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REVISED STRUCTURES FOR NEOLIGNANS FROM *ARUM ITALICUM*

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Key Word Index—*Arum italicum*; Araceae; 8-*O*-4′-neolignans; dilignols; guaiacylglycerol-β-coniferyl ether; ^{1}H NMR spectra.

Abstract—On the basis of ^{1}H NMR spectral comparison with known dilignols, the neolignans isolated from *Arum italicum*, for which unusual 8-*O*-3′-structures were proposed, have been reassigned to those with the conventional 8-*O*-4′-structures, *erythro* and *threo*-guaiacylglycerol-β-coniferyl ether respectively. In addition, the 8-*O*-4′-neolignan glucoside with a 1,3,5-trisubstitution pattern for ring A has been reassigned to *threo*-guaiacylglycerol-β-coniferyl ether-4-β-D-glucopyranoside, with the conventional 1,3,4-trisubstituted ring A. Thus far there is no evidence for the existence of 8-*O*-3′-neolignans in nature.

INTRODUCTION

Lignans and neolignans belong to an important group of optically active natural products consisting of two phenylpropanoid-derived monomers linked through carbon–carbon or carbon–oxygen bonds [1]. In one class of neolignans the monomers are linked through the 8-*O*-4′ atoms, as in formula **1**. Greca *et al.* [2] have recently isolated four neolignans from *Arum italicum* which they described as ether-linked through C-8. They assigned unusual 8-*O*-3′ structures to two compounds (**2a** and **3a**) and 8-*O*-4′ structures to the glucosides **4c** and **5c** on the basis of ^{1}H NMR spectroscopy. In addition, they proposed the unusual 1,3,5-trisubstitution pattern of ring A of compounds **3a** and **5c**. An 8-*O*-3′ linkage was previously proposed for a neolignan glucoside found as a component of citrus peelings [3], but the structure was later revised to that of the 8-*O*-4′ neolignan **4c** [4]. Furthermore, a neolignan from *Piper capense* that had originally been assigned an 8-*O*-3′ structure [5, 6] was found to possess an 8-*O*-4′ linkage [7]. We present evidence here to show that the compounds **2a**, **3a** and **5c** are the conventional 8-*O*-4′ neolignans **4a**, **6a** and **6c**, respectively, all with a 1,3,4-trisubstitution pattern for ring A.

RESULTS AND DISCUSSION

Both *erythro* and *threo* dilignols **4a** and **6a** were isolated from the hydrolysates from treatment of spruce (*Picea abies*) wood and high-yield pulps derived from spruce wood with an aqueous solution at pH4 [8]. A mixture of the dilignol isomers **4a** and **6a** was previously obtained by mild acid treatment of spruce wood [9], and the structure of the isomers confirmed by catalytic hydrogenation to the known dihydro compound (isomer not specified) [10]. Assignment of configuration to *erythro* and *threo* isomers analogous to **4a** and **6a** has been made on the basis of chemical transformations, and confirmed by NMR spectroscopy and X-ray crystallography [11].

The ^{1}H NMR spectral data for deuteriochloroform solutions of the dilignol tetraacetates **4b** and **6b** [8] and those reported by Greca *et al.* [2] for the neolignan tetraacetates **2b** and **3b** are given in Table 1. It is clear from comparison of the spectra that compounds **2b** and **3b** are essentially identical to **4b** and **6b**, respectively. In the spectrum of **4b** the three protons, H-2′, H-5′ and H-6′ are not resolved, and occur as two singlets at 6.90 (1-H) and 6.99 ppm (2-H). The lack of coupling for these signals which led Greca *et al.* to propose the 8-*O*-3′ structure for their neolignan [2] probably occurs because the 5′ and 6′ proton signals have identical chemical shifts. The ^{1}H NMR spectrum of the *erythro* compound **4b** in acetone-d_6 afforded resolution of all the aromatic protons, and assignment of the protons was made on the basis of C–H correlation experiments and of coupling constants (Table 1). The aromatic protons in the ^{1}H NMR spectrum of the *threo* compound **6b** in deuteriochloroform occurred as four signals, which could not be assigned. However, the spectrum of **6b** in acetone-d_6 gave well resolved signals for the aromatic protons, which were assigned by C-H correlation experiments and on the basis of coupling constants, as for **4b** (Table 1).

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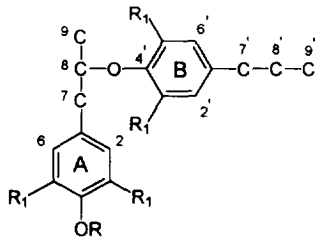
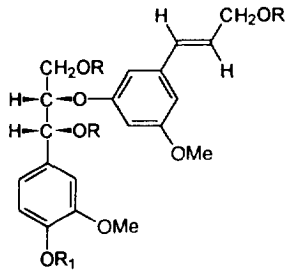


1 R = H or OMe
R_1 = H or OMe



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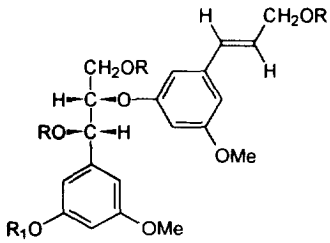

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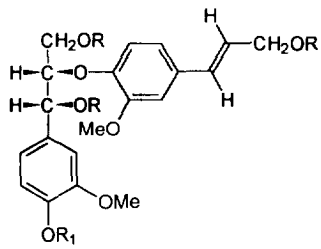

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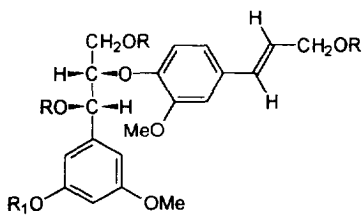

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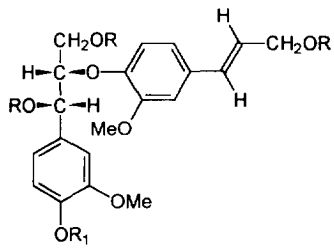

6

2-6 **a** R = R_1 = H
b R = R_1 = $COCH_3$
c R = H R_1 = β-D-glucopyranosyl
d R = $COCH_3$ R_1 = β-D-heptaacetylglucopyranosyl

The neolignan glucoside heptaacetate **5d** has a reported ^{1}H NMR spectrum in deuteriochloroform [2] similar to those of compound **4d** and the aglycone **6b**. The lack of coupling of the three signals at 6.91, 6.94 and 6.96 ppm is consistent with the spectra of **4b** and **6b**. There is thus no reason to invoke the 1,3,5-trisubstitution pattern for ring A, as in **5d**, for the acetylated neolignan glucoside, and the glucoside should be reassigned as structure **6d**.

The above results show that the 8-*O*-3′ structures **2a** and **3a** proposed for the neolignans isolated from *Arum italicum* [2] are incorrect, and that the compounds should be reassigned structures **4a** and **6a** with the conventional 8-*O*-4′ linkage between the units. The 1,3,5-trisubstitution pattern in **3a** and **5c** is also incorrect, and the compounds should be reassigned to **4a** and **6c**, with the conventional 1,3,4-trisubstitution pattern. At present there is no evidence to support the existence of 8-*O*-3′-linked neolignans in nature.

Compounds **4a** and **6a** are important substructures of lignin, and have been previously prepared as an isomeric mixture by two research groups [10, 12]. As neolignan extracts, one of the isomers (**4a** or **6a**) has been isolated from the wood of *Larix leptolepis* [13]; the 8-*O*-4′ neolignan glucoside **4c** has been isolated from citrus peelings [4, 14, 15].

EXPERIMENTAL

Spectra. ^{1}H NMR spectra in $CDCl_3$ were recorded at 250 MHz on a Bruker AC-250 instrument, and the spectra in acetone-d_6 were recorded at 360 MHz on

Table 1. ^{1}H NMR chemical shifts of acetylated compounds

Proton no.	**2b*** ($CDCl_3$)	**4b†** ($CDCl_3$)	**4b** ($(CD_3)_2CO$)	**4d*** ($CDCl_3$)	**3b*** ($CDCl_3$)	**6b†** ($CDCl_3$)	**6b** ($(CD_3)_2CO$)	**5d*** ($CDCl_3$)
$OCOCH_3$		2.03, 2.10, 2.10, 2.31	1.93, 2.02, 2.07, 2.21			2.00, 2.05, 2.10, 2.31	1.95, 2.01, 2.02, 2.21	
OCH_3	3.80 (*s*) 3.82 (*s*)	3.80 (*s*) 3.82 (*s*)	3.83 (*s*) 3.85 (*s*)	3.81 (*s*) 3.81 (*s*)	3.83 (*s*) 3.84 (*s*)	3.82 (*s*) 3.83 (*s*)	3.81 (*s*) 3.85 (*s*)	3.81 (*s*) 3.84 (*s*)
9a (1H)	4.25 (*dd*) (11.8, 4.2)	4.24 (*dd*) (11.9, 3.9)	4.22 (*dd*) (11.9, 4.2)	4.18 (*dd*) (11.8, 4.0)	4.06 (*dd*) (11.9, 5.9)	4.06 (*dd*) (11.9, 5.8)	4.02 (*dd*) (11.9, 5.7)	4.03 (*dd*) (11.9, 5.9)
9b (1H)	4.45 (*dd*) (11.8, 5.7)	4.45 (*dd*) (11.9, 5.8)	4.36 (*dd*) (11.9, 5.9)	4.41 (*dd*) (11.8, 5.7)	4.31 (*dd*) (11.9, 4.4)	4.31 (*dd*) (11.9, 4.4)	4.26 (*dd*) (11.9, 4.1)	4.28 (*dd*) (11.9, 4.5)
8 (1H)	4.67 (*m*)	4.66 (*m*)	4.85 (*m*)	4.67 (*m*)	4.64 (*m*)	4.62 (*m*)	4.81 (*m*)	4.63 (*m*)
9′ (2H)	4.71 (*d*) (5.8)	4.71 (*d*) (6.3)	4.66 (*dd*) (6.4, 1.3)	4.71 (*d*) (5.9)	4.72 (*d*) (5.7)	4.71 (*d*) (6.4)	4.67 (*dd*) (6.4, 1.3)	4.79 (*d*) (5.8)
7 (1H)	6.07 (*d*) (4.3)	6.06 (*d*) (5.3)	6.06 (*d*) (5.1)	5.99 (*d*) (4.3)	6.11 (*d*) (6.4)	6.11 (*d*) (6.4)	6.10 (*d*) (6.4)	6.10 (*d*) (6.3)
8′ (1H)	6.18 (*dt*) (16.0, 5.8)	6.18 (*dt*) (15.9, 6.5)	6.18 (*dt*) (15.9, 6.4)	6.18 (*dt*) (15.9, 5.8)	6.16 (*dt*) (15.8, 5.7)	6.18 (*dt*) (15.8, 6.5)	6.18 (*dt*) (15.9, 6.4)	6.19 (*dt*) (16.0, 5.8
7′ (1H)	6.57 (*d*) (16.0)	6.57 (*d*) (15.9)	6.62 (*br d*) (16.0)	6.57 (*d*) (15.9)	6.58 (*d*) (15.8)	6.57 (*d*) (15.8)	6.63 (*br d*) (16.0)	6.59 (*d*) (16.0)
2 (1H)	7.07 (*d*) (1.9)	7.07 (*br s*)	7.13 (*d*) (1.9)	7.04 (*d*) (1.8)			7.14 (*d*) (1.9)	
5 (1H)	6.78 (*d*) (8.1)	6.78 (*d*) (8.2)	6.97 (*d*) (8.2)	6.78 (*d*) (8.2)			7.00 (*d*) (8.3)	
6 (1H)	6.88 (*dd*) (8.1, 1.9)	6.87 (*dd*) (8.2, 1.9)	6.93 (*dd*) (8.2, 1.9)	6.86 (*dd*) (8.2, 1.8)			6.96 (*dd*) (8.3, 1.9)	
2′ (1H)			7.25 (*d*) (1.5)	6.92 (*d*) (1.8)			7.22 (*d*) (1.7)	6.93 (*d*) (1.8)
5′ (1H)			7.02 (*d*) (8.1)	7.07 (*d*) (8.2)			7.03 (*d*) (8.2)	7.07 (*d*) (8.2)
6′ (1H)			7.05 (*dd*) (8.1, 1.5)	6.89 (*dd*) (8.2, 1.8)			7.06 (*dd*) (8.2, 1.7)	6.90 (*dd*) (8.2, 1.8)
Unassigned aromatic H	6.90, 6.99 (*br s*)	6.90, 6.99 (*br s*)			6.90, 6.94, 7.01, 7.04 (*br s*)	6.90, 6.94, 7.00, 7.01 (*br s*)		6.91, 6.94, 6.96 (*br s*)

*Data from [2].
†Data from [8].

a Bruker AMX-360 instrument. Chemical shifts are given in ppm from tetramethylsilane (δ0.00).

Dilignols **4a** *and* **6a**. The dilignols were obtained from spruce wood shavings by hydrolysis for 19 hr at pH 4, according to Gellerstedt and Zhang [8]. Acetylation of the dilignols was carried out with acetic anhydride–pyridine [16].

REFERENCES

1. Whiting, D. A. (1985) *Nat. Prod. Rep.* **2**, 191.
2. Greca, M. D., Molinaro, A., Monaco, P. and Previtera, L. (1994) *Phytochemistry* **35**, 777.
3. Matsubara, Y., Kumamoto, H., Sawabe, A., Iizuka, Y. and Okamoto, K. (1985) *Kinki Daigaku Igaku Zasshi* **10**(4), 51.
4. Sawabe, A., Matsubara, Y., Kumamoto, H., Iizuka, Y. and Okamoto, K. (1986) *Nippon Nogei Kagaku Kaishi* **60**, 593.
5. Green, T. P., Galinis, D. L. and Wiemer, D. F. (1991) *Phytochemistry* **30**, 1649.
6. Green T. P. and Wiemer, D. F. (1991) *Phytochemistry* **30**, 3759.
7. Reilly, M. J., Wallis, A. F. A., Lundquist, K. and Stomberg, R. (1992) *J. Wood Chem. Technol.* **12**, 471.
8. Gellerstedt, G. and Zhang, L. (1992) *J. Wood Chem. Technol.* **12**, 387.
9. Nimz, H. (1965) *Chem. Ber.* **98**, 533.
10. Freudenberg, K. and Eisenhut, W. (1955) *Chem. Ber.* **88**, 626.
11. Stomberg, R. and Lundquist, K. (1994) *Nord. Pulp Pap. Res. J.* **9**, 37.
12. Nakatsubo, F. and Higuchi, T. (1980) *Wood Res.* **66**, 23.
13. Miki, K., Takehara, T., Sasaya, T. and Sakakibara, A. (1980) *Phytochemistry* **19**, 449.
14. Matsubara, Y., Sawabe, A., Ueno, K., Iizuka, Y. and Okamoto, K. (1986) *Kinki Daigaku Igaku Zasshi* **11**(4), 65.
15. Matsubara, Y., Yusa, T., Sawabe, A., Iizuka, Y. and Okamoto, K. (1991) *Agric. Biol. Chem.* **55**, 647.
16. Gellerstedt, G. and Zhang, L. (1992) *Nord. Pulp Pap. Res. J.* **7**, 75.