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FURTHER NEOLIGNANS FROM *OCOTEA POROSA**

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Key Word Index—*Ocotea porosa*; Lauraceae; trunk wood; hydrobenzofuranoid neolignans.

Abstract—The trunk wood of *Ocotea porosa* contains, besides porosin, porosin-B and licarin-B, six additional new 7.*O*.2′,8.1′-neolignans of the porosin, canellin and megaphone type.

INTRODUCTION

The trunk wood of *Ocotea porosa* (Lauraceae) [2] has been found to contain the hydrobenzofuranoid neolignan porosin (**1a**) [3]. The present paper describes the presence of some additional minor constituents, the novel neolignans **1b**, **2a**, **3a**, **4a**, **5a** and **5b**, besides the known neolignans **1c** (porosin-B), isolated previously from *Urbanodendron verrucosum* [4], and **6** (licarin-B), isolated previously from *Licaria aritu* [5].

In order to facilitate comparisons among the different compounds, the numbering of neolignans follows the biogenetic rules outlined in a review [6].

RESULTS AND DISCUSSION

The molecular formulae of all six novel compounds were determined by a combination of low-resolution mass spectrometry and NMR C and H counts. Functional analysis by IR and NMR allowed these formulae to be expanded to $C_{18}H_{17}O_2 \cdot OMe \cdot CH_2O_2$ (**1b**, **2a**), $C_{18}H_{18}O \cdot OMe \cdot CH_2O_2 \cdot OH$ (**3a**, **4a**) and $C_{18}H_{19}O(OMe)_3(OH)_2$ (**5a**, **5b**). This suggests for **1b** and **2a** porosin (**1**) [3], canellin (**2**) [7] or armenin (**7**) [8] like structures. Indeed, the ^{1}H NMR spectra of **1a** (porosin, taken as a model) and **1b** (Table 1) are closely comparable. One of the discrepancies stems from the aromatic substitution, 3,4-dimethoxy in **1a** and 3,4-methylenedioxy in **1b**. Another refers to the orientation of the methoxyl at C-5′, β in **1a** (δH-5′ 4.02, MeO-5′ 3.60), and hence, α in **1b** (δH-5′ 3.33, MeO-5′ 3.45). This difference in stereochemistry can also be gauged by comparison of the ^{13}C NMR spectra of **1c** and **1b** (Table 2). In spite of identical constitutions, carbons 1′ to 6′ of porosin-B (**1c**) and those of the novel porosin-C (**1b**) show relevant differences in their chemical shifts.

In contrast, **2a** possesses a canellin-type structure. This becomes evident by comparison of the ^{1}H NMR spectra of **2b** as a model and **2a**. The relevant spectral difference of porosin (**1**) and the canellin (**2**) type compounds refers to the chemical shifts of the C-methyls: 0.55 in the 7,8-*cis*-porosins and 1.01 in the 7,8-*trans*-canellins (Table 1). The sole significant difference in the ^{1}H and ^{13}C NMR spectra (Tables 1 and 2) of **2a** and **2b** is due to the MeO-3′ group, absent in the novel **2a** (canellin-F) and present in **2b** (canellin-B).

The ^{1}H NMR spectra of **3a** and the model compound **3b** [9] are closely comparable (Table 1). The sole major difference is due to the replacement of the methoxyl group in **3a** by a hydroxyl in **3b**.

The ^{1}H and ^{13}C NMR spectra of **4a** and the model compound **4b** [10] (Tables 1 and 2) are also closely comparable. The relevant differences are due to differential substitution of the aryl group: two methoxyls at positions 3 and 4 in **4a** and three methoxyls at positions 3, 4 and 5 in **4b**. Megaphone (**4b**) in $CHCl_3$ solution exists in equilibrium with its hemiketal (**8b**) [10]. Compound **4a** reacts in the same manner forming **8a**. Both **8a** and **8b** give closely comparable ^{1}H NMR spectra (Table 1).

No closely related model compounds exist for comparisons with the isolates **5a** and **5b**. Nevertheless, it is clear that the compounds also belong to the hydrobenzofuranoid group of neolignans. Indeed, ^{1}H and ^{13}C NMR signals reveal the *cis*-relation of vicinal C-methyl (δ0.55) and C-veratryl groups. Signals attributed to a C-allyl group are also present in the spectra of both compounds. Attempted acetylation gave different results with **5a** being smoothly converted into a monoacetate. The reaction was accompanied by a 1.3 ppm diamagnetic shift of the H-4′ signal, demonstrating the secondary nature of the original carbinol. In contrast, **5b** was converted into two substances, the expected acetate and the α,β-unsaturated ketone **4a**. In the formation of **4a** the hemiketal of **5b** had been opened and the elements of H_2O had been lost. Clearly the hydroxyl group at C-4′ must be equatorial, and hence easily acylated, in **5a**, and axial, and hence prone to loss through a *trans*-elimination, in **5b**.

The ease of the reaction **5b** → **4a** suggests that hemiketals of type **5** may be precursors of megaphones (type **4**). Whether this transformation occurs *in vivo* or during the isolation procedure is not known. In the latter case, compounds of type **4** would be artefacts. It thus seems advisable to re-examine *Aniba megaphylla* for the presence of neolignans of type **5**.

*Part LXXX in the series "The Chemistry of Brazilian Lauraceae". For Part LXXIX see ref. [1]. Based on the doctorate thesis submitted by D.A.D. (present address: Faculdade de Ciências Farmacêuticas de Ribeirão Preto, Universidade de São Paulo) to Universidade de São Paulo.

Table 1. ^{1}H NMR spectral comparison (δ, multiplicity/J in Hz) of novel neolignans (**1b**, **2a**, **3a**, **4a**, **5a**, **5b**, **8a**) and model compounds (**1a**, **2b**, **3b**, **4b**, **8b**) (CD_3Cl, TMS)

H	**1a** (220 MHz)	**1b** (60 MHz)	**2a** (60 MHz)	**2b** (220 MHz)	**3a** (60 MHz)	**3b** (60 MHz)	**4a** (60 MHz)	**4b** (100 MHz)	**5a** (60 MHz)	**5b** (60 MHz)	**8a** (60 MHz)	**8b** (100 MHz)
2	6.76 *d* 2											
6	6.83 *dd* 8, 2	6.6 *m*	6.76 *m*	6.7 *m*	6.8 *m*	6.9 *m*	6.96 *m*	6.66 *s*	6.83 *s*	6.95 *m*	6.9 *m*	6.48 *s*
5	6.93 *d* 8							—				—
7	5.80 *d* 6	5.80 *d* 6	5.05 *d* 10	5.05 *d* 10	4.53 *d* 10	4.0 *d* 10	4.66 *d* 2	4.64 *d* 1.5	5.23 *d* 8	5.28 *d* 10	4.66 *d* 2	4.64 *d* 1.5
9	0.52 *d* 8	0.55 *d* 8	1.01 *d* 8	1.04 *d* 7	0.90 *d* 8	0.87*d* 8	0.70 *d* 7	0.77 *d* 7.5	0.55 *d* 8	0.55 *d* 8	0.60 *d* 7	0.60 *d* 7.5
3′	5.60 *s*	5.55 *s*	5.50 *s*	—	3.95 *m*	3.95 *m*	7.10 *m*	7.00 *d* 10	1.7 *m*	1.5 *m*	7.10 *m*	7.00 *d* 10
4′	—	—	—	—	7.0 *m*		6.10 *dd* 10, 2	6.02 *dd* 10, 2	3.8 *m*	3.2 *m*	6.10 *dd* 10, 2	6.02 *dd* 10, 2
8′	5.9 *m*	5.9 *m*	6.1*m*	5.85 *m*	6.45 *m*	5.3–6.2	5.76 *m*	5.83 *m*	5.9 *m*	5.9 *m*	5.76 *m*	5.83 *m*
5′	4.02 *dd* 12, 5	3.33 *m*	4.02 *m*	4.03 *dd* 12, 5.5	5.8 *m*		4.26 *m*	4.23 *m*	3.1 *m*	3.4 *m*	4.26 *m*	4.23 *m*
8	2.69 *m*			2.07 *dq* 10, 7	2.6 *m*		1.93 *m*	1.96 *q* 6.9	2.75 *m*	2.75 *m*	1.93 *m*	1.96 *q* 6.9
6′ eq	2.22 *dd* 12, 5			2.48 *dd* 12, 5.5					2.1 *m*	2.1 *m*		
6′ ax	1.90 *t* 12	2.4 *m*	2.2 *m*	1.76 *t* 12	2.3 *m*	1.9–2.9	2–2.6	2.2–2.6			2–2.6	2.2–2.6
7′	2.60 *dd* 14.5, 7			2.60 *dd* 15, 6.5					2.35 *m*	2.4 *m*		
7′	2.36 *dd* 14.5, 7			2.45 *dd* 15, 8.5								
9′	5.5 *m*	5.1 *m*	5.1 *m*	5.22 *m*	5.1 *m*	5.2 *m*	5.2 *m*	5.2 *m*	5.15 *m*	5.15 *m*	5.2 *m*	5.2 *m*
MeO-3	3, 90 *s*	—	—	—	—	—	3.93 *s*	3.88 *s*	3.80 *s*	3.80 *s*	3.93 *s*	3.88 *s*
MeO-4		—	—	—	—	—	3.86 *s*	3.83 *s*			3.86 *s*	3.83 *s*
MeO-5	—	—	—	—	—	—	—	3.88 *s*	—	—	—	3.88 *s*
MeO-2′	—	—	—	—	3.43 *s*	—	—	—	—	—	—	—
MeO-3′	—	—	—	3.70 *s*	—	—	—	—	—	—	—	—
MeO-5′	3.60 *s*	3.45 *s*	3.58 *s*	3.55 *s*	—	—	3.45 *s*	3.46 *s*	3.30 *s*	3.30 *s*	3.26 *s*	3.37 *s*
CH_2O_2	—	5.9 *s*	5.97 *s*	5.97 *s*	5.97 *s*	5.97 *s*	—	—	—	—	—	—

Table 2. ^{13}C NMR spectral comparison of novel neolignans (**1b**, **2a**, **4a**, **5a**, **5b**) and model compounds (**1c**, **2c**, **4b**) (20 MHz, $CDCl_3$, TMS)

C	1b	1c	2a	2c	4a	4b	5a	5b
1	130.0	131.0	132.0	133.0	135.1	135.1	132.3	132.1
2	106.0	106.0	105.9	103.6	109.3	102.5	109.9	110.7
3	147.0	147.0	147.9	153.6	148.8	152.5	148.2	148.8
4	147.6	147.6	147.9	136.2	147.6	140.0	147.5	148.0
5	108.0	108.0	107.9	153.6	110.6	152.5	110.6	111.0
6	118.0	118.1	116.0	103.6	117.3	102.5	118.6	119.5
7	86.7	87.0	90.3	91.0	73.1	73.1	81.3	81.5
8	42.0	42.0	43.2	48.8	44.9	44.8	43.8	44.0
9	11.4	11.2	8.5	11.9	6.0	6.2	11.7	11.9
1′	48.8	52.4	52.4	53.0	52.2	52.3	48.6	49.0
2′	184.0	183.3	183.0	183.6	202.0	193.4	105.1	104.5
3′	96.8	99.8	100.0	100.8	128.2	132.2	39.1	37.7
4′	194.0	196.7	196.0	197.2	149.8	149.9	70.2	66.0
5′	78.1	76.2	78.5	76.8	70.7	71.0	80.1	77.4
6′	30.0	31.1	36.0	38.9	37.7	37.7	29.7	27.1
7′	40.7	40.7	38.3	37.3	36.2	36.3	38.7	38.7
8′	133.0	133.3	133.5	133.8	132.1	128.7	135.0	135.2
9′	119.4	119.6	120.0	119.6	118.9	119.1	117.2	117.0
MeO-3	—	—	—	56.5	55.5	55.8	55.5	55.9
MeO-4	—	—	—	61.0	55.5	56.4	55.5	55.9
MeO-5	—	—	—	56.5	—	55.8	—	—
MeO-2′	—	—	—	—	—	—	—	—
MeO-3′	—	—	—	—	—	—	—	—
MeO-5′	58.5	58.4	58.5	59.1	56.3	60.5	56.4	56.2
CH_2O_2	100.0	105.0	104.0	—	—	—	—	—

EXPERIMENTAL

Isolation of constituents. Trunk wood of *O. porosa* (Nees *et* Mart. *ex* Nees) L. Barroso, collected at the Forest Reserve of Instituto Botânico (São Paulo, SP) was dried and pulverized. The powder (1 kg) was percolated with C_6H_6. The solvent was evaporated and the residue (30 g) submitted to CC (silica gel, hexane and EtOAc mixtures of increasing polarity). The 93 fractions (150 ml each) were combined into 16 groups. The solvent of each group was evaporated. The residues were then fractionated by repeated TLC. Thus group 3 (from fractions 3–7 eluted with hexane–EtOAc (99:1), 2.34 g) gave **6** (13 mg). Group 10 (from fractions 37–52 eluted with hexane–EtOAc (9:1), 570 mg) gave **1b** (40 mg). Group 11 (from fractions 54–56 eluted with hexane–EtOAc (9:1), 1.79 g) was washed in succession with hexane, CH_2Cl_2, $CHCl_3$ and Me_2CO. The Me_2CO soln was evaporated and the residue (860 mg), by TLC, gave **2a** (12 mg) and **3a** (22 mg). Group 13 (from fractions 60–67 eluted with EtOAc, 1.79 g), submitted to CC (silica gel, hexane–EtOAc mixtures of increasing polarity), gave, in order, **1c** (12 mg), **4a** (60 mg), **1a** (35 mg) and **5a** (20 mg). Group 16 (from fractions 84–93 eluted with EtOAc, 1.1 g) gave **5b** (32 mg).

Identification of known neolignans **1a** [3], **1c** [4] and **6** [5] was performed by direct comparison with authentic samples.

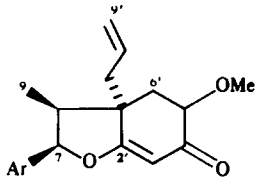
rel-(7R,8S,1′R,5′S)-$\Delta^{8'}$-*5′-Methoxy*-3,4-*methylenedioxy*-1′,4′,5′,6′-*tetrahydro*-4′-*oxo*-7.O.2′,8.1′-*neolignan* (**1b**). Mp 112–113° (MeOH). IR ν_{max}^{KBr} cm^{-1}: 1640, 1500, 1490, 1440, 1350, 1240, 1260, 1170, 1110, 1040, 930. UV λ_{max}^{MeOH} nm: 260, 290 infl. (ε14 000, 5100). NMR: Tables 1 and 2. MS *m/z* (rel. int.): 342 $[M]^+$ (50), 312 (30), 297 (18), 284 (16), 270 (18), 269 (22), 256 (21), 243 (10), 241 (20), 228 (11), 215 (33), 214 (15), 213 (15), 175 (95), 162 (25), 149 (68), 136 (14), 135 (100), 115 (53), 103 (70), 91 (90).

rel-(7R,8R,1′R,5′R)-$\Delta^{8'}$-5′-*Methoxy*-3,4-*methylenedioxy*-1′,4′,5′,6′,-*tetrahydro*-4′-*oxo*-7.O.2′,8.1′-*neolignan* (**2a**). Oil. IR ν_{max}^{film} cm^{-1}: 1630, 1580, 1440, 1350, 1230, 1190. UV λ_{max}^{MeOH} nm: 260 (ε11 650). NMR: Tables 1 and 2. MS *m/z* (rel. int.): 342 $[M]^+$ (31), 312 (30), 297 (10), 284 (11), 269 (13), 270 (13), 205 (15), 175 (71), 174 (12), 167 (23), 162 (24), 149 (84), 135 (100).

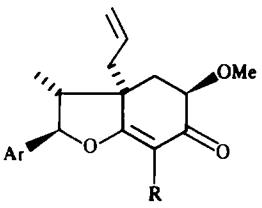
rel-(7S,8S,1′S,2′S)-$\Delta^{8'}$-3′-*Hydroxy*-2′-*methoxy*-3,4-*methylenedioxy*-1′,2′,3′,6′-*tetrahydro*-7.O.2′,8.1′-*neolignan* (**3a**). Mp 139–142° (MeOH). IR ν_{max}^{KBr} cm^{-1}: 3400, 1510, 1480, 1440, 1250, 1100, 1040, 760. UV λ_{max}^{MeOH} nm: 235, 280 (ε 28 300, 20 000). NMR: Tables 1 and 2. MS *m/z* (rel. int.): 344 $[M]^+$ (1), 326 (4), 271 (8), 178 (100), 162 (8), 98 (38).

rel-(7R,8S,1′R,5′R)-$\Delta^{8'}$-7-*Hydroxy*-3,4,5′-*trimethoxy*-1′,2′,5′,6′-*tetrahydro*-2′-*oxo*-8.1′-*neolignan* (**4a**). Mp 149–151° ($CHCl_3$–Et_2O). IR ν_{max}^{film} cm^{-1}: 3440, 1660, 1500, 1440, 1230, 1020, 750. NMR: Tables 1 and 2. MS *m/z* (rel. int.): 360 $[M]^+$ (3), 342 (8), 301 (3), 194 (100), 178 (10), 167 (88), 153 (40), 139 (42), 121 (22), 98 (80). 7-O-*Acetyl derivative*. Oil. IR ν_{max}^{film} cm^{-1}: 1720, 1660, 1500, 1430. ^1H NMR (60 MHz, $CDCl_3$): δ6.7–7.15 (*m*, H-2, H-5, H-6, H-4′), 6.0 (*dd*, *J* = 10, 2 Hz, H-3′), 5.73 (*br s*, H-7), 5.2–5.8 (*m*, H-8′), 4.7–5.25 (*m*, 2H-9′), 3.95–4.45 (*m*, H-5′), 3.95 (*s*, MeO-3), 3.88 (*s*, MeO-4), 3.47 (*s*, MeO-5′), 1.7–2.7 (*m*, H-8, 2H-6′, 2H-7′), 0.93 (*d*, *J* = 8 Hz, 3H-9).

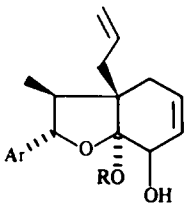
rel-(7R,8S,1′R,2′S,4′R,5′R)-$\Delta^{8'}$-2′,4′-*Dihydroxy*-3,4,5′-*trimethoxy*-1′,2′,3′,4′,5′,6′-*hexahydro*-7.O.2′,8.1′-*neolignan* (**5a**). Mp 68–71° (EtOH). IR ν_{max}^{KBr} cm^{-1}: 3410, 1590, 1510, 1450, 1490, 1420, 1050, 1230, 1150, 1100, 1020, 810. UV λ_{max}^{MeOH} nm: 230, 275 (ε80 200, 12 000). NMR: Tables 1 and 2. MS *m/z* (rel. int.): 378 M^+ (3), 360 (2), 342 (10), 335 (20), 301 (3), 194 (40), 178 (20), 172 (30), 171 (100), 165 (30), 139 (40). 6-O-*Acetyl derivative*. Oil. IR ν_{max}^{film} cm^{-1}: 3490,, 1730, 1590, 1510, 1450, 1230, 750. ^1H NMR (60 MHz, $CDCl_3$): δ7.0 (*br s*, H-2, H-5, H-6), 5.23 (*d*, *J* = 10 Hz, H-7), 2.6–2.9 (*m*, H-8), 0.58 (*d*, *J* = 8 Hz, 3H-9), 2.2–2.6 (*m*, 2H-7′), 5.6–6.1 (*m*, H-8′), 5–5.3 (*m*, 2H-9′), 1.2–1.4 (*m*, 2H-3′), 4.9–5.2 (*m*,



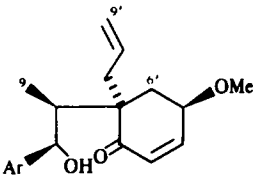
1a Ar = Ve, 5′β-OMe
1b Ar = Pi, 5′α-OMe
1c Ar = Pi, 5′β-OMe



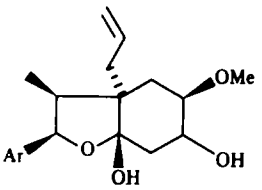
2a Ar = Pi, R = H
2b Ar = Pi, R = OMe
2c Ar = Tm, R = H



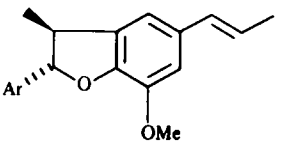
3a Ar = Pi, R = Me
3b Ar = Pi, R = H



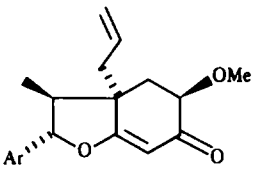
4a Ar = Ve
4b Ar = Tm



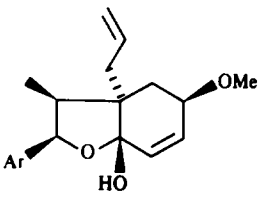
5a Ar = Ve, 4′α-OH
5b Ar = Ve, 4′β-OH



6 Ar = Pi



7 Ar = Pi



8a Ar = Ve
8b Ar = Tm

Ve = veratryl
Pi = piperonyl
Tm = 3,4,5-trimethoxyphenyl

H-4′), 3.5–3.8 (*m*, H-5′), 1.2–1.9 (*m*, 2H-6′), 3.23 (*s*, MeO-5), 3.70 (*s*, MeO-3, MeO-4), 2.00 (*s*, AcO-4′).

rel-(7R,8S,1′R,2′S,4′S,5′R)-Δ$^{8'}$-2′, 4′-*Dihydroxy*-3, 4,5′-*trimethoxy*-1′,2′,3′,4′,5′,6′-*hexahydro*-7.O.2′,8.1′-*neolignan* (**5b**). Mp 55–56°. IR ν_{max}^{KBr} cm^{-1}: 3430, 1590, 1510, 1460, 1430, 1260, 1230, 1140, 1020, 749. UV λ_{max}^{MeOH} nm: 220, 287 (ε 27000, 9000). NMR: Tables 1 and 2. MS *m/z* (rel. int.): 378 [M]$^+$ (4), 360 (3), 342 (19), 335 (8), 300 (9), 249 (40), 178 (40), 172 (100), 153 (40), 149 (25), 139 (32), 124 (43), 121 (28), 98 (25), 75 (33), 43 (58). 6-O-*Acetyl derivative*. Oil. ^{1}H NMR (60 MHz, $CDCl_3$): δ6.75–6.95 (*m*, H-2, H-5, H-6), 5.15 (*d*, *J* = 10 Hz, H-7), 2.6–2.9 (*m*, H-8), 0.67 (*d*, *J* = 8 Hz, 3H-9), 2.35–2.5 (*m*, 2H-7′), 6.25–6.75 (*m*, H-8′), 5.2–5.5 (*m*, 2H-9′), 1.5–1.8 (*m*, 2H-3′) 5.2 (*m*, H-4′), 3.5–3.75 (*m*, H-3′), 1.8–2.3 (*m*, 2H-6′), 3.40 (*s*, MeO-5′), 3.95 (*s*, MeO-3, MeO-4), 2.27 (*s*, AcO-4).

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