Tetrahedron Letters Vol. 21, pp 4255 - 4258
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0040-4039/80/1029-4255$02.00/0

THE STRUCTURE OF NEW LIGNANS FROM THE SEEDS OF PHYTOLACCA AMERICANA

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Abstract: From the seeds of Phytolacca americana two new lignans, Americanin B and D, have been isolated and their strucutres elucidated mainly by spectroscopic methods

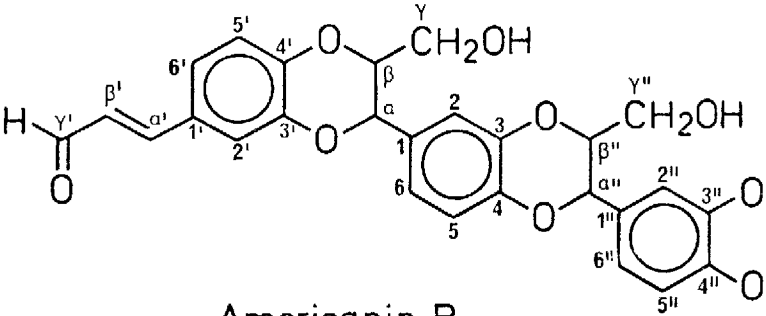
In a previous communication we reported[1] on the isolation and structure elucidation of a new lignan, Americanin A, from the seeds of Phytolacca americana.Since this compound turned out to be an anti-hepatotoxic agent[2], we continued our investigations and isolated two more new lignans (Americanin B and D) as minor constituents from the mother liquor.

Americanin B (1) $C_{27}H_{24}O_9$ (M^+492), m.p. 258-260°, $[\alpha]_D^{17} = +1.7^{\circ}$ (c = 0.3 in pyridine) showed in its IR spectrum absorptions for the same α,ß unsaturated C=O group (1650, 1610 cm^{-1}) and aromatic system (1580, 1510 and 1450 cm^{-1}) as Americanin A.Formation of a dimethylether (m.p. = 185-7°) and dimethylether diacetate (m.p. = 93-4°) showed the presence of two alcoholic and two phenolic groups in Americanin B. The ^1H-NMR spectrum in DMSO-d_6, with a doublet at δ = 9,47 (1H, J= 8 Hz), a doublet at δ = 7,55 (1H, J=16 Hz) and a double doublet centred at δ = 6,58 (1H, J=8 Hz and 16 Hz) indicated the presence of a $CH=CH-C{<}^{H}_{O}$ moiety. One multiplet in the aliphatic region at δ = 3,55, integrating for 4 H shifted downfield by ca. 0,7 ppm on acetylation indicating that two primary alcoholic and two phenolic OH-groups must be present. This accounts for five of the nine oxygen atoms in Americanin B. The close similarity in spectral characteristics (UV, IR, NMR and MS) with those of Americanin A[1)], as well as their co-occurrence in the same plant, suggested that the four remaining oxygen atoms in Americanin B were part of two benz-1,4-dioxane moieties. The presence of 9 aromatic protons and 11 aliphatic and olefinic protons in Americanin B as well as the molecular weight of its dimethylether (M^+ m/e = 520) led to the postulation of a C_6-C_3 trimer structure. The 3,4-dioxygenation pattern of the terminal aromatic ring corresponds to that of Americanin A and 3,4-dihydroxy-cinnamaldehyde, also isolated from the same plant. The ^{13}C-NMR spectrum provided a final confirmation of the proposed structure, as the chemical shifts of the carbon atoms in Americanin B are very closely similar to that of Americanin A (see Table 1). However, a distinction between the four possible stereoisomers, resulting from the interchange of substituents on C-α, C-β and C-γ", C-β" respectively, cannot be made at this stage*).

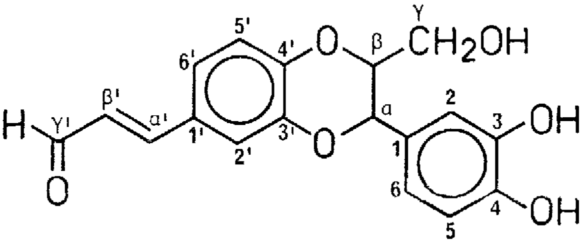
Table 1

Americanin A**)		Americanin B		Americanin A		Americanin B		Americanin B	
C-1'	127.6[a]	C-1'	127.5	C-1	127.2[a]	C-1	129.4	C-1"	127.5
C-2'	116.8	C-2'	116.7	C-2	115.0[b]	C-2	116.1	C-2"	115.0
C-3'	143.5	C-3'	143.7	C-3	145.3[c]	C-3	143.2	C-3"	145.2
C-4'	146.6	C-4'	146.1	C-4	145.9[c]	C-4	144.0	C-4"	145.8
C-5'	117.3	C-5'	117.3	C-5	115.5[b]	C-5	116.7	C-5"	115.5
C-6'	122.6	C-6'	123.0	C-6	118.9	C-6	120.4	C-6"	118.8
C-α'	126.8	C-α'	126.9	C-α	76.1	C-α	75.2	C-α"	75.7
C-β'	153.0	C-β'	152.9	C-β	78.1	C-β	78.2	C-β"	78.2
C-γ'	194.0	C-γ'	193.9	C-γ	60.1	C-γ	60.0	C-γ"	60.0

a,b,c) Assignments bearing the same alphabetical superscript in any one spectrum may be reversed



Americanin B



Americanin A

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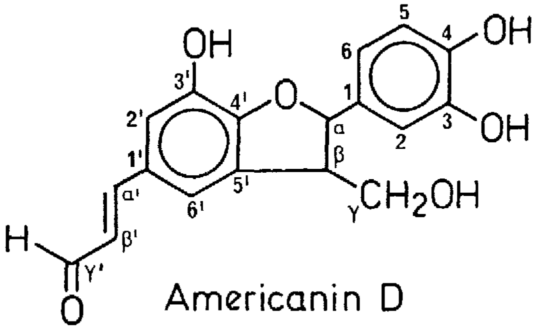
*) The recently achieved partial synthesis of hydnocarpin (3-desoxy-2,3-dehydro silybin) tetramethylether[3] starting from Americanin A[4] favours the C-1' position for the C_3 side chain in Americanin A as well as in Americanin B.

**) Americanin A was earlier called Americanin.

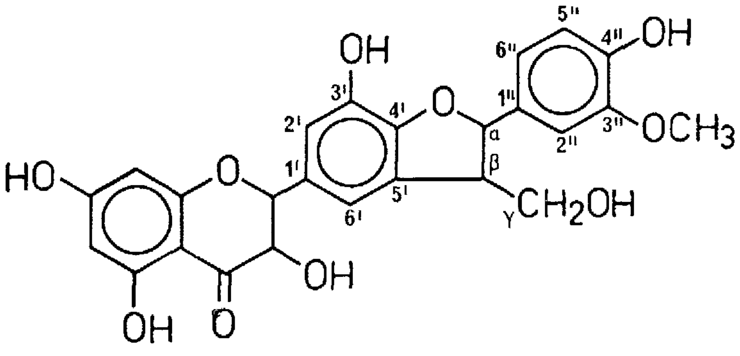
Americanin D (2) $C_{18}H_{16}O6$ (M^+328), m.p. 197-200° exhibited a negative H_2SO_4 colour test indicating the absence of a benz-1,4-dioxane structure. The ^{1}H-NMR spectrum shows signals characteristic for a $Ar{-}CH{=}CH{-}CH{\lesssim}^{H}_{O}$ moiety. Unlike Americanin A, there were resonances for only five aromatic protons. After acetylation a tetraacetate was prepared having 3 aromatic OAc (2,30 and 2,35 ppm) and 1 aliphatic OAc-group (2,10 ppm). The appearance of two doublets at 5.69 (1H, J=6 Hz) and 4.43 (2H, J=7 Hz) and a multiplet at 3,85 strongly suggested the presence of 2,3-dihydrobenzofurane system[5)]. The coumarane type of structure could be corroborated by comparison of the chemical shifts as well as the coupling constants in the ^{1}H-NMR spectra with those of silychristin[6)] and licarin A[7)]. ^{13}C-NMR spectral comparison provided additional confirmation of the structure (see Table 2).

Table 2

Silychristin		Americanin D		Silychristin		Americanin D	
		C-α' 125,5; C-ß' 154,0; C-γ' 193,8					
C-1'	129,0^{b}	C-1'	127,4	C-2"	110.4	C-2	113.1
C-2'	115,3^{a}	C-2'	117,0^{a}	C-3"	147.0^{c}	C-3	145.2
C-3'	147.5^{c}	C-3'	141.3	C-4"	146.3^{c}	C-4	145.2
C-4'	140.6	C-4'	150.2	C-5"	115.3^{a}	C-5	115.3
C-5'	129.9^{b}	C-5'	132.3	C-6"	118.6	C-6	116.6^{a}
C-6'	115.6^{a}	C-6'	116.6	C-α"	86.9	C-α	87.5
C-1"	132.4	C-1	130.2	C-ß"	53.3	C-ß	52.9
				C-γ	62.9	C-γ	63.0



Americanin D



Silychristin

Since in the ^{1}H-NMR spectrum of Americanin D the protons of the oxymethylene group did not appear at an unusually high field position, as is characteristic for cis-2-aryl-3-substituted dihydrobenzofurane [8, 9], a trans orientation of the primary alcohol group and the aryl substituent as in silychristin[11] and lappaol F has been assigned. Americanin D thus belongs to the same structure type as the lignans herpetotriol and herpetotetrol, recently isolated from Herpetospermum candigerum[12].

Aknowledgement:

The authors thank DFG (Bonn) and KOSEF (Seoul, Korea) for financial support and a fellowship in the framework of the Korea-Germany Cooperative Science Programmes.

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(Received in Germany 5 August 1980)