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J. Nat. Prod., **1994**, 57 (2), 324-327 • DOI:
10.1021/np50104a024 • Publication Date (Web): 01 July 2004

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DC 20036

COUMARINS FROM TWO ASTEROLASIA SPECIES

SATYAJIT D. SARKER, ALEXANDER I. GRAY, PETER G. WATERMAN,*

*Phytochemistry Research Laboratories, Department of Pharmaceutical Sciences,
University of Strathclyde, Glasgow, G1 1XW, Scotland, UK*

and JAMES A. ARMSTRONG

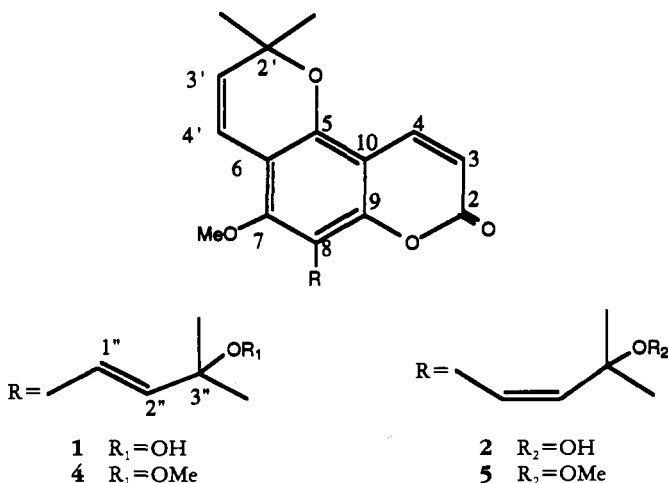
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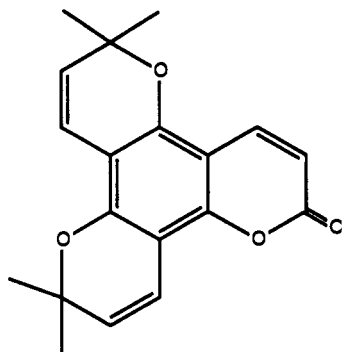
ABSTRACT.—Five pyranocoumarins, avicennol, *cis*-avicennol, dipetalolactone, avicennol methyl ether, and *cis*-avicennol methyl ether have been isolated from the aerial parts of *Asterolasia drummondii*. Examination of the aerial parts of *Asterolasia squamuligera* has shown it to contain 3-(3-hydroxy-3-methyl-*trans*-but-1-enyl)-7-methoxycoumarin [6], which is novel. *Asterolasia drummondii*, in addition to containing coumarins, has afforded the furoquinoline alkaloids, maculosidine and γ -fagarine.

Asterolasia F. Muell. is an Australian genus of the Rutaceae for which 11 species are recognized (1). No phytochemical information is currently available on any species of this genus. As part of our ongoing chemotaxonomic survey of Australian Rutaceae, we have undertaken the phytochemical investigation of two *Asterolasia* species, *Asterolasia drummondii* P.G. Wilson and *Asterolasia squamuligera* (Hook.) Benth. Both of these species are small shrubs that occur in Western Australia (2). Here we wish to report on the major secondary metabolites found in samples of the aerial parts of these two species.

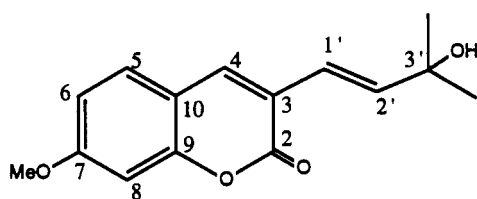
From an *n*-hexane extract of *Asterolasia drummondii* five pyrano-

coumarins were isolated by a combination of vacuum-liquid chromatography (vlc) and preparative thin-layer chromatography (prep. tlc). They were characterized as avicennol [1] (3), *cis*-avicennol [2] (4), dipetalolactone [3] (5), avicennol methyl ether [4] (6), and *cis*-avicennol methyl ether [5] (6), by direct comparison of their physical and spectroscopic properties with that of the authentic samples previously isolated in our Strathclyde laboratory. ¹³C-Nmr chemical shift data for the pyranocoumarins 1–3 are published here for the first time. Two furoquinoline alkaloids, maculosidine and γ -fagarine, were also isolated from this plant. These alkaloids are very common in the Rutaceae (7).





3



6

Similar purification of the petroleum ether (bp 60–80°) extract of the aerial parts of *Asterolasia squamuligera* yielded a novel coumarin that was identified and characterized by spectroscopic methods. This compound was observed on tlc as a purple fluorescent spot under uv light (366 nm) and showed an uv absorption maximum at 334 nm suggestive of a

coumarin (8). The empirical formula was found to be $C_{15}H_{16}O_4$, from hreims data. From the 1H -nmr spectrum (Table 1) a broadened singlet (1H) at δ 7.63 was typical for H-4 of a 3-substituted coumarin having no oxygen attachment at C-5 (8). Ortho, ortho-meta, and meta couplings were observed for three aromatic protons which were assigned to C-5, C-6 and C-8. A three-proton singlet at δ 3.88 was assigned for a methoxyl group at C-7 and this was confirmed by a NOESY experiment. The remaining signals, which must be attributed to the C-3 substituent, were identical to those of the 3-hydroxy-3-methyl-*trans*-but-1-enyl side-chain of avicennol [1]. In a NOESY spectrum, H-4 showed strong correlation with the H-1' and H-5. The presence of a hydroxyl group was confirmed by the mass spectral fragment ion at m/z 342 $[M-18]^+$. Finally, an HMBC spectrum (9) (Table 2) allowed unequivocal assignment of all the observed carbon resonances (the signal for C-10 was not observed in the ^{13}C -nmr spectrum). The new compound must therefore be assigned the structure 6.

The presence of the pyranocoumarins 1–5 in *Asterolasia drummondii* is of considerable chemotaxonomic interest. These

TABLE 1. 1H -Nmr and ^{13}C -Nmr Spectral Data for Compound 6.

Position	δ $^{13}C^a$	δ $^1H^b$
2	161.0	
3	116.1	
4	138.1	7.63 (s)
5	128.8	7.38 (d, $J=8.6$ Hz)
6	113.1	6.85 (dd, $J=8.6, 2.3$ Hz)
7	162.2	
8	100.8	6.83 (d, $J=2.3$ Hz)
9	154.0	
10	— ^c	
1'	120.1	6.59 (d, $J=16$ Hz)
2'	141.9	6.84 (d, $J=16$ Hz)
3'	71.9	
3'-2 \times CH ₃	30.2	1.43 (s)
7-CH ₃ O	56.0	3.88 (s)

^aSolution in $CDCl_3$ referenced to $CHCl_3$ at δ 77.23 ppm; 100 MHz.

^bSolution in $CDCl_3$ referenced to $CHCl_3$ at δ 7.27 ppm; 400 MHz.

^cNot observed.

TABLE 2. HMBC H-C-C-C Long-Range Coupling of Compound 6.

Proton(s)	$\delta^{13}\text{C}$		
	Direct	2J	3J
H-4			120.1 (C-1'), 128.8 (C-5), 161.0 (C-2) and 154.0 (C-9) 138.1 (C-4)
H-5			
H-1'	120.1 (C-1')		
3'-CH ₃		71.9 (C-3)	141.9 (C-2')
7-CH ₃ O		162.2 (C-7)	

same compounds, or at least a subset of them, have also been found in several other species in the Rutaceae: *Philotheca citrina* (6), *Eriostemon coccineus* (6), *Geleznovia verrucosa* (10), and several species of *Zanthoxylum* (3–5). In each of these sources, this group of coumarins clearly represent the major secondary metabolites. As was previously pointed out (6), the coincidence of these coumarins in *Eriostemon coccineus* and *Philotheca citrina* is very supportive of the close affinity between *Eriostemon* sect. *Nigrostipulae* A and *Philotheca* suggested by cladistic studies (11). *Geleznovia* and *Asterolasia* also belong to the same tribe, *Boronieae*, as do *Eriostemon* and *Philotheca*, but are not currently regarded as being particularly closely related to them. Some chemotaxonomic affinity between *Asterolasia drummondii* and *Asterolasia squamuligera* may be reflected in the co-occurrence of the 3-hydroxy-3-methyl-*trans*-but-1-enyl side-chain in **1** and **6**.

EXPERIMENTAL

GENERAL EXPERIMENTAL PROCEDURES.—The ir and uv spectra were recorded on a Perkin-Elmer 781 and a Perkin-Elmer 552 spectrophotometer, respectively. The ms were recorded on an AEI MS 902 spectrometer. ^1H -, ^{13}C -, ^1H - ^1H COSY, NOESY, and HMBC nmr spectra were recorded on a Bruker AMX-400 instrument (d_6 set for $J = \text{ca. } 7 \text{ Hz}$). Chemical shifts were reported in ppm relative to solvent (CDCl_3). The following Si gels were used: Si gel (Merck 7749) for vlc and Si gel 60-PF₂₅₄ for tlc.

PLANT MATERIAL.—*Asterolasia drummondii* (Voucher: PERTH 01194879) and *Asterolasia squamuligera* (Voucher: PERTH 01656279) were

collected in the southwest of Western Australia. Vouchers are deposited at the Western Australian Herbarium, Perth, Australia.

EXTRACTION AND ISOLATION OF COMPOUNDS FROM ASTEROLASIA DRUMMONDII.—Powdered aerial parts of *Asterolasia drummondii* (150 g) were extracted in a Soxhlet with, successively, *n*-hexane, EtOAc, and MeOH. The concentrated *n*-hexane extract (4 g) was subjected to vlc, eluting with petroleum ether containing increasing amounts of CHCl_3 , followed by EtOAc. The fractions eluted with petroleum ether- CHCl_3 (1:4 to 1:9) were mixed and subjected to further vlc eluting with a petroleum ether-EtOAc solvent mixture of increasing polarity. Prep. tlc of the bulked petroleum ether-EtOAc (3:2) fraction, eluting with CHCl_3 -EtOAc (4:1) yielded **1** (15 mg) and **2** (10 mg). Compound **3** (13 mg) was isolated from the 2–15% EtOAc in petroleum ether eluate using prep. tlc [CHCl_3 -EtOAc (9:1)]. From the 24% EtOAc in petroleum ether eluate, **4** and **5** were isolated as a mixture (3.2 mg), by prep. tlc [CHCl_3 -EtOAc (3:2)]. The two furoquinoline alkaloids, maculosidine and γ -fagarine, were isolated as a mixture (3 mg) from the 100% EtOAc eluate by prep. tlc [CHCl_3 -EtOAc (4:1)].

EXTRACTION AND ISOLATION OF COUMARINS FROM ASTEROLASIA SQUAMULIGERA.—Powdered aerial parts of *Asterolasia squamuligera* (330 g) were extracted as above but using petroleum ether (bp 60–80°) instead of *n*-hexane as the initial solvent. The concentrated petroleum ether extract (7.2 g) was subjected to vlc eluting with petroleum ether-EtOAc mixtures of increasing polarity. The 60% EtOAc eluate yielded the coumarin **6** (3.4 mg) after prep. tlc using the solvent system toluene-EtOAc-HOAc (35:14:1).

Avicennol [**1**] (15 mg).—Yellow plates from *n*-hexane-EtOAc (19:1), mp 124.5–125.5°; hreims m/z [M]⁺ 342.1475 (calcd 342.1467 for $\text{C}_{20}\text{H}_{22}\text{O}_3$); mp, uv, ir, ^1H nmr, eims in agreement with literature values (3); ^{13}C nmr (100 MHz, CDCl_3) δ 161.0 (C-2), 116.6 (C-3), 138.5 (C-4), 149.3 (C-5), 110.9 (C-6), 157.2 (C-7), 111.3 (C-8), 152.7

(C-9), 106.3 (C-10), 71.4 (C-2'), 129.3 (C-3'), 112.8 (C-4'), 143.1 (C-1''), 114.4 (C-2''), 77.9 (C-3''), 29.9 (2×CH₃-2'), 61.6 (CH₃O-7), and 28.1 (2×CH₃-3'').

cis-Avicennol [2] (10 mg).—Amorphous, hreims *m/z* [M]⁺ 342.1463 (calcd 342.1467 for C₂₀H₂₂O₅); uv, ir, ¹H nmr, eims in agreement with literature values (4); ¹³C nmr (100 MHz, CDCl₃) δ 161.1 (C-2), 116.5 (C-3), 138.5 (C-4), 149.4 (C-5), 110.5 (C-6), 155.4 (C-7), 112.5 (C-8), 152.2 (C-9), 106.4 (C-10), 71.6 (C-2'), 129.4 (C-3'), 113.2 (C-4'), 143.1 (C-1''), 115.3 (C-2''), 78.1 (C-3''), 29.9 (2×CH₃-2'), 61.6 (CH₃O-7), and 28.3 (2×CH₃-3'').

Dipetalolactone [3] (13 mg).—Plates from EtOH; mp 119–120°; hreims *m/z* [M]⁺ 310.1198 (calcd 310.1205 for C₁₅H₂₂O₄), mp, uv, ir, ¹H nmr and eims in agreement with literature values (5); ¹³C nmr (100 MHz, CDCl₃) δ 161.5 (C-2), 110.8 (C-3), 139.0 (C-4), 150.3 (C-5), 106.4 (C-6), 150.3 (C-7), 102.5 (C-8), 152.2 (C-9), 103.3 (C-10), 78.2 (C-2'), 127.9 (C-3'), 116.1 (C-4'), 78.2 (C-2''), 127.9 (C-3''), 115.4 (C-4''), 28.4 (2×CH₃-2'), and 28.4 (2×CH₃-2'').

Avicennol methyl ether [4] + *cis-avicennol methyl ether* [5] (3.2 mg).—Gum. Hreims *m/z* [M]⁺ 356.1613 (calcd 356.1624 for C₂₁H₂₄O₅); uv, ir, ¹H nmr, eims in agreement with literature values (6).

Maculosidine + *γ-fagarine* (3 mg).—Gum; ¹H nmr in agreement with literature values (7) and (12), respectively.

3-(3-Hydroxy-3-methyl-trans-but-1-enyl)-7-methoxycoumarin [6].—Amorphous; uv λ max (EtOH) 334 nm; ¹H nmr and ¹³C nmr see Table 1; HMBC correlation data, see Table 2; hreims *m/z* [M]⁺ 260.1050 (calcd 260.1049 for C₁₅H₁₆O₄); major fragment ions *m/z* 245 [M-15]⁺ (24), 242 [M-18]⁺ (15), 217 [M-43]⁺ (100), 201 [M-59]⁺ (44) and 189 [M-71]⁺ (79).

ACKNOWLEDGMENTS

S.D. Sarker thanks the Association of Commonwealth Universities for the award of a scholarship. Nmr studies were performed at the University of Strathclyde nmr laboratory. The Royal Society of London is thanked for support (to P.G.W.) for the collection of plant material.

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Received 1 September 1993