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J. Nat. Prod., **1992**, 55 (2), 245-248• DOI: 10.1021/np50080a018 • Publication Date (Web): 01 July 2004

Journal of Natural Products
Vol. 55, No. 2, pp. 245-248, February 1992

CALODENONE, A NEW ISOBIFLAVONOID FROM *OCHNA CALODENDRON*

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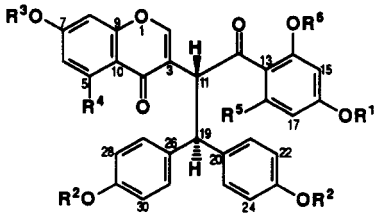
ABSTRACT.—The MeOH extract of the stem bark of *Ochna calodendron* has furnished a new biflavonoid, calodenone [**2**], the structure of which has been established from spectroscopic and chemical evidence.

Ochna calodendron Gilg. et Mildbr. (Ochnaceae) is a tall tree widely distributed in the west African forest where its extracts are used to solve several health problems. Previous chemical studies of members of the Ochnaceae (1–9) have revealed the structures of several biflavonoids; especially interesting are those from the genus *Lophira* (3–9). In continuation of our phytochemical studies of the Ochnaceae, we have examined the MeOH extract of stem bark of *O. calodendron*. Our work has resulted in the isolation and identification of two known compounds (β-sitosterol-β-D-glucoside and lophirone A [**1**]) and the structural determination of a new isobiflavonoid, calodenone [**2**], whose structure we report in this paper.

Lophirone A [**1**] ($C_{30}H_{22}O_8$, $[M]^+$ *m/z* 510), was isolated as an amorphous light brown solid and gave a positive flavonoid test (Mg/HCl) (10). Spectroscopic studies (nmr, ir, ms) gave parameters identical with those reported for lophirone A (4). Confirmation came from a direct comparison of the spectra with those of an authentic sample of lophirone A earlier obtained from *Lophira lanceolata* (4). β-Sitosterol-β-D-glucoside gave the normal physical, chemical, and spectral data (11).

Compound **2** ($C_{31}H_{24}O_8$, $[M]^+$ *m/z* 524) was obtained as an amorphous brown solid and gave a positive flavonoid test (10). Its ir spectrum was very similar to that of lophirone A [**1**] and had absorption bands at 3333 cm^{-1} (hydroxyl groups), 1631 cm^{-1} (conjugated carbonyl groups), and 1541 cm^{-1} (aromatic rings and conjugated double bonds).

The presence of four hydroxyl groups in the structure of **2** was revealed by its complete acetylation (Ac_2O/pyridine)



1 $R^1=R^2=R^3=R^4=R^5=R^6=H$
2 $R^1=Me$, $R^2=R^3=R^4=R^5=R^6=H$
3 $R^1=Me$, $R^2=R^3=R^4=CO$, $R^5=R^6=H$
4 $R^1=R^2=R^3=R^6=CO$, $R^4=R^5=H$
5 $R^1=R^2=R^3=Me$, $R^4=R^5=R^6=H$
6 $R^1=R^3=Me$, $R^2=R^6=CO$, $R^4=AcO$, $R^5=Me$
7 $R^1=R^2=R^3=R^6=H$, $R^4=R^5=OH$

which gave **3** ($C_{39}H_{32}O_{12}$, $[M]^+$ 692), the ^1H nmr of which had four sharp singlets at δ 2.26, 2.19, 2.16, and 2.10 ppm (each 3H) assigned to four acetyl groups. Since the ir spectrum of **3** had no residual OH absorption bands, it was deduced that **2** had four hydroxyl groups which were transformed to acetates by acetylation.

The ^1H-nmr spectrum of **2** (Table 1) was very similar to that of lophirone A [**1**] in that it showed the same signals for proton systems on rings A, A′, B, B′, and C, as well as the AB system of two aliphatic protons. Equally, the signal for a peri-hydroxyl group observed at 12.60 ppm in the spectrum of lophirone A [**1**] was also seen in that of calodenone [**2**] at 12.69 ppm. Differences noted included modification of the chemical shifts of the ring-A′ protons and the presence of an MeO signal at δ 3.78 ppm (3H, s) in calodenone [**2**] but not in lophirone A [**1**].

These results suggested that calodenone [**2**] should have the same basic skeleton as lophirone A [**1**], but unlike **1**, which has five hydroxyl groups, **2** has only four, the fifth being naturally methylated to give an MeO group. In an attempt to locate the site of the MeO group, we compared the δ values of protons ortho or para to hydroxyl groups in lophirone A [**1**] with those of calodenone [**2**], as well as those of their corresponding acetates **3** and **4**. Protons of the A, B, and B′ ring in **1** and **2** showed only small differences in δ values (Table 1). Similar results obtained between their acetylated derivatives **3** and **4** implied the absence of the MeO group in rings A, B, and B′.

Evidence that the MeO group was linked to the A′ ring came from the large chemical shift differences ($\delta H_{15} = 0.74$ and $\delta H_{17} = 0.34$) between the corresponding protons (H-15 and H-17) in the acetylated derivatives **3** and **4**. Since the signal at 12.69 ppm can only be attributed to the chelated hydroxyl group at C-14, it follows that the MeO group is on C-16, leading to structure **2**. Confir-

TABLE 1. ^1H-nmr (250 MHz, Me_2CO-d_6) of Compounds **1–4**.

Proton	Ring	Compound							
		1		**2**		**3**		**4**	
		δ (ppm)	*J* (Hz)	δ (ppm)	*J* (Hz)	δ (ppm)	*J* (Hz)	δ (ppm)	*J* (Hz)
H-2	C	8.268 s		8.261 s		8.217 s		8.286 s	
H-5	A	7.936 d	8.8	7.913 d	8.8	8.051 d	8.7	8.191 d	8.6
H-6	A	6.911 dd	8.8, 2.3	6.886 dd	8.8, 2.3	7.74 dd	8.7, 2.2	7.130 dd	8.6, 2.2
H-8	A	6.769 d	2.3	6.749 d	2.3	7.270 d	2.3	6.885 d	2.3
H-11		6.140 d	12.3	6.145 d	12.3	6.114 d	12.1	6.108 d	12.1
H-15	A′	6.197 d	2.4	6.289 d	2.4	6.553 d	2.6	7.294 d	2.4
H-17	A′	6.442 dd	9.0, 2.4	6.486 dd	8.1, 2.4	6.858 dd	8.6, 2.1	7.197 dd	8.6, 2.1
H-18	A′	8.338 d	9.0	8.371 d	8.1	8.234 d	9.7	8.060 d	8.6
H-19		4.793 d	12.3	4.788 d	12.3	4.925 d	12.1	4.973 d	12.1
H-21	B	7.255 m		7.246 m		7.428 m		7.520 m	
H-22	B	6.606 m		6.595 m		6.858 m		6.977 m	
H-24	B	6.606 m		6.595 m		6.858 m		6.977 m	
H-25	B	7.255 m		7.246 m		7.428 m		7.520 m	
H-27	B′	7.255 m		7.246 m		7.470 m		7.450 m	
H-28	B′	6.650 m		6.635 m		6.944 m		6.889 m	
H-30	B′	6.650 m		6.635 m		6.944 m		6.889 m	
H-31	B′	7.255 m		7.246 m		7.470 m		7.459 m	
Ac						2.264 s		2.289 s	
Ac								2.249 s	
Ac						2.187 s		2.206 s	
Ac						2.155 s		2.187 s	
Ac						2.097 s		2.122 s	
MeO				3.779 s		3.813 s			
OH		12.600 s		12.690 s					

mation of structure **2** came from cross peaks noticed between the MeO group at 3.78 ppm and each of the protons H-15 (δ 7.29) and H-17 (δ 7.20) in the long range ^1H-^1H correlation spectrum of **2**.

The large coupling constant ($J = 12.3$ Hz) between the aliphatic protons H-11 and H-19 showed an equally trans disposition of both protons, as in lophirone A [**1**].

Chemical confirmation of the structure of calodenone [**2**] came from its methylation with CH_2N_2, which gave a compound identical in all respects to lophirone A tetramethyl ether [**5**] (4).

Further confirmation of structure **2** came from eims studies of its acetate **3**. Structures of intense ion fragments were readily obtained, and fragmentation pathways were found similar to those of chameochromone trimethyl ether tetraacetate [**6**] (12). The molecular ion formed the base peak at *m/z* 692 (100%) and lost a $CH_2{=}C{=}O$ group, probably from C-14, to give an intense ion fragment at *m/z* 651 (30%). Cleavage of the C-11–C-19 bond led to two ion fragments at *m/z* 283 (20%) and *m/z* 241 (10%), while the rupture of the bond adjacent to the ketone carbonyl at C-12 gave ion fragments at *m/z* 151 (12%) and *m/z* 125 (30%).

Calodenone [**2**] is the third member of the isobiflavonoid family, along with lophirone A [**1**] and chameochromone [**7**].

EXPERIMENTAL

GENERAL EXPERIMENTAL PROCEDURES.—^1H-nmr spectra were recorded in Me_2CO-d_6 solutions on a Bruker Nm 250 spectrometer, while cims were obtained on a Riber Nermag U30 spectrometer with NH_3 as ionizing gas. Ir spectra were recorded in KBr discs. Cc was conducted on Merck Si gel of particle size 0.04–0.063 nm and on Sephadex LH20.

PLANT MATERIAL.—The stem bark of *O. calodendron* was harvested in Moloundou, Cameroon, in December 1989. A voucher specimen was deposited at the National Herbarium in Yaounde, Cameroon.

EXTRACTION AND PURIFICATION.—Air-dried stem bark of *O. calodendron* was pulverized to give a fine powder (20 kg) which was extracted with cold MeOH for 24 h in a tank equipped with a mechanical stirrer. After filtration and removal of solvent, the resultant gum was re-extracted with EtOAc-MeOH (9:1). The soluble fraction was concentrated to give a dark brown gum (170 g) which was fractionated by cc over Si gel, using $CHCl_3$-MeOH (10:1) followed by $CHCl_3$-MeOH (5:1) to give eleven fractions (E_1–E_{11}). Fraction E_6 (6.5 g) was purified by cc with the solvent mixture $CHCl_3$-MeOH (10:1). Further purification was realized by gel permeation chromatography over Sephadex LH 20 with MeOH to give β-sitosterol-β-D-glucoside as well as **1** and **2**.

Lophirone A [**1**].—$C_{30}H_{22}O_8$; $[M]^+$ 510; ir (KBr paste) ν cm^{-1} 3333, 1631, 1514, 1456; ^1H nmr (250 MHz, Me_2CO-d_6) see Table 1.

Calodenone [**2**].—$C_{31}H_{24}O_8$; $[M]^+$ 524; ir (KBr paste) ν cm^{-1} 3333, 1631, 1514, 1456; ^1H nmr (250 MHz, Me_2CO-d_6) see Table 1.

ACETYLATED DERIVATIVE **3**.—Calodenone [**2**] (15 mg) was dissolved in pyridine (5 ml), and Ac_2O (5 ml) was added. The mixture was left overnight at 50° in an H_2O bath. Distilled H_2O (20 ml) was added, and the compound that precipitated was extracted, dried, and purified over Sephadex LH 20 to give **3** (10 mg): $C_{39}H_{32}O_{12}$; eims *m/z* (%) $[M]^+$ 692 (100), 651 (35), 411 (8), 393 (7), 369 (11), 302 (20), 283 (20), 260 (5), 241 (8), 151 (12), 125 (31); ^1H nmr (250 MHz, Me_2CO-d_6) see Table 1.

ACKNOWLEDGMENTS

We thank Dr. Nkonmeneck, University of Yaounde, for the harvest and identification of the plant material. We also thank M.M. Satabie, National Herbarium, Yaounde, Nolé and Mbita, CEPM, Yaounde, for botanical information.

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Received 8 April 1991