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LIGNANS AND NEOLIGNANS FROM *LICARIA ARMENIACA**

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Key Word Index—*Licaria armeniaca*; Lauraceae; bicyclo[3.2.1]octanoid neolignan; magnolin; tri-*O*-methylmoschatoline; 6,7-dimethoxycoumarin.

Abstract—A re-examination of the trunk wood of *Licaria armeniaca* led to the isolation of 6,7-dimethoxycoumarin, 1,2,3-trimethoxy-7-oxoaporphine (tri-*O*-methylmoschatoline), 2e-(3,4,5-trimethoxyphenyl)-6e-(3,4-dimethoxyphenyl)-3,7-dioxabicyclo [3.3.0]octan (magnolin) and a novel neolignan (7*S*,8*R*,1′*S*,2′*S*,3′*S*)-2′-acetoxy-1′-allyl-3′,5′-dimethoxy-8-methyl-7-piperonyl-bicyclo[3.2.1]-oct-5′-en-4′-one.

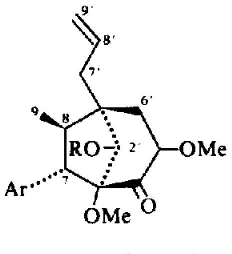
INTRODUCTION

A previous study of the trunk wood of the Amazonian Lauraceae species *Licaria armeniaca* (Nees) Kosterm. revealed the presence of 6,7-dimethoxycoumarin and of two porosin-type neolignans [2]. The species is rather widespread and seemingly prone to chemical variation. Indeed, the study of another specimen indicated 6,7-dimethoxycoumarin and the oxoaporphine tri-*O*-methylmoschatoline [3] to be accompanied by the furofuran lignan magnolin [4] and a novel neolignan. For reasons stated in a previous paper of this series [5], nomenclature and numbering of neolignans follow the rules outlined in a recent review [6].

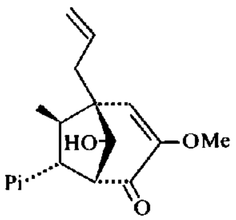
RESULTS AND DISCUSSION

The neolignan, $C_{23}H_{28}O_7$ by C and H NMR counts associated with a mass spectrometric molecular weight determination, was assigned structure **1a** upon comparison with **1b** [6] and **2** [7] by IR, ^{1}H NMR (Table 1), ^{13}C NMR (Table 2) and ORD (Table 3) data. Indeed the H-9 (δ 0.92 ± 0.02) and H-6′ (δ 5.65 ± 0.05) signals of **1a** and **1b** are similar and differ significantly from the H-9 (δ 1.23) and H-6′ (δ 6.10) signals of **2**. As expected, the ^{13}C NMR signals for C-9 (δ 13.9) and C-6′ (δ 124.1) of **1a** (*endo*-Me-8) occur at a higher field than the signals for C-9 (δ 17.4) and C-6′ (δ 126.8) of **2** (*exo*-Me-8), in view of the reciprocal γ-effects felt by these carbons in the former compound.

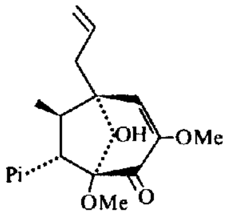
The significant spectral differences between **1a** and **1b** are due to the existence of piperonyl and acetoxyl in **1a** vs 3-methoxypiperonyl and hydroxyl in **1b**. This was confirmed respectively by MS, which cleaves **1a** into the typical $[CH_2O_2 . C_6H_3 . CH{=}CH . Me]^{+\cdot}$ fragment of the piperonyl-substituted neolignans, and by hydrolysis of **1a** into **1c**, which is accompanied by a 1.37 ppm diamagnetic shift of the H-2′ signal to δ 4.00, the chemical shift value shown by H-2′ in **1b** (Table 1). The epimeric alcohol **3** is a by-product in this reaction. The ^{13}C NMR spectra of the



1a Ar = Pi, R = Ac
1b Ar = Mp, R = H
1c Ar = Pi, R = H



2



3

Pi ... Piperonyl,
Mp ... 3-Methoxypiperonyl.

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*Part LXII in the series "The Chemistry of Brazilian Lauraceae". For Part LXI see ref. [1]. Taken from part of the M.S. thesis presented by L.V.A. to Universidade Federal Rural do Rio de Janeiro.

Table 1. ^1H NMR chemical shifts (δ values from TMS) and multiplicities (*J* values in Hz) of neolignan (**1a** in CCl_4, all others in $CDCl_3$) signals

Position	**1a** (60 MHz)	**1b** (60 MHz)	**1c** (100 MHz)	**3** (100 MHz)	**2** (220 MHz)
H-2	6.70 (*s*)	6.68 (*d*, 2)	6.70		6.51 (*s*)
H-5	6.70 (*s*)		6.70	6.5–6.8 (*m*)	6.66 (*d*, 8)
H-6	6.95 (*s*)	6.49 (*d*, 2)	6.98		6.53 (*d*, 8)
H-7	*	2.54 (*d*, 8)	*	2.3–2.7 (*m*)	3.55 (*d*, 7)
H-8	*	*	*	*	2.22 (*d*, 7)
Me-8	0.94 (*d*, 6)	0.90 (*d*, 7)	0.90 (*d*, 6)	0.9 (*d*, 6)	1.23 (*d*, 7)
H-2′	5.37 (*s*)	4.00 (*s*)	4.00 (*s*)	4.32 (*d*, 2)	3.98 (*s*)
H-3′					3.19 (*d*, 7)
H-6′	5.60 (*s*)	5.70 (*s*)	5.68 (*s*)	5.28 (*s*)	6.10 (*s*)
H-7′	*	*	*	*	2.64 (*dd*, *J* = 14, 7)
H-8′	5.5–6.1 (*m*)	5.83–6.20 (*m*)	5.7–6.1 (*m*)	5.7–6.2 (*m*)	5.75–5.95 (*m*)
H-9′	4.95–5.1 (*m*)	5.02–5.42	5.1–5.35 (*m*)	5.1–5.35 (*m*)	5.13–5.32 (*m*)
OMe-3		3.97 (*s*)			
OMe-3′	3.20 (*s*)	3.30 (*s*)	3.32 (*s*)	3.22 (*s*)	
OMe-5′	3.90 (*s*)	3.87 (*s*)	3.70 (*s*)	3.70 (*s*)	3.62 (*s*)
O_2CH_2	6.00 (*s*)	5.98 (*s*)	5.95 (*s*)	5.95 (*s*)	5.82 (*s*)
OAc-8′	2.30 (*s*)				

* Included in a band envelope between δ 2.2 and 2.8.

epimers (Table 2) were assigned by the comparison of totally decoupled spectra with single frequency off-resonance decoupled spectra and theoretical considerations [9–11]. Hydrogen bonding of the hydroxyl to the MeO-3′ oxygen impels the MeO-methyl to such a position as to exert γ-effects on C-2′ of **1c** (δ 78.2 vs 84.5 for C-2′ in **3**) and on C-7 of **3** (δ 55.6 vs 57.0 for C-7 of **1c**). As the natural compound **1a** is recovered upon acetylation of **1c**, the configuration of its acetoxy is confirmed.

An independent confirmation of the spatial vicinity vs distance of hydroxyl and aryl was achieved by measurement of the C_5D_5N-induced solvent shifts for the

Table 2. ^{13}C NMR chemical shifts (δ values from TMS) of neolignan (in $CDCl_3$) signals

Position	**1a** (20 MHz)	**1c** (25.2 MHz)	**3** (25.2 MHz)	**2** (20 MHz)
C-1	131.0	131.4	132.2	133.3
C-2	107.7	107.6	107.9	108.2
C-3	147.5	147.4	147.5	148.0
C-4	146.5	146.3	146.4	147.8
C-5	110.6	110.8	109.6	108.7
C-6	119.5	120.3	119.4	121.4
C-7	57.5	57.0	55.6	53.1
C-8	49.4	48.6	46.3	47.4
C-9	13.9	13.9	13.4	17.4
C-1′	50.8	51.4	48.1	51.8
C-2′	77.6	78.2	84.5	80.9
C-3′	90.2	90.8	90.2	64.9
C-4′	193.6	194.6	195.8	185.8
C-5′	152.1	151.4	151.2	153.0
C-6′	124.1	123.8	123.0	126.8
C-7′	37.1	36.6	38.1	34.6
C-8′	133.9	134.4	132.4	134.3
C-9′	118.6	117.9	117.9	118.2
OMe-3′	54.8	54.5	53.5	
OMe-5′	55.5	55.4	55.4	55.3
O_2CH_2	100.9	100.8	100.8	100.9
OAc	21.0 169.1			

epimeric alcohols. Association with pyridine causes consistently stronger shifts of the aromatic proton signals pertaining to **1c** than those pertaining to **3**. Most conspicuously, the CH_2O_2 band, split into two doublets in the case of **1c**, remains a singlet in the case of **3**.

EXPERIMENTAL

Isolation of constituents. Trunk wood of a specimen (voucher herbarium INPA, Manaus, 47251), identified by Dr. W. A. Rodrigues, was collected at Igarapé de Piauí, Rio Castanho, near Manaus, Amazonas State. The powdered wood (5 kg) was percolated successively with C_6H_6 and EtOH. The solvents were evapd and the residues submitted to chromatographic fractionation employing solvent (C_6H_6, $CHCl_3$, EtOAc, MeOH) mixtures of gradually increasing polarity. The C_6H_6 extract (16 g on 480 g Si gel) gave, in order, sitosterol (1 g), 6,7-dimethoxycoumarin (30 mg), **1a** (130 mg) and a mixture. Purification of the mixture by prep. TLC (Si gel, C_6H_6–Me_2CO, 4:1) gave tri-*O*-methylmoschatoline (16 mg). The EtOH extract (10 g on 350 g Si gel) gave, in order, sitosterol (0.3 g), tri-*O*-methylmoschatoline (82 g) and magnolin (14 mg).

Table 3. ORD extremes of the neolignan **1a** and of the models **1b** and **2**

nm	352 ± 8	321 ± 9	298 ± 6	286 ± 8	271 ± 14
1a	−5800	0	+1240	0	−1660
1b	−3150	0	+3950	0	−9650
2	+2500	0	−9750	0	+13000

Identifications. Sitosterol, 6,7-dimethoxycoumarin [2] and tri-*O*-methylmoschatoline [3] were identified by direct comparison with authentic samples. Magnolin was identified by comparison of ^1H NMR and MS with the analogous data reported in the lit. [4].

(7S, 8R, 1′S, 2′S, 3′R)-$\Delta^{8'}$-1′,2′,3′,4′-*Tetrahydro-4′-oxo-7.3′.8.1′-neolignan* (**1a**). Mp 153–154° (Et_2O). IR ν_{max}^{KBr} cm^{-1}: 1745, 1695, 1620, 1485, 1240, 1050. MS *m/z* (rel. int.): 414 (22) $M^{+\cdot}$, 252 (1), 210 (100), 209 (1), 195 (7), 181 (39), 169 (14), 163 (8), 162 (15), 161 (4), 151 (13), 135 (10).

Hydrolysis. A soln of **1a** in 5% NaOH (H_2O–MeOH, 5 ml) was maintained under reflux (2 hr). H_2O was then added gradually to maintain a constant vol., while the MeOH was removed by distillation. The mixture was cooled to room temp., acidified with 10% HCl and extracted with $CHCl_3$. The $CHCl_3$ soln was washed, dried and evapd. The residue was separated by Si gel column chromatography into **1c** (63 mg) and **3** (17 mg). **1c**, oil, MS *m/z* (rel. int.): 372 (29) $M^{+\cdot}$, 210 (8), 195 (6), 194 (18), 182 (14), 181 (100), 179 (5), 169 (45), 167 (11), 163 (4), 162 (12), 151 (14), 150 (9), 149 (36). **3**, oil, MS *m/z* (rel. int.): 372 (56) $M^{+\cdot}$, 331 (17), 210 (26), 195 (9), 189 (14), 187 (47), 169 (100), 167 (10), 163 (30), 162 (16), 150 (16), 149 (37), 135 (44).

Acetylation of **1c** (Ac_2O, C_5H_5N, room temp., 24 hr), followed by the usual work-up gave a product shown to be identical with **1a** by TLC (Si gel) and ^1H NMR spectroscopy.

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