofler hot-stage apparatus and are uncorrected. The IR spectra were determined on a Unicam SP-200 spectrophotometer using KBr. UV spectra refer to a solution in MeOH and were recorded on a Unicam SP-800 spectrophotometer. NMR spectra were recorded on a Varian HA-100 instrument with TMS as internal standard (τ 10·00) in $CDCl_3$. Mass spectra were recorded on an AEI M.S.9 spectrometer with direct insertion technique. Optical rotations were measured with a Perkin-Elmer 411 polarimeter. Elementary analysis were done by Dr. F. Pascher, Mikroanalytisches Laboratorium, Bonn. Merck silica gel (0·05 – 0·20 mm) and Merck silica gel GF_{254} were used for column chromatography and TLC, respectively.

Extraction and isolation. The sun-dried and ground plant material (1·26 kg) was extracted with CH_2Cl_2 for 24 hr in a Soxhlet apparatus. The CH_2Cl_2 extract was concentrated to a small volume (2 l) and washed with 6N HCl. The CH_2Cl_2 was evaporated and the residue dissolved in MeOH : H_2O (9 : 1, 2 l). The aqueous MeOH soln was extracted with n-hexane (20 × 250 ml). Water was added to the aqueous MeOH until the ratio of MeOH to H_2O was 2 : 1. The resulting soln was extracted with benzene (10 × 400 ml). The combined benzene extracts yielded a brown gum (10 g, 0·79%). The gum was dissolved in $CHCl_3$ and fractionated by column chromatography on silica gel (1 kg) using $CHCl_3$ as eluant. Fractions (100 ml) were collected by utilising the distinctive fluorescence of the components on the column on UV illumination. Appropriate fractions (TLC, $CHCl_3$: MeOH, 98 : 2 v/v) were combined to give three main fractions.

Fraction 1

Rechromatography on SiO_2 with $CHCl_3$ and crystallization from benzene-light petroleum (40–60°) gave **1**, as colourless crystals (3·5 g), m.p. 176–178°. $[\alpha]_D^{24} - 369·3°$ (*c*, 1·04 in $CHCl_3$). λ_{max} 216, 249 (sh), 256, 274 and 309 nm (log ε 4·21, 4·23, 4·24, 4·02 and 4·19, respectively). ν_{max} 1730 (acetate CO), 1640 (flavone CO) cm^{-1}. *m/e* 392 (35), 333 (22), 332 (100), 317 (37), 303 (18), 289 (23), 263 (23), 230 (9), 105 (5), 43 (47). (Found: C, 70·27; H, 5·11. $C_{23}H_{20}O_6$ requires: C, 70·40; H, 5·14%).

Fraction 2

This fraction was further purified by column chromatography with $CHCl_3$ as eluant and crystallized from benzene-light petroleum (40–60°) to give glabratephrin (230 mg), m.p. 227–228°. $[\alpha]_D^{24}$ −214·9° (*c*, 0·98 in $CHCl_3$). λ_{max} 218, 247, 256 and 309 (log ϵ 4·22, 4·23, 4·23 and 4·27, respectively). ν_{max} 1760 (CO), 1740 (acetate CO), 1640 (flavone CO) cm^{-1}. NMR: τ 8·51 (s, 3H), 8·48 (s, 3H), 8·41 (s, 3H), 5·02 (s, 2H), 4·59 (s, 1H), 3·23 (s, 1H), 3·04 (d, 1H, J = 8·5 Hz), 2·47 (m, 3H), 2·11 (m, 2H), 1·81 (d, 1H, J = 8·5 Hz). (Found: C, 68·60; H, 4·89. $C_{24}H_{20}O_7$ requires: C, 68·57; H, 4·80%).

Fraction 3

Rechromatography on silica with $CHCl_3$ as eluant followed by crystallization from acetone gave **2** (300 mg) as colourless needles, m.p. 273–275°. $[\alpha]_D^{24}$ −289·7° (*c*, 0·97 in $CHCl_3$). ν_{max} 3360 (OH), 1640 (flavone CO) cm^{-1}. (Found: C, 72·05; H, 5·12. $C_{21}H_{18}O_5$ requires: C, 71·99; H, 5·18%).

Semiglabrinol (**2**)

A soln of **1** (200 mg) in 0·1 N methanolic KOH (10 ml) was stirred at room temp for 30 min. The mixture was diluted with H_2O and extracted with CH_2Cl_2 to give a colourless oil. Crystallization from acetone gave **2** (170 mg) identical with natural semiglabrinol.

Alkaline hydrolysis of semiglabrin

A soln of **1** (600 mg) and KOH (1 g) in aqueous EtOH (80% EtOH, 50 ml) was refluxed for 8 hr under N_2. The mixture was diluted with H_2O (40 ml) and extracted with CH_2Cl_2. The CH_2Cl_2 extracts yielded a colourless oil (145 mg) which was purified by column chromatography. The major component (135 mg) was characterized as the oxime and was identical with authentic acetophenone oxime.

The alkaline aqueous soln was acidified (6N HCl) and extracted with CH_2Cl_2 to yield a mixture (TLC) of two acids (330 mg). The mixture in MeOH (10 ml) was methylated with an excess of ethereal diazomethane. After 2 min the excess reagent was decomposed by addition of AcOH, and the mixture worked-up to give the methyl esters (300 mg). The mixture of esters was separated and purified by column chromatography to give products A and B.

Recrystallization of product A from light petroleum (40–60°) gave **4** (90 mg), m.p. 81–82°. $[\alpha]_D^{24}$ −210·9° (*c*, 0·92 in $CHCl_3$); λ_{max} 231, 265 and 297 nm (log ϵ 4·07, 4·09 and 3·69, respectively); ν_{max} 3370 (OH), 2650 (phenol OH), 1650 (ester CO) cm^{-1}; *m/e* 280 (48), 262 (55), 247 (22), 231 (21), 230 (100), 207 (25), 161 (53), 43 (72). (Found: C, 59·73; H, 5·68. $C_{14}H_{16}O_6$ requires: C, 60·00; H, 5·75%).

Product B gave on crystallization from acetone-n-hexane colourless needles of **3** (130 mg), m.p. 168–169°. $[\alpha]_D^{24}$ −153·8° (*c*, 0·91 in $CHCl_3$); λ_{max} 215, 226, 264 and 296 nm (log ϵ 4·43, 4·29, 4·20 and 3·68 respectively); ν_{max} 3180 (OH), 2650 (phenol OH), 1655 (ester CO); *m/e* 280 (61), 262(50), 247 (20), 231 (18), 230 (100), 193 (20), 161 (25), 43 (24). (Found: C, 60·09; H, 5·64. $C_{14}H_{16}O_6$ requires: C, 60·00; H, 5·75%).

Acetylation of methyl semiglabrinate (**3**)

The ester **3** (50 mg), Ac_2O (3 ml) and pyridine (0·5 ml) were refluxed for 2 hr. Work-up of the mixture yielded **5** (50 mg) as a colourless oil; $\nu_{max}^{CHCl_3}$ 1750 (acetate CO), 1735 (acetate CO), 1720 (ester CO) cm^{-1}. (Found: M^+ 364·1170. $C_{18}H_{20}O_8$ requires: 364·1158).

Acetylation of methyl pseudosemiglabrinate (**4**)

Acetylation of **4** (40 mg) with Ac_2O (3 ml) and pyridine (0·5 ml) gave **6** (45 mg), m.p. 138–140° (from acetone-light petroleum 40–60°); $[\alpha]_D^{24}$ −66·7° (*c*, 1·02 in $CHCl_3$); ν_{max} 1765 (acetate CO), 1745 (acetate CO), 1725 (ester CO) cm^{-1}. (Found: C, 59·39; H, 5·50. $C_{18}H_{20}O_8$ requires: C, 59·34, H, 5·53%).

Oxidation of semiglabrin with alkaline hydrogen peroxide

Semiglabrin **1** (600 mg) was added to a 3% soln of KOH in aqueous EtOH (80% EtOH, 50 ml) and the stirred soln was warmed at 40–45° for 5 hr. During this period sufficient 30% H_2O_2 was added at 15 min intervals to maintain a gentle evolution of O_2. The resulting yellow soln was concentrated under diminished pressure, water was added and the soln acidified with 6N HCl. Extraction of this soln with CH_2Cl_2 yielded a mixture (TLC) of three carboxylic acids. The mixture in MeOH was treated for 2 min with an excess of ethereal diazomethane, acetic acid was added and the mixture extracted with CH_2Cl_2 to yield the esters. The mixture of esters was separated and purified by column chromatography to give **3** (180 mg), **4** (120 mg) and a neutral ester (150 mg). Saponification of the neutral gave benzoic acid (120 mg) m.p. 122°.

Oxidation of semiglabrinol (**2**)

A soln of **2** (450 mg) in acetone (100 ml) was titrated with chromic acid (2 ml) (from 3 g CrO_3, 30 ml H_2O and 3 ml H_2SO_4) over a period of 2 hr. The mixture was diluted with H_2O (50 ml) and the acetone evaporated. The aqueous soln was extracted with CH_2Cl_2 to give **7** (350 mg), m.p. 159–161° (from acetone-light petroleum 40–60°); λ_{max} 217, 259 and 311 nm (log ϵ 4·35, 4·22 and 4·15, respectively); ν_{max} 1750 (CO), 1645 (flavone CO) cm^{-1}. (Found: C, 72·15; H, 4·68. $C_{21}H_{16}O_5$ requires: C, 72·41; H, 4·63%).

Tephroglabrin (**8**)

A mixture of **7** (200 mg), anhyd K_2CO_3 (2 g), MeI (1·5 ml) and anhyd acetone (30 ml) was refluxed for 2 hr. The mixture was filtered and the K_2CO_3 washed with acetone (3 × 20 ml). The combined acetone filtrates were evaporated to give a colourless oil. Column chromatography of the oil, followed by recrystallization from benzene-light petroleum (40–60°) gave **8** (175 mg), m.p. 232–233°; λ_{max} 217, 257, 284 (sh) and 312 nm (log ϵ 4·49, 4·52, 4·29 and 4·34 respectively); ν_{max} 1690 (α,β-unsaturated CO), 1635 (flavone CO) cm^{-1}; NMR: τ 8·40 (s, 6H, *gem*-Me_2), 6·06 (s, 3H, C_7-OMe), 3·28 (s, 1H, C_3-H), 2·96 (d, 1H, $J_{5,6}$ = 8·5 Hz, C_6-H), 2·57 (m, 3H) and 2·20 (m, 2H) (B-ring H), 1·78 (d, 1H, $J_{5,6}$ = 8·5 Hz, C_5-H), 1·62 (s, 1H, C_5-H). (Found: C, 73·00; H, 5·01. $C_{22}H_{18}O_5$ requires: C, 72·92; H, 5·01%).

Tephroglabrinol (**9**)

A soln of **8** (100 mg) in 3% methanolic KOH (20 ml) was refluxed for 2 hr. The mixture was diluted with water (20 ml), the methanol evaporated under diminished pressure and the resulting soln extracted with CH_2Cl_2. The combined CH_2Cl_2 extracts gave a colourless solid which was purified by column chromatography using $CHCl_3$ as eluant. Crystallization from $CHCl_3$-light petroleum (40–60°) gave **9** (80 mg), m.p. 197–198°; λ_{max} 213, 247 (sh), 257 and 311 nm (log ϵ 4·43, 4·25, 4·28 and 4·28

respectively); ν_{max} 3300 (OH), 1705 (CO), 1635 (flavone CO) cm^{-1}; *m/e* 352 (1), 294 (10), 267 (17), 266 (100), 265 (35), 251 (14), 163 (14), 59 (31), 43 (7); NMR (pyridine-d_5): τ 8·28 (s, 6H, *gem*-Me_2), 6·24 (s, 3H, C_7-OMe), 5·16 (s, 2H, C_1-H), 2·98 (s, 1H, C_3-H), 2·92 (d, 1H, $J_{5,6}$ = 8·5 Hz, C_6-H), 2·55 (m, 3H) and 2·04 (m, 2H) (B-ring H), 1·60 (d, 1H, $J_{5,6}$ = 8·5 Hz, C_5-H). (Found: C, 71·66; H, 5·75. $C_{21}H_{20}O_5$ requires: C, 71·51; H, 5·72%).

Alkali hydrolysis of tephroglabrin (**8**)

Potassium hydroxide (1·5 g) was added to a soln of **8** (610 mg) in aqueous EtOH (80% EtOH, 50 ml). The mixture was refluxed for 3 hr under N_2 and diluted with water (50 ml). The aqueous soln was extracted with CH_2Cl_2 to yield a yellow oil (200 mg). Chromatographic fractionation of this yellow oil gave acetophenone (120 mg) (characterized as the oxime) and product A (50 mg).

The aqueous alkaline soln was acidified (6N HCl) and extracted with CH_2Cl_2 to give a mixture (TLC) of carboxylic acids. The acids were esterified with an excess of ethereal diazomethane. Column chromatography of the mixture of esters yielded product B and a neutral ester (30 mg) which was characterized, after saponification with 10% NaOH as benzoic acid m.p. 122°.

Product A, a colourless oil, which could not be induced to crystallize was **10** (50 mg); $\nu_{max}^{CHCl_3}$ 3420 (OH), 2650 (phenol OH), 1700 (CO), 1625 (chelated CO) cm^{-1}; *m/e* 266 (1), 281 (11), 280 (100), 279 (34), 265 (75), 262 (9), 149 (7), 59 (23), 43 (13); NMR: τ 8·44 (s, 6H, *gem*-Me_2), 7·39 (s, 3H, —$COCH_3$), 6·09 (s, 3H, C_4-OMe), 6·01 (s, 2H, $C_{1'}$-H), 3·46 (d, 1H, $J_{5,6}$ = 8·5 Hz, C_5-H), 2·25 (d, 1H, $J_{5,6}$ = 8·5 Hz, C_6-H), and −2·83 (s, 1H, C_2-OH, disappears on addition of D_2O). (Found: M^+ 266·1142. $C_{14}H_{18}O_5$ requires: 266·1152).

Recrystallization of product B from acetone-light petroleum (40–60°) gave **11** (350 mg), m.p. 119–120°; λ_{max} 215, 263 and 301 nm (log ϵ 4·34, 4·20 and 3·70, respectively); ν_{max} 3450 (OH), 2700 (phenol OH), 1710 (CO), 1665 (ester CO) cm^{-1}; *m/e* 282 (1), 197 (10), 196 (100), 195 (14), 164 (75), 163 (46), 59 (21); NMR: τ 8·42 (s, 6H, *gem*-Me_2), 6·11 (s, 3H, C_4-OMe), 6·00 (s, 2H, $C_{1'}$-H), 3·47 (d, 1H, $J_{5,6}$ = 8·5 Hz, C_5-H), 2·15 (d, 1H, $J_{5,6}$ = 8·5 Hz, C_6-H) and −1·14 (s, 1H, C_2-OH, disappears on addition of D_2O). (Found: C, 59·75; H, 6·40. $C_{14}H_{18}O_6$ requires: C, 59·57; H, 6·43%).

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