Oligomeric isoflavonoids. Part 3.† Daljanelins A–D, the first pterocarpan- and isoflavanoid-neoflavonoid analogues

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The structures of daljanelins A–C **1**, **3** and **5**, the first pterocarpan-neoflavonoid oligomers, and of daljanelin D **6** a related isoflavonoid-neoflavonoid analogue from *Dalbergia nitidula* were established by spectroscopic methods. The structure and stereochemistry of daljanelin C **5** were unambiguously confirmed by synthesis *via* introduction of an electrophilic C-1 fragment to a pterocarpan nucleus followed by anionic coupling of a C_6•C_2 precursor and the late introduction of the final C_6 fragment by a Grignard reaction.

In contrast to the ubiquitous natural occurrence of the flavonoids, the iso- and neo-flavonoids have a more limited taxonomic distribution.[1,2] The relatively recent recognition of the existence of isoflavonoid oligomers,[3–12] featuring isoflavonoid-isoflavonoid, isoflavonoid-flavonoid isoflavonoid-stilbene and isoflavonoid-phenylpropanoid systems, similarly contrasts with their flavonoid counterparts, which constitute a major group of flavonoid derivatives that has long been recognized.[13] The noted biological activity and the reported presence of iso- and neo-flavonoids in plants of traditional medicine prompted continuation of our search for prototypes of these polyphenols in the durable and termite resistant heartwood of *Dalbergia nitidula* Welw. *ex* Bak.[14] We now report the first isoflavonoid oligomers comprising pterocarpan-neoflavonoid and isoflavonoid-neoflavonoid constituent units.

Results and discussion

The first bi-isoflavonoid[3,4] and an isoflavone-isoflavan analogue[8] are accompanied in the heartwood of *D. nitidula* by three pterocarpan-neoflavonoid oligomers **1**, **3** and **5**, as well as an isoflavonoid-neoflavonoid analogue **6**. The ^{1}H NMR spectra (Table 1) of compounds **1**, **3** and **5** exhibit the highly complex but characteristic four-spin system reminiscent of the heterocyclic ring protons of pterocarpans.[15] In addition to an ABX system in the aromatic region of each of the spectra, those of compounds **1** and **5** show four singlets and that of compound **3** an aromatic AB system and two singlets. The ^{1}H NMR data further indicate that compounds **1**, **3** and **5** all contain an unsubstituted phenyl ring, two methoxy groups and an isolated methylene functionality. Collectively, the above data suggest that these structures are comprised of a 3,9-dioxygenated pterocarpan nucleus substituted with the same structural moiety at respectively C-2, C-4 and C-8 for analogues **1**, **3** and **5**. These bonding positions were corroborated *via* decoupling experiments using 6a- and 11a-H as reference signals, while the position of the *O*-methyl group at C-9 was established by an NOE experiment which showed association of the methoxy protons with both 8- and 10-H. Having established the spin systems of the pterocarpanoid protons, the remaining *O*-methyl group, two aromatic protons, the phenyl ring and the isolated methylene group in compounds **1**, **3** and **5** are then compatible with a 1,2,4,5-tetrasubstituted E-ring involved in one of the partial structures **7**–**12**. Owing to the absence of both scalar and dipolar coupling between an 'E-ring' proton and the isolated methylene function in analogues **1**, **3** and **5**, structures **9**, **10** and **12** could, however, be discarded. In the natural product **1** 1-H displayed NOE association with both 11a-H and the isolated methylene, while both the latter protons and an 'E-ring' proton could be correlated with the unsubstituted phenyl ring, associations which are only permitted in partial structures **7** and **11**. Although the same approach similarly did not permit differentiation between the 2*H*-[1]benzopyran- and benzofuran-type structures **7** and **11** for the natural products **3** and **5** it nevertheless defined the location of the 'E-ring' *O*-methyl group in compounds **1**, **3** and **5** by NOE association between these protons and the 'residual' hydrogen on the same ring (*vide supra*). Similar ambiguities regarding differentiation between substuctures **7** and **11** were encountered with long distance carbon–hydrogen correlations *via* a COLOC experiment optimized for ^3J = 10–14 Hz, which consistently also showed ^2J or ^4J coupling of the hydrogens of the isolated methylene group and the relevant carbons of the pterocarpanoid moiety in all three natural products. However, the chemical shifts of the methylene carbon and hydrogens indicated that this carbon is not linked to oxygen, an observation that strongly favours the benzo[*b*]furanoid-type EFG-moiety for the natural products **1**, **3** and **5**. Extensive ^{13}C NMR experiments on the C-4 substituted analogue **3** facilitated assignment of all its carbon resonances (*cf.* Experimental section).

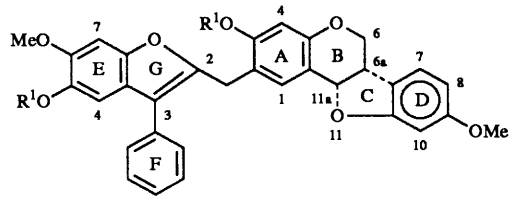
Although mass spectrometry confirmed the molecular formula $C_{32}H_{26}O_7$ (*m/z* 522; 78, 38 and 100% for **1**, **3** and **5**, respectively) the fragmentation patterns and especially the *m/z* 240 fragment **13**, which is common to the spectra of all three analogues, are also explicable in terms of partial structure **11**. Comparison of the CD spectra of compounds **1**, **3** and **5** with that of an authentic sample of the pterocarpan, (+)-homopterocarpin **20**, showed very similar Cotton effects in the 230–300 nm region of the spectra, which presumably indicate 6a*S*, 11a*S* absolute configuration for the three natural products. This was unambiguously confirmed *via* synthesis of the analogue **5** (*vide infra*). Compounds **1**, **3** and **5** therefore not only represent the first neoflavonoid-pterocarpan dimers but also complement the rare series of neoflavonoids with the 3-arylbenzo[*b*]furan constitution.[16,17] A bi-neoflavonoid, dalcriodain, with unknown stereochemistry has previously been obtained from *D. latifolia*.[16]

The ^{1}H NMR spectrum of daljanelin D **6** exhibits the characteristic five-spin system indicative of the heterocyclic ring protons of isoflavans[18] [δ 4.18 (ddd, $2_{eq.}$-H), 3.89 (dd, $2_{ax.}$-H), 3.35–3.45 (m, 3-H), 2.98 (ddd, $4_{ax.}$-H) and 2.87 (ddd, $4_{eq.}$-H)].

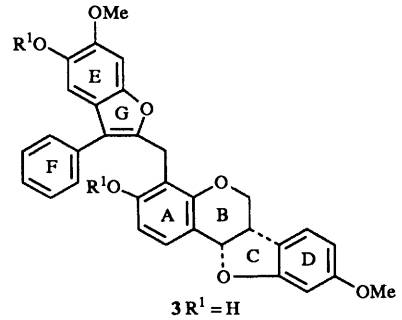
† Part 2, ref. 9.

Table 1 ^{1}H NMR peaks (ppm) of the isoflavonoid oligomers **1**, **3** and **5**, and derivatives **2** and **4** in $CDCl_3$ (24 °C) at 300 MHz. Splitting patterns and *J* values (Hz) are given in parentheses

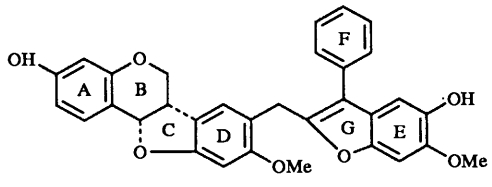
Ring	Proton	1	2	3	4	5
A	1	7.25 (s)	7.42 (s)	7.29 (d, 8.5)	7.36 (d, 8.5)	7.35 (d, 8.5)
	2	—	—	6.61 (d, 8.5)	6.58 (d, 8.5)	6.52 (dd, 2.5, 8.5)
	4	6.41 (s)	6.67 (s)	—	—	6.38 (d, 2.5)
B	6_{ax}	3.58 (dd, 11.0, 11.0)	3.47–3.65 (m)	3.40–3.50 (m)	3.45–3.58 (m)	3.55 (dd, 11.0, 11.0)
	6_{eq}	4.19 (dd, 4.5, 11.0)	4.24 (dd, 4.5, 11.0)	4.04–4.07 (m)	4.14 (m)	4.15 (dd, 5.0, 11.0)
	6a	3.48 (ddd, 4.5, 6.5, 11.0)	3.47–3.65 (m)	3.40–3.50 (m)	3.45–3.58 (m)	3.39–3.48 (m)
	11a	5.42 (d, 6.5)	5.45 (d, 6.5)	5.46 (d, 6.5)	5.50 (d, 6.5)	5.43 (d, 6.5)
D	7	7.10 (d, 8.5)	7.10 (d, 8.5)	7.09 (d, 8.5)	7.10 (d, 8.5)	6.90 (br s)
	8	6.42 (dd, 2.5, 8.5)	6.44 (dd, 2.5, 8.5)	6.43 (dd, 2.5, 8.5)	6.42 (dd, 2.5, 8.5)	—
	10	6.42 (d, 2.5)	6.43 (d, 2.5)	6.41 (d, 2.5)	6.42 (d, 2.5)	6.43 (s)
E	4	7.07 (s)	7.23 (s)	7.01 (s)	6.92 (s)	7.11 (s)
	7	7.00 (s)	7.07 (s)	6.95 (s)	6.90 (s)	7.01 (s)
F		7.45–7.53, 7.34–7.40 (each m)	7.45–7.47 (m)	7.52–7.56, 7.42–7.47, 7.31–7.38 (each m)	7.53–7.59, 7.43–7.49, 7.30–7.38 (each m)	7.39–7.50 (m)
	CH_2	4.15, 4.08 (each d, 16.0)	4.09, 4.03 (each d, 16.0)	4.24, 4.18 (each d, 16.0)	4.20 (s)	4.13, 4.03 (each d, 16.5)
	OMe	3.91 (6-E), 3.74 (9-D) (each s)	3.85, 3.74 (each s)	3.89 (6-E), 3.74 (9-D) (each s)	3.85 (5-E), 3.83 (6-E), 3.75 (9-D), 3.67 (3-A) (each s)	3.92 (6-E), 3.69 (9-D) (each s)
	OAc	—	2.30, 2.02 (each s)	—	—	—



1 R^1 = H
2 R^1 = Ac



3 R^1 = H
4 R^1 = Me



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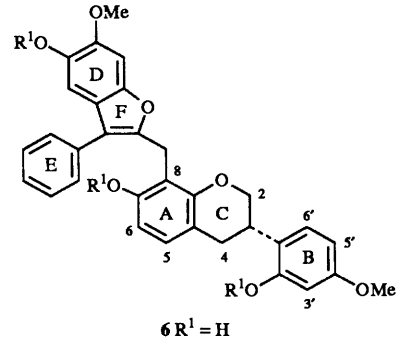
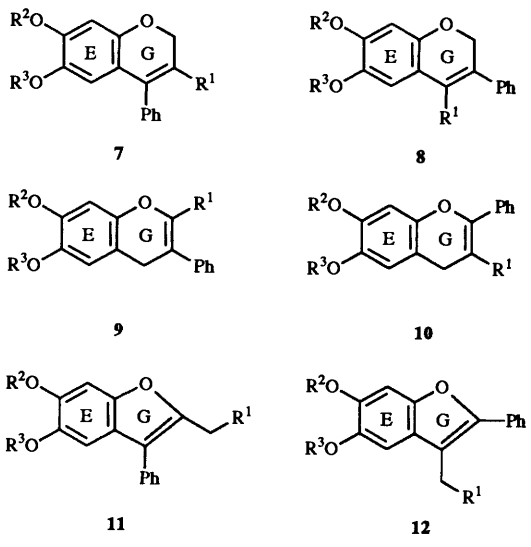


6 R^1 = H

Utilization of the decoupling-, NOE- and CD-experiments described for analogues **1**, **3** and **5** facilitated definition of the isoflavan ABC unit as a (+)-vestitol moiety **14** substituted at C-8. Comparison of the spin systems of the remaining protons with those of the hydrogens of the neoflavonoid units in daljanelins A–C indicated that this moiety was identical in all four natural products. The 3*S* absolute configuration and structure **6** may thus unambiguously be assigned to daljanelin D **6**. Such a structure is additionally supported by the mass fragmentation pattern which confirmed the molecular mass (M^+, *m*/*z* 524) and also the *m*/*z* 240 fragment **13** (100%). The two novel compounds **3** and **6** complement the unique series of oligomeric flavonoids/isoflavonoids substituted at C-8 of the resorcinol-type ring of the chromane unit.[19]

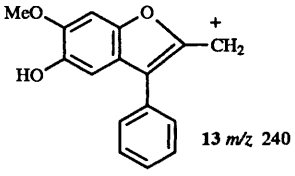
The ambiguities regarding the constitution of the neoflavonoid units and the need to establish the absolute configuration of the pterocarpanoid unit beyond doubt necessitated recourse to synthesis of at least one of the isomeric pterocarpan-neoflavonoids **1**, **3** or **5**.

The neoflavonoid precursor **19** was synthesized according to literature procedures in four steps from vanillin **15** by stepwise application of Dakin oxidation (**15** ⟶ **16**; 71%

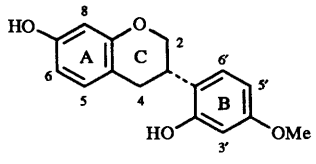


7 8 9 10 11 12

For **7-12**
R^1 = pterocarpanyl unit
R^2 = H, R^3 = Me or
R^3 = H, R^2 = Me



13 *m/z* 240



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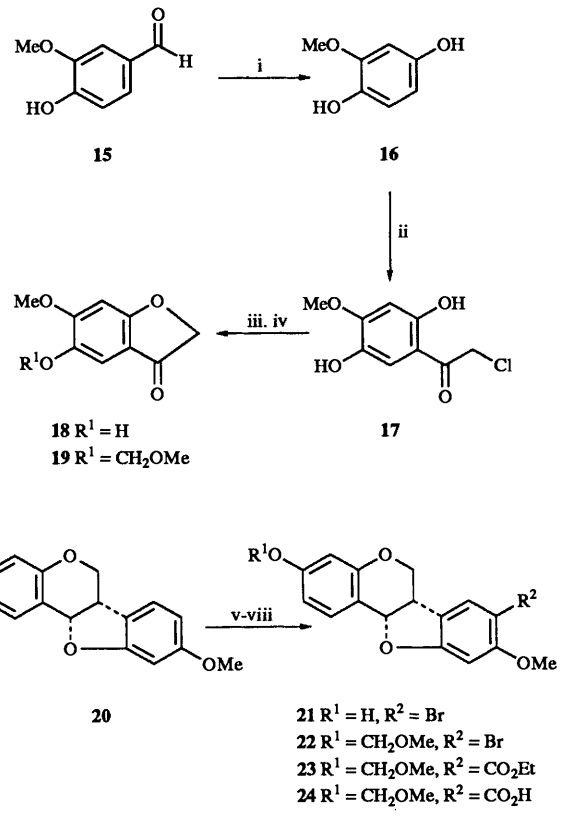
yield), Houben–Hoesch acylation (**16** ⟶ **17**, 84%), base-mediated cyclization (**17** ⟶ **18**, 90%) and protection of the phenolic hydroxy group (**18** ⟶ **19**, 97%) in *ca.* 50% overall yield (Scheme 1).

Bromination of (+)-medicarpin **20** with known 6a*S*, 11a*S* absolute configuration[20] under free radical conditions with NBS (*N*-bromosuccinimide) in methyl acetate led to the facile formation of the 8-bromo derivative **21** (78%) (Scheme 1). Successful introduction of the precursor unit to the methylene bridge at C-8 of (+)-medicarpin was accomplished by treating the protected 8-bromo derivative **22** with butyllithium and TMEDA (*N*,*N*,*N*′,*N*′-tetramethylethylenediamine) at low temperature (*ca.* −110 °C) followed by quenching of the lithio derivative with ethyl chloroformate to give the ethyl ester **23** (75%). Subsequent reduction with LAH in THF afforded the hydroxymethyl compound **24** (82%). Compounds **21**–**24** were differentiated from the alternative C-2 isomers by ^{1}H NMR decoupling experiments illustrating a benzylic connection between 6a-H and 7-H.

In order to establish conditions to effect mono-alkylation at C-2 of the benzofuranone **19** a variety of bases, *e.g.* sodium hydride in THF, DBU (1,8-diazabicyclo[5.4.0]undec-7-ene) and LDA in THF containing HMPA (hexamethylphosphoric triamide) were used for enolate formation. Subsequent trapping with a benzyl halide, however, invariably led to recovery of



15 **16** **17** **18** R^1 = H, **19** R^1 = CH_2OMe

20

21 R^1 = H, R^2 = Br
22 R^1 = CH_2OMe, R^2 = Br
23 R^1 = CH_2OMe, R^2 = CO_2Et
24 R^1 = CH_2OMe, R^2 = CO_2H

Scheme 1 Synthesis of the neoflavonoid precursor **19** and introduction of the methylene function at C-8 of (+)-medicarpin **20**. *Reagents and conditions:* i, H_2O_2/NaOH, then HCl(c); ii, $ZnCl_2$/HCl(g)/$ClCH_2CN$, then H_2O/reflux; iii, NaOAc–EtOH–reflux; iv, NaH–DMF, then $ClCH_2OMe$; v, NBS in $MeCO_2Me$; vi, NaH–THF, then $ClCH_2$-OMe; vii, BuLi–TMEDA, then $ClCO_2Et$, then H_2O; viii, $LiAlH_4$.

starting material (20–30%) as well as the formation of mono- and di-benzylated analogues (*ca.* 20 and 30%, respectively). Preparation of the trimethylsilyl (TMS) enol ether using TMSCl–sodium iodide–triethylamine in acetonitrile[21] and subsequent desilylation with TBAF (tetrabutylammonium fluoride) on silica gel in the presence of benzyl bromide again afforded starting material (*ca.* 20%) and the mono- and di-benzylated compounds (*ca.* 50 and 10%, respectively). Recovery of starting material may, in this case, be attributed to hydrolysis of the labile TMS enol ether by moisture in TBAF. Benzylation was finally optimized by first preparing the stable *tert*-butyldimethylsilyl (TBDMS) enol ether **26** in quantitative yield by treatment of the benzofuranone **19** with TBDMSCl/NaI/NEt_3 in acetonitrile. Subsequent desilylation of **26** with the powerful siliconophile,[22] tris(dimethylamino) sulfonium difluorotrimethylsilicate (TASF), which may be prepared in a rigorously anhydrous state,[23] in the presence of benzyl bromide afforded only the mono- and di-alkylated products in yields of *ca.* 70 and 20%, respectively.

The final stages of the synthesis of daljanelin C **5** are outlined in Scheme 2. Preparation of the highly labile benzyl bromide **25** from the corresponding hydroxymethyl compound **24** was accomplished in quantitative yield‡ *via* the Collington–Meyers protocol[24] using a mixture of methanesulfonyl anhydride, lithium bromide and 2,6-dimethylpyridine in THF. Coupling of the bromide **25** and the stable silyl enol ether **26** was effected in 22% yield *via* the TASF–HMPA procedure to give the *C*-

‡ In the ^{1}H NMR spectrum used to monitor the reaction, the 8-methylene protons of **25** resonate as an AB system in contrast to the single doublet that was observed in the spectrum of the benzyl alcohol **24**.

Table 2 ^{1}H NMR peaks (ppm) of the (+)-medicarpin analogues **21**–**25** (27 °C) at 300 MHz. Splitting patterns and *J* values (Hz) are given in parentheses

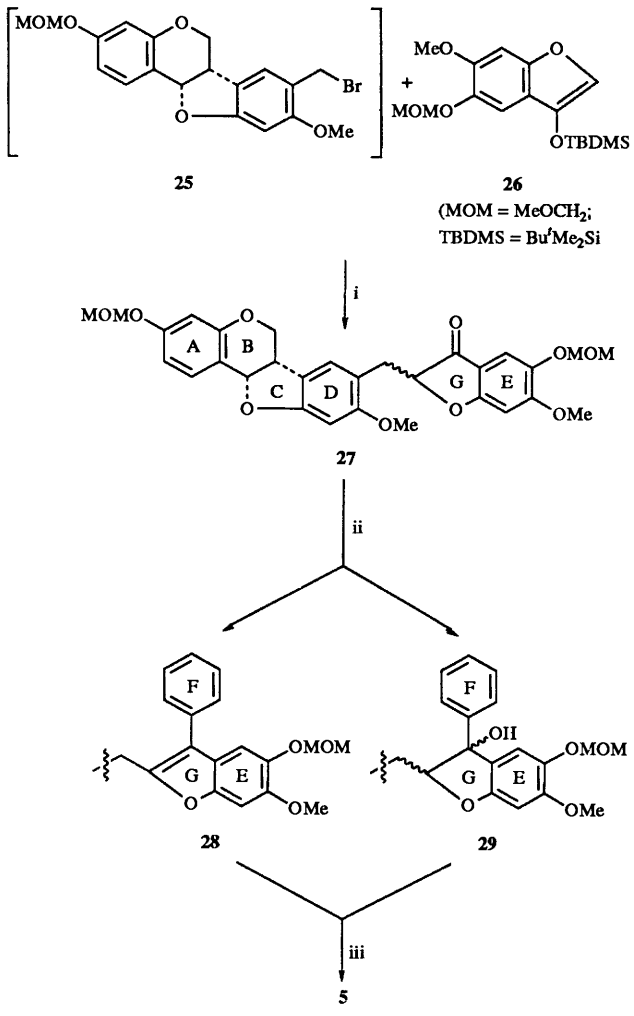
Ring	Proton	**21**/$CDCl_3$	**22**/$CDCl_3$	**23**/$CDCl_3$	**24**/$CDCl_3$	**25**/C_6D_6
A	1	7.36–7.33 (m)	7.39 (d, 8.5)	7.40 (d, 8.5)	7.41, 7.44† (d, 8.5)	7.39 (dd, 1.0, 8.5)
	2	6.54 (dd, 2.5, 8.5)	6.74 (dd, 2.5, 8.5)	6.74 (dd, 2.5, 8.5)	6.73, 6.80† (dd, 2.5, 8.5)	6.80 (dd, 2.5, 8.5)
	4	6.40 (d, 2.5)	6.62 (d, 2.5)	6.63 (d, 2.5)	6.62, 6.92† (d, 2.5)	6.91 (d, 2.5)
B	6_{ax}	3.62 (dd, 11.0, 11.0)	3.64 (dd, 11.0, 11.0)	3.68–3.54 (m)	3.62 (dd, 11.0, 11.0)	3.77–3.83 (m)
	6_{eq}	4.22 (dd, 4.0, 11.0)	4.23 (ddd, 1.0, 4.0, 11.0)	4.35–4.24 (m)	4.24 (dd, 4.0, 11.0)	3.83 (dd, 5.0, 11.0)
	6a	3.58–3.50 (m)	3.60–3.51 (m)	3.68–3.54 (m)	3.57–3.49 (m)	—
	11a	5.51 (d, 6.5)	5.53 (d, 6.5)	5.58 (d, 6.5)	5.50, 5.25† (d, 6.5)	5.20 (d, 7.0)
D	7	7.36–7.33 (m)	7.35 (br s)	7.77 (br s)	7.13, 7.12† (br s)	6.65 (br s)
	10	6.47 (br s)	6.47 (br s)	6.47 (br s)	6.45, 6.31† (br s)	6.20 (br s)
	3-OH	5.00 (s)	—	—	—	—
	3-OCH_2	—	5.13, 5.16 (2 × d, 6.5 each)	5.13, 5.16 (2 × d, 6.5 each)	5.13, 5.16 (2 × d, 6.5 each)	4.80, 4.77 (2 × d, 6.5 each)
	3-OCH_2OMe	—	3.45 (s)	3.44 (s)	3.44 (s)	3.07 (s)
	8-CO_2CH_2	—	—	4.35–4.24 (m)	—	—
	8-$CO_2CH_2CH_3$	—		1.35 (t, 7.0)	—	—
	8-CH_2OH	—	—	—	4.59 (s), 4.77† (d, 6.0)	4.52, 4.36 (2 × d, 9.5 each)
	9-OMe	3.82 (s)	3.82 (s)	3.84 (s)	3.80, 3.17† (s)	3.16 (s)

† Chemical shifts of compound **24** in C_6D_6

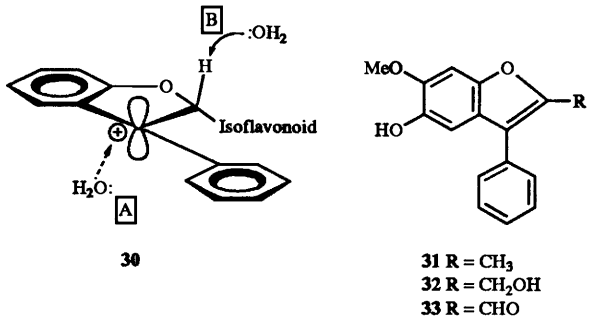
Table 3 ^{1}H NMR peaks (ppm) of the synthetic intermediates **27**, **28** and **29** in $CDCl_3$ (27 °C) at 300 MHz. Splitting patterns and *J* values (Hz) are given in parentheses

Ring	Proton	**27**	**28**	**29**
A	1	7.41 (2 × d, 8.5 each)	overlapped by 5 × H-F	overlapped by 5 × H-F
	2	6.73 (2 × dd, 2.5, 8.5 each)	6.72 (dd, 2.5, 8.5)	6.73 (2 × dd, 2.5, 8.5 each)
	4	6.62 (2 × d, 2.5 each)	6.61 (d, 2.5)	6.65 (2 × d, 2.5 each)
B	6_{ax}	3.61 (2 × dd, 11.0 each)	3.56 (dd, 11.0, 11.0)	3.61 (dd, 11.0, 11.0)
	6_{eq}	4.26–4.19 (m)	4.17 (dd, 5.0, 11.0)	4.25, 4.16 (2 × dd, 5.0, 11.0 each)
	6a	3.56–3.45 (m)	3.53–3.39 (m)	3.53–3.47 (m)
	11a	5.50, 5.48 (2 × d, 6.5 each)	5.45 (d, 6.5)	5.45–5.40 (m)
D	7	7.05 (2 × s)	6.89 (br s)	7.10, 7.07 (2 × s)
	10	6.45, 6.44 (2 × s)	6.42 (s)	6.54 (2 × s)
	CH_2	3.44, 3.33, 2.75, 2.58 (4 × dd, 3.0, 4.0, 9.0, 10.0, 14.5)	4.13, 4.03 (2 × d, 17.0 each)	3.22, 3.17, 3.03, 2.98 (4 × dd, 5.0, 8.0, 8.5, 18.0)
E	4	7.35, 7.34 (2 × s)	7.31 (s)	6.77 (2 × s)
	7	6.57, 6.53 (2 × s)	7.05 (s)	6.28, 6.25 (2 × s)
F		—	7.51–7.33 (m, 5 × H)	7.41–7.34, 7.29–7.19 (2 × m)
G		4.86–4.80 (m)	—	4.82–4.75 (m)
	OMe	3.79, 3.78 (2 × s, 9-D), 3.92 (2 × s, 6-E)	3.69 (s, 9-D), 3.90 (s, 6-E)	3.84, 3.82 (each s, 9-D), 3.84, 3.82 (each s, 6-E)
	OCH_2OMe	5.16–5.14 (4 × s)	5.20 (s), 5.15, 5.13 (2 × d, 7.0 each)	5.16, 5.13, 5.04, 5.00 (4 × d, 7.0 each)
	OCH_2OMe	3.49, 3.45, 3.44 (3 × s)	3.55, 3.41 (each s)	3.55, 3.47, 3.45, 3.42 (each s)

alkylated product **27** as a diastereoisomeric mixture as was evident from the double set of signals in the ^{1}H NMR spectrum (Table 3). Grignard reaction of compound **27** with phenylmagnesium bromide in THF afforded the dehydrated product **28** (13%) and the carbinol **29** (47%). The conspicuous stability of the carbinol **29** a mixture of diastereoisomers, towards acidic work-up may, presumably, be attributed to the high degree of stabilization of the double-benzylic carbocation **30**. The distribution of products is thus the result of a kinetic effect with the carbocation **30** being formed rapidly from the carbinol



Scheme 2 Coupling of the activated neoflavonoid precursor **26** to the functionalized (+)-medicarpin **25**. *Reagents and conditions:* i, TASF–HMPA, then aq. NH_4Cl; ii, PhMgBr–THF, then 3 mol dm^{-3} HCl, 0 °C; iii, 0.1 mol dm^{-3} HCl–MeOH–reflux.



29 in a reversible step (path A) due to a small activation energy term ($\Delta G^{\ddagger}$). Subsequent formation (path B) of the thermodynamically favoured product **28** then proceeds slowly under the relatively mild acidic conditions, such mild conditions being a prerequisite due to the known acid lability of the benzylic carbon–oxygen σ-bond of the pterocarpan unit. This bond, however, remained intact when a mixture of compounds **28** and **29** were refluxed in methanol containing 0.1 mol dm^{-3} hydrochloric acid to effect simultaneous deprotection and dehydration affording daljanelin C **5** (84%), identical with the natural product by comparison of ^1H NMR and CD data. The synthesis of this compound was thus completed in eight linear steps in 4.6% overall yield.

A putative 3-arylbenzo[*b*]furan **32**, one of a small group, **31**–**33**, of true neoflavonoids with a five-membered heterocycle[16,17] and whose presence has been demonstrated in *Dalbergia* species, with its highly labile allylic alcohol functionality presumably serves as the electrophile in coupling with the nucleophilic positions of the relevant rings of the isoflavonoid moieties during the biosynthetic sequence to these novel natural products.

The electron-withdrawing effect of the benzylic oxygen function on the pterocarpan A-ring, disfavours electrophilic aromatic substitution as viable method of functionalizing this ring. Synthesis of the remaining isomers **1**, **3** and **6** will thus require a different approach to that pursued in the first step of the sequence in Scheme 3. Several of these approaches are at present being investigated, details of which will be the subject of a separate paper.

Experimental

^1H NMR spectra were recorded on a Bruker AM-300 spectrometer for solutions in $CDCl_3$, C_6D_6 and $(CD_3)_2CO$ with Me_4Si as internal standard. *J* Values are given in Hz. Mass spectra were obtained with a Kratos MS-80 instrument, CD data in methanol on a JASCO J-710 spectropolarimeter, and UV data in methanol on a Hitachi 150-20 spectrophotometer. Mps were determined with a Reichert Thermopan microscope with Koffler hot-stage and are uncorrected. TLC was performed on pre-coated Merck plastic sheets (silica gel 60 PF_{254}, 0.25 mm) and the plates were sprayed with H_2SO_4–HCHO (40:1, v/v) after development. Preparative plates (PLC), 20 × 20 cm, Kieselgel PF_{254} (1.0 mm) were air-dried and used without prior activation. Separations on Sephadex LH-20 were on various column sizes and at differing flow rates in different solvent systems (to be specified in each instance). Flash column chromatography (FCC) was carried out in a glass column (5 cm diameter) charged with 100 g of Merck Kieselgel 60 (230–400 mesh) for 1 g of crude product. Methylations were performed with an excess of diazomethane in methanol–diethyl ether over a period of 48 h at −15 °C, while acetylations were in acetic anhydride–pyridine at ambient temperature. Evaporations were carried out under reduced pressure at ~ 50 °C in a rotary evaporator. An authenticated log of *D. nitidula* was kindly supplied by Mr D. P. Gwaze, Forest Research Centre, Forestry Commission, PO Box HG 595, Harare, Zimbabwe.

Phenolic metabolites from the ether extract of the heartwood of *D. nitidula*

The ether extract (25 g)[8] was subjected to column chromatography on Sephadex LH-20 (5 × 12 cm column, 2.6 cm^3 min^{-1} flow rate, 0.6–0.8 bar pressure) in ethanol and repeated nine times to give 12 fractions: 1 [retention time 6 h (6.23 g)], 2 [9 h (1.18 g)], 3 [10 h (0.94 g)], 4 [11 h (6.1 g)], 5 [12.5 h (13.53 g)], 6 [14 h (110.67 g)], 7 [18.5 h (9.21 g)], 8 [21 h (9.18 g)], 9 [25 h (9.41 g)], 10 [29 h (19.71 g)], 11 [32.5 h (6.18 g)] and 12 [34.5 h (7.3 g)]. A 13th fraction (7.5 g) was obtained when the columns were washed with methanol. Fraction 9 (6 g) was further resolved by column chromatography on Kieselgel 60 (5 × 95 cm column, flow rate 0.4 cm^3 min^{-1}) in hexane–benzene–acetone–methanol (42:40:15:3, v/v) to give 21 sub-fractions: 9.1 [retention time 30.5 h (18.3 mg)], 9.2 [35 h (89 mg)], 9.3 [44 h (45.4 mg)], 9.4 [49 h (50.5 mg)], 9.5 [53.5 h (218.8 mg)], 9.6 [63 h (27.2 mg)], 9.7 [65 h (60.5 mg)], 9.8 [70.5 h (66.9 mg)], 9.9 [73.5 h (293.2 mg)], 9.10 [83 h (1227.5 mg)], 9.11 [87.5 h (399.5 mg)], 9.12 [93 h (470.2 mg)], 9.13 [104.5 h (239.8 mg)], 9.14 [113 h (38.5 mg)], 9.15 [121.5 h (185.1 mg)], 9.16 [161 h (154.3 mg)], 9.17 [201.5 h (63.3 mg)], 9.18 [219 h (276 mg)], 9.19 [318 h (187.7 mg)], 9.20 [396 h (323.7 mg)] and 9.21 [> 400 h (897.3 mg)]. Only fractions 9.8, 9.9 and 9.10 showed

the potential to contain oligomers and will thus be considered here.

Fraction 9.8 (66.9 mg) was purified by successive PLC [benzene–acetone (19:1, v/v, ×4; R_F 0.58); chloroform–methanol (49:1, v/v, ×2)] to give a band at R_F 0.57 (3.5 mg) which comprised of (6aS, 11aS)-2-(*5-hydroxy-6-methoxy-3-phenylbenzo*[b]*furan-2-ylmethyl*)*medicarpin* **1** as a light brown solid (Found: M^+, 522.1676. $C_{32}H_{26}O_7$ requires *M*, 522.1679); δ_H (Table 1); CD $[\theta]_{320}$ 0, $[\theta]_{300}$ 0.8×10^4, $[\theta]_{293}$ 0, $[\theta]_{287}$ -0.8×10^4, $[\theta]_{276}$ 0, $[\theta]_{240}$ 3.3×10^4 and $[\theta]_{224}$ 0.1×10^4; *m/z* 522 (M^+, 78%), 283, 282 (100), 270, 240, 226 and 225; λ_{max}(MeOH)/nm 211 (log ε 5.55), 260 (4.80), 291 (4.61) and 310sh (4.93). Acetylation of compound **1** (14 mg) afforded the *diacetate* **2** (12 mg) as a light brown solid (Found: M^+, 606.1884. $C_{36}H_{30}O_9$ requires *M*, 606.1888); δ_H (Table 1); *m/z* 606 (M^+, 8.1%), 551, 550 (100), 548, 519, 310, 298, 297, 296, 283, 267, 257, 256, 254, 244, 228 and 227.

Fraction 9.9 (293 mg) was resolved by successive PLC [benzene–acetone (19:1, v/v, ×4; R_F 0.57 and 0.50); chloroform–methanol (49:1, v/v, ×2)] into two bands at R_F 0.66 (43 mg) and 0.40 (3.7 mg). The R_F 0.66 band was further purified by PLC in hexane–acetone–ethyl acetate (6:3:1, v/v, ×2) to give a fraction at R_F 0.60 (38 mg) comprising (6aS, 11aS)-4-(*5-hydroxy-6-methoxy-3-phenylbenzo*[b]*furan-2-ylmethyl*)*medicarpin* **3** as a light brown solid (Found: M^+, 522.1672. $C_{32}H_{26}O_7$ requires *M*, 522.1679); δ_H (Table 1); CD $[\theta]_{315}$ 0, $[\theta]_{288}$ -1.4×10^4, $[\theta]_{254}$ 0, $[\theta]_{238}$ 2.4×10^4 and $[\theta]_{224}$ 0; *m/z* 522 (M^+, 38%), 283, 282 (100), 281, 280, 270, 254, 253, 240, 227, 225, 118 and 91; δ_C($CDCl_3$) 160.9 [C-9(D)], 160.5 [C-10a(D)], 155.6 [C-3(A)], 154.1 [C-4a(A)], 150.6 [C-2(G)], 147.7 [C-7a(E)], 144.8 (C-6(E)], 142.6 [C-5(E)], 132.2 [C-1(F)], 130.0 [C-1(A)], 129.0 [C-2/6(F)], 128.5 [C-3/5(F)], 127.0 [C-4(F)], 124.6 [C-7(D)], 121.2 [C-3a(E)], 119.0 [C-6b(D)], 117.4 [C-4(A)], 112.6 [C-11b(A)], 112.2 [C-3(G)], 110.3 [C-2(A)], 106.2 [C-8(D)], 103.7 [C-4(E)], 96.8 [C-10(D)], 94.5 [C-7(E)], 79.0 [C-11a(B)], 66.6 [C-6(B)], 56.4 [6(E)-OCH_3], 55.5 [9(D)-OCH_3], 39.4 [C-6a(B)] and 21.0 (CH_2); λ_{max}(MeOH)/nm 209 (log ε 4.93), 262 (4.13), 287 (4.19) and 310 (3.89). Methylation of compound **3** (30 mg) and purification by PLC in chloroform–methanol (98:2, v/v) afforded the *di-O-methyl ether* **4** (18 mg) as a light brown solid (Found: M^+, 550.1994. $C_{34}H_{30}O_7$ requires *M*, 550.1992); δ_H (Table 1); *m/z* 550 (M^+, 100%), 519, 297, 296, 267, 258 and 257. The R_F 0.40 band (*vide supra*) was further purified by PLC in hexane–1,2–dichloroethane–acetone (6:3:1, v/v, ×3) to give a fraction at R_F 0.35 (2.3 mg) which comprised of (6aS, 11aS)-8-(*5-hydroxy-6-methoxy-3-phenylbenzo*[b]*furan-2-ylmethyl*)-*medicarpin* **5** as a light brown solid (Found: M^+, 522.1677. $C_{32}H_{26}O_7$ requires *M*, 522.1679); δ_H (Table 1); CD $[\theta]_{320}$ 0.05×10^4, $[\theta]_{308}$ 0.2×10^4, $[\theta]_{300}$ 0, $[\theta]_{290}$ -0.6×10^4, $[\theta]_{279}$ 0, $[\theta]_{248}$ 1.3×10^4 and $[\theta]_{229}$ 0; *m/z* 522 (M^+, 100%), 521, 283, 282, 270, 268, 256, 253, 241, 240 and 225; λ_{max}(MeOH)/nm 206 (log ε 5.23), 257 (4.2), 287 (4.12) and 310sh (3.73).

Fraction 9.10 (127 mg) was further resolved by successive PLC [chloroform–methanol (49:1, v/v, ×2; R_F 0.40); hexane–1,2-dichloroethane–acetone (6:3:1, v/v, ×3) to give a band at R_F 0.19 (8.8 mg) comprising (3S)-8-(*5-hydroxy-6-methoxy-3-phenylbenzo*[b]*furan-2-ylmethyl*)*vestitol* **6** as a light brown solid (Found: M^+, 524.1927. $C_{32}H_{28}O_7$ requires *M*, 524.1954); δ_H($CDCl_3$) 7.54–7.59 [m, 2 × H(E)], 7.39–7.46 [m, 2 × H(E)], 7.28–7.35 [m, 1 × H(E)], 7.02 [s, 4-H(D)], 6.97 [s, 7-H(D)], 6.94 [d, *J* 8.5, 6-H(B)], 6.83 [d, *J* 8.5, 5-H(A)], 6.46 (d, *J* 8.5, 6-H(A)], 6.41 [dd, *J* 8.5, 2.5, 5-H(B)], 6.34 [d, *J* 2.5, 3-H(B)], 5.79 [br s, OH], 5.48 [br s, OH], 5.16 [br s, OH], 4.23, 4.17 [each d, *J* 16.0, CH_2], 4.18 [ddd, *J* 2.0, 3.5, 10.0, 2-$H_{eq.}$(C)], 3.89 [dd, *J* 10.0, 10.0, 2-$H_{ax.}$(C)], 3.90 [s, 6-OMe(D)], 3.74 [s, 4-OMe(B)], 3.35–3.45 [m, 3-H(C)], 2.98 [ddd, *J* 1.0, 6.5, 16.5, 4-$H_{ax.}$(C)] and 2.87 [ddd, *J* 1.0, 10.0, 16.5, 4-$H_{eq.}$(C)]; δ_C($CDCl_3$) 159.4, 154.3, 153.6, 152.5, 151.5, 147.8, 144.9, 142.7, 132.4, 129.3, 128.5, 128.3, 128.2, 127.1, 119.9, 117.4, 114.6, 111.8, 108.8, 105.9, 103.8, 102.1, 94.8, 69.7, 56.4, 55.3, 53.7 and 20.9; CD $[\theta]_{338}$ 0, $[\theta]_{287}$ -0.6×10^4, $[\theta]_{254}$ 0, $[\theta]_{238}$ 1.2×10^4 and $[\theta]_{223}$ 0; *m/z* 524 (M^+, 51%), 522, 297, 282, 271, 254, 253, 241, 240 (100), 227, 225, 150, 149, 148, 137, 135, 115, 105, 91 and 77; λ_{max}(MeOH)/nm 209 (log ε 5.09), 286 (4.33) and 331sh (4.68).

Synthesis of daljanelin C 5

Synthesis of the neoflavonoid precursor 18. *Methoxyhydroquinone* **16**.—A 6% aqueous solution of H_2O_2 (150 cm^3) at 0 °C was slowly added under N_2 to a N_2-purged solution of vanillin **15** (20 g) in 2 mol dm^{-3} NaOH (200 cm^3) at 0 °C. The mixture was stirred at 0 °C for 30 min and subsequently at ambient temperature for 45 min. After acidification with conc. HCl, the mixture was extracted with ether (3 × 100 cm^3) and the extracts were combined and sodium pyrosulfite (excess) added to them. The solution was washed with water, dried (Na_2SO_4) and then evaporated under reduced pressure. Sublimation of the residue afforded the title compound **16** (13.3 g), mp 84–86 °C (lit.,[25] 84 °C), R_F 0.15 [(SiO_2), hexane–benzene–acetone (5:4:1, v/v)] (Found: M^+, 140.0400. Calc. for $C_7H_8O_3$: *M*, 140.0473); δ_H[$(CD_3)_2CO$] 7.73–7.71 (br s, OH), 6.87–6.85 (br s, OH), 6.62 (d, *J* 8.5, 6-H), 6.45 (d, *J* 2.5, 3-H), 6.26 (dd, *J* 8.5, 2.5, 5-H) and 3.77 (s, OMe).

2-*Chloroacetyl-5-methoxybenzene*-1,4-*diol* **17**.—Dry HCl(g) was bubbled through a mixture of methoxyhydroquinone **16** (5.0 g) and freshly fused $ZnCl_2$ (9.7 g) in anhydrous ether (25 cm^3) at ambient temperature under N_2 for 1.5 h. Freshly distilled chloroacetonitrile (2.5 cm^3) in dry ether (25 cm^3) was subsequently added to the mixture over 1 h under N_2 and HCl-bubbling was continued for 6 h to give a dark green paste. The mixture was left at 4 °C for 30 h, after which the solvent was decanted and an excess of water added to the residue. This solution was refluxed for 2 h and left at 4 °C for 5 h to yield the title compound **17** (6.5 g) as light brown crystals (Found: M^+, 216.0185. $C_9H_9ClO_4$ requires *M*, 216.0189; δ_H($CDCl_3$) 11.95 (s, 1-OH), 7.13 (s, 3-H), 6.48 (s, 6-H), 5.25 (s, 4-OH), 4.60 (s, CH_2) and 3.94 (s, 5-OMe). This compound was not recrystallized owing to its susceptibility to oxidation.

5-*Hydroxy-6-methoxy*-2,3-*dihydrobenzo*[b]*furan*-3-*one* **18**.—A slurry of the hydroquinone **17** (6.5 g) and NaOAc (7.4 g) in EtOH (100 cm^3) was refluxed for 3 h under N_2. Crushed ice was added to the mixture and the resulting brown precipitate filtered off. Recrystallization from water afforded the title compound **18** as light brown needles (4.8 g), mp 182–184 °C (Found: C, 60.1; H, 4.40; M^+, 180.0419. $C_9H_8O_4$ requires C, 60.0; H, 4.5%; *M*, 180.0422); δ_H($CDCl_3$) 7.10 (s, 4-H), 6.57 (s, 7-H), 5.42 (s, 5-OH), 4.58 (s, CH_2) and 3.98 (s, 6-OMe).

6-*Methoxy*-5-*methoxymethoxy*-2,3-*dihydrobenzo*[b]*furan*-3-*one* **19**.—A solution of the benzofuranone **18** (4.8 g) in dry DMF was added to a stirred suspension of NaH (1.2 equiv.) in dry DMF at 0 °C. The mixture was stirred for 10 min after which, freshly distilled chloromethyl methyl ether (1.1 equiv.) was added to it and stirring continued for 1 h. Crushed ice was added to the mixture which was then acidified with 1 mol dm^{-3} HCl and extracted with ether (4 × 50 cm^3). The combined extracts were successively washed with water, saturated aqueous $NaHCO_3$, brine and water. The ethereal phase was dried (Na_2SO_4) and evaporated and the residue recrystallized from ethanol to give the protected product **19** (5.9 g) as yellow needles, mp 161–163 °C (Found: M^+, 224.0692. $C_{11}H_{12}O_5$ requires *M*, 224.0683); δ_H($CDCl_3$) 7.34 (s, 4-H), 6.57 (s, 7-H), 5.15 (s, OCH_2OMe), 4.58 (s, CH_2), 3.93 (s, 6-OMe) and 3.48 (s, OCH_2OMe).

Synthesis of (6a*S*, 11a*S*)-8-hydroxymethyl-3-*O*-methoxymethyl-(+)-medicarpin 24

8-*Bromo*-(+)-*medicarpin* **21**.—A solution of (+)-medicarpin **20** (50 mg) in MeOAc (5 cm^3) was added in one portion to a slurry of NBS (35 mg) in MeOAc (5 cm^3) at −98 °C and the mixture was stirred at this temperature for 10 min. Filtration and evaporation of the mixture followed by PLC of the residue in hexane–benzene–acetone (5:4:1, v/v) afforded the title compound **21** (R_F 0.24; 50 mg) as a light-yellow, amorphous solid (Found: C, 55.1; H, 3.8%; M^+, 349.9977. $C_{16}H_{13}BrO_4$ requires C, 55.0; H, 3.75%; *M*, 349.9977); δ_H (Table 2).

8-*Bromo*-3-O-*methoxymethyl*-(+)-*medicarpin* **22**.—A solution of 8-bromo-(+)-medicarpin **21** (371 mg) in dry THF (10 cm^3) was slowly added to a stirred slurry of NaOH (1.2 equiv.) in dry THF (5 cm^3) at 0 °C. The mixture was stirred for 10 min after which, freshly distilled chloromethyl methyl ether (1.1 equiv.) was aded to it and stirring continued for 30 min at 0 °C. Crushed ice was added to the mixture which was then extracted with ether (4 × 50 cm^3). The combined extracts were washed with water (4 × 50 cm^3), saturated aqueous $NaHCO_3$ (1 × 25 cm^3), brine (1 × 25 cm^3) and water (3 × 100 cm^3), dried (Na_2SO_4) and evaporated under reduced pressure. Purification by FCC in hexane–benzene–acetone (5:4:1, v/v) gave the title compound **22** (359 mg) as a white amorphous solid (Found: C, 54.9; H, 4.5%; M^+, 394.0235. $C_{18}H_{17}BrO_5$ requires C, 55.0; H, 4.4%; *M*, 394.0239); δ_H (Table 2); CD $[\theta]_{314}$ 0, $[\theta]_{290}$ -1.6×10^4, $[\theta]_{268}$ 0, $[\theta]_{238}$ 6.9×10^4 and $[\theta]_{226}$ 1.8×10^4.

8-*Ethoxycarbonyl*-3-O-*methoxymethyl*-(+)-*medicarpin* **23**.—Butyllithium (1.47 mol dm^{-3} solution in hexanes; 95 mm^3)§ was slowly added to a stirred solution of the medicarpin analogue **22** (50 mg) in THF (1.0 cm^3) at −110 °C under N_2 tetramethylethylenediamine (TMEDA) (40 mm^3) was added to the mixture and stirring continued for 1 h (−110→−78 °C). After this a solution of freshly distilled ethyl chloroformate (30 mm^3) in THF (1.0 cm^3) at −78 °C was added to the mixture and stirring continued for 4 h (−78→0 °C). Saturated aqueous NH_4Cl (excess) was then added to the mixture which was then extracted with ether (4 × 50 cm^3). The combined extracts were washed with water (3 × 50 cm^3) and brine (1 × 25 cm^3), dried (Na_2SO_4) and evaporated under reduced pressure. PLC in hexane–benzene–acetone (5:4:1, v/v) afforded the title compound **23** (37 mg, R_F 0.38) as a colourless oil (Found: C, 65.2; H, 5.8%; M^+, 386.1365. $C_{21}H_{22}O_7$ requires C, 65.3; H, 5.7%; *M*, 386.1366); δ_H (Table 2); ν_{max}/cm^{-1} 1716 (>C=O).

8-*Hydroxymethyl*-3-O-*methoxymethyl*-(+)-*medicarpin* **24**.—A solution of the ethyl ester **23** (37 mg) in anhydrous THF (1.0 cm^3) was slowly added to a stirred suspension of $LiAlH_4$ (11 mg) in THF (1.0 cm^3) at 0 °C under N_2. The mixture was stirred at 0 °C for 10 min and then carefully diluted with EtOAc until evolution of H_2 had ceased. The mixture was extracted with ether (4 × 50 cm^3) and the combined ethereal layers were washed with water (4 × 50 cm^3), dried (Na_2SO_4) and evaporated to dryness. PLC in hexane–benzene–acetone (5:4:1, v/v) afforded the 8-hydroxymethyl analogue **24** (27 mg; R_F 0.13) as a white amorphous solid (Found: C, 66.25; H, 5.9%; M^+, 344.1263. $C_{19}H_{20}O_6$ requires C, 66.3; H, 5.85%; *M*, 344.1260); δ_H (Table 2).

Coupling of the activated neoflavonoid precursor 26 to the functionalized (+)-medicarpin 25: synthesis of 8-bromomethyl-3-*O*-methoxymethyl-(+)-medicarpin 25. 2,6-Dimethylpyridine (80 mm^3) was added to a stirred solution of the 8-hydroxymethyl-(+)-medicarpin **24** (113 mg) and oven-dried LiBr (86 mg) in dry THF (1.0 cm^3) at ambient temperature under argon until all the LiBr had dissolved. The mixture was cooled to 0 °C and a solution of methanesulfonyl anhydride (69 mg) in THF (1.0 cm^3) was added to it under Ar. The resulting suspension was stirred at ambient temperature until ^1H NMR (Table 2) indicated complete conversion of the alcohol **24** into the bromide **25**. The latter compound was used directly in the alkylation step (*vide infra*).

3-tert-*Butyldimethylsilyloxy*-6-*methoxy*-5-*methoxymethyl*-*benzo*[b]*furan* **26**.—Triethylamine (50 mm^3) was slowly added to a stirred solution of 6-methoxy-5-methoxymethoxy-2,3-dihydrobenzo[*b*]furan-3-one **19** (50 mg) and oven-dried NaI (50 mg) in dry acetonitrile (0.5 cm^3). A solution of *tert*-butyldimethylsilyl chloride (50 mg) in MeCN (0.5 cm^3) was slowly added at ambient temperature to the mixture which was then stirred at room temperature for 12 h, before being diluted with cold water (2 cm^3) and exhaustively extracted with cold pentane. The combined pentane layers were kept at *ca.* 0 °C and washed with chilled water, dried ($MgSO_4$) and then evaporated to give the title compound **26** (75 mg) as a yellow oil (Found: M^+, 338.1551. $C_{17}H_{26}O_5Si$ requires *M*, 338.1550); $\delta_H(C_6D_6)$ 7.60 (s, 4-H), 7.18 (s, 2-H), 6.79 (s, 7-H), 5.03 (s, 5-OCH_2OMe), 3.25 (s, 5-OCH_2OMe and 6-OMe), 0.99 (s, 3-Bu^t) and 0.10 (s, 2 × Me).

8-(6-*Methoxy*-5-*methoxymethoxy*-2,3-*dihydrobenzo*[b]*furan*-3-*one*-2-*ylmethyl*)-3-O-*methylmethoxy*-(+)-*medicarpin* **27**.—A solution of the silyloxybenzofuran **26** (279 mg) in THF (2.5 cm^3) was slowly added to a stirred suspension of tris(dimethylamino)sulfonium difluorotrimethylsilicate (238 mg) in THF (2.5 cm^3) at −78 °C under Ar. The mixture was stirred for 15 min after which HMPA (0.75 cm^3) was added to it and stirring continued for 15 min. After this suspension containing the 8-bromomethyl-(+)-medicarpin **25** was slowly added to it by filtration under Ar through a septum-capped syringe (10 cm^3) charged with cotton wool. The resulting mixture was stirred (1 h: −78→−30 °C, 8 h: −30 °C) and then worked up and the residue purified by PLC in hexane–benzene–acetone (5:4:1, v/v) to give the title compound **27** (40 mg; R_F 0.25) as a yellow oil and as a diastereoisomeric mixture that was not resolved (Found: M^+, 550.1839. $C_{30}H_{30}O_{10}$ requires *M*, 550.1839); δ_H (Table 3); CD $[\theta]_{310}$ 0, $[\theta]_{288}$ -6.2×10^3, $[\theta]_{269}$ 0, $[\theta]_{238}$ 2.1×10^4 and $[\theta]_{223}$ 5.1×10^3.

8-[6-*Methoxy*-5-*methoxymethoxy*-3-*phenylbenzo*[b]*furan*-2-*ylmethyl*]-3-O-*methylmethoxy*-(+)-*medicarpin* **28**.—Phenylmagnesium bromide (1.52 mol dm^{-3} solution in THF; 100 mm^3) was added to a stirred solution of the diastereoisomeric (+)-medicarpin analogue **27** (40 mg) in THF (1.0 cm^3) at 0 °C and the solution was stirred at ambient temperature for 8 h. An excess of crushed ice was added to the mixture which was then carefully acidified with 3 mol dm^{-3} HCl and exhaustively extracted with ether. The combined extracts were washed with water (4 × 25 cm^3), saturated aqueous $NaHCO_3$ (1 × 10 cm^3) and water (4 × 25 cm^3), dried (Na_2SO_4) and evaporated under reduced pressure. PLC in hexane–benzene–acetone (5:4:1, v/v) of the residue afforded two fractions at R_F 0.48 (6 mg) and 0.21 (22 mg). The former fraction gave the title compound **28** as a yellow oil (Found: M^+, 610.2202. $C_{36}H_{34}O_9$ requires *M*, 610.2203); δ_H (Table 3); δ_C¶($CDCl_3$) 159.4, 158.5, 158.2, 156.5, 152.1, 150.0, 148.5, 143.5, 132.8, 131.8, 128.8 (5 × C-F), 127.0, 124.9 [C-7(D)], 120.8, 118.6, 118.2, 118.0, 113.7, 110.5, 107.6 [C-4(E)], 104.4 [C-4(A)], 96.5 and 94.3 [3(A)- and 5(E)-OCH_2OCH_3], 95.7 [C-7(D)], 94.1 [C-10(D)], 78.4, 66.6, 56.3 [6(E)-OMe and 3(A)- or 5(E)-OCH_2OCH_3], 56.0 [3(A)- or 5(E)-OCH_2OCH_3], 55.5 [9(D)-OMe], 39.7 and 26.8 [8(D)-CH_2]; CD $[\theta]_{320}$ 0, $[\theta]_{305}$ 2.8×10^3, $[\theta]_{299}$ 0, $[\theta]_{288}$ -9.7×10^3, $[\theta]_{279}$ 0, $[\theta]_{238}$ 3.9×10^4 and $[\theta]_{223}$ 9.4×10^3. The R_F 0.21 band comprised mainly of the 8-[3-*hydroxy*-

§ 1 mm^3 = 1 μl.

¶ Only the carbon atoms that were evident from C-H correlation were assigned.

6-methoxy-5-methoxymethoxy-3-phenyl-2,3-dihydrobenzo[b]-*furan-2-ylmethyl*]-3-O-*methylmethoxy-(+)-medicarpin* **29** as an unstable yellow oil which was characterized by ^{1}H NMR (Table 3) only.

***(6aS, 11aS)-8-(5-Hydroxy-6-methoxy-3-phenylbenzo*[b]-*furan-2-ylmethyl)medicarpin* 5.** 0.1 mol dm^3 HCl (5 cm^3) was added to a mixture of the aforementioned intermediates **28** (6 mg) and **29** (22 mg) in MeOH (5 cm^3). The mixture was refluxed for 1 h and then cooled to room temperature, neutralized with saturated aqueous $NaHCO_3$ and exhaustively extracted with ether. The combined extracts were washed with water (4 × 50 cm^3), saturated aqueous NH_4Cl (1 × 10 cm^3) and water (4 × 50 cm^3), dried (Na_2SO_4) and evaporated under reduced pressure. PLC in benzene–acetone–methanol (6:3:1, v/v) of the residue afforded daljanelin C **5** (R_F 0.88, 20 mg) (Found: M^+, 522.1678. $C_{32}H_{26}O_7$ requires M, 522.1679); δ_H (Table 1); CD $[\theta]_{320}$ 0, $[\theta]_{307}$ 1.6 × 10^3, $[\theta]_{301}$ 0, $[\theta]_{289}$ −8.7 × 10^3, $[\theta]_{278}$ 0, $[\theta]_{240}$ 2.6 × 10^4 and $[\theta]_{223}$ 0.

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