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STAUDTIENIC ACID, A DITERPENE ACID FROM *STAUDTIA KAMERUNENSIS*[1]

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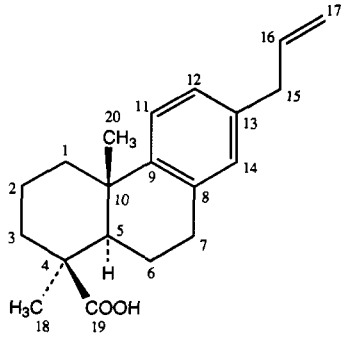
ABSTRACT.—A new diterpene acid, staudtienic acid [**1**], has been isolated from *Staudtia kamerunensis*, and its structure has been determined from a spectroscopic study including ir, ms, and ^1H and ^{13}C nmr.

Plants of the Myristicaceae have been extensively studied because of their nutritive and other values. In Cameroon, plants of this family are abundant and are used fairly extensively in traditional medicine. As a continuation of an ongoing study (1) on Cameroon medicinal plants, the chemical constituents of *Staudtia kamerunensis* Warb. were investigated.

The EtOAc extract of the stem bark of *S. kamerunensis* was re-extracted with C_6H_6 and the soluble part subjected to cc to afford staudtienic acid [**1**]. This diterpene acid was obtained as colorless crystals from petroleum ether, mp 155–156° and was optically active. Ir absorption at ν max 1697 cm^{-1} was indicative of a carboxylic acid function. The molecular mass 298 was clearly deduced from the ei and ci mass spectra, and the molecular formula $C_{20}H_{26}O_2$ was determined by hrms.



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The ^{13}C-nmr spectrum showed signals for 20 carbon atoms: one carbonyl at δ_C 184.51, eight sp^2 carbons, five of them being protonated, two methyl and six methylene groups, one methine, and two quaternary sp^3 carbon atoms (Table 1). The ^1H-nmr spectrum revealed three aromatic protons of an ortho-meta trisubstituted aromatic ring, three ethylenic protons between 5 and 6 ppm, two methyl groups as singlets at δ_H 1.31 and 1.09 ppm, and between 1.0 and 3.3 ppm, the signals of 13 protons involved in complex spin systems. These protons, along with the three ethylenic protons, were assigned to three spin systems on the basis of ^1H-^1H and ^1H-^{13}C COSY data: (a) $-CH_2-CH_2-CH_2-$, (b) $>CH-CH_2CH_2-$, (c) $-CH_2-CH=CH_2$.

These substructures, together with the aromatic system, the carbonyl and the methyl groups, were linked from analysis of the cross peaks observed in the ^1H-^{13}C long range COSY optimized for a J_{C-H} coupling constant value of 7 Hz. The carbonyl at δ_C 184.51 (C-19) showed cross peaks with Me-18 and protons at δ_H 1.07 (H-3ax) and δ_H 1.54 (H-5ax). The methine carbon at δ_C 52.86 (C-5) showed $^3J_{C-H}$ connectivities with methyls at δ_H 1.31 (Me-18) and δ_H 1.09 (Me-20). The aromatic quaternary carbon at δ_C 145.79 (C-9) was linked to Me-20 and with protons at δ_H 6.94 (H-

[1]Part 1 in the series "The Myristicaceae of Cameroon."

TABLE 1. ^{13}C-nmr (75.47 MHz) and ^{1}H-nmr (300.13 MHz) Data of Staudtienic Acid [**1**] ($CDCl_3$ with TMS as internal standard).

Carbon	ppm	mult.	Proton	ppm	mult.	*J*(Hz)
C-1	39.29	t	H-1eq	2.23	ddd	−13.7, 3.9, 2.4
			H-1ax	1.35	ddd	−13.7, 13.7, 4.5
C-2	18.85	t	H-2eq	1.59	ddddd	−13.7, 4.5, 4.4, 2.4, 2.4
			H-2ax	1.99	ddddd	−13.7, 13.7, 13.7, 3.9, 3.9
C-3	37.29	t	H-3eq	2.23	ddd	−13.7, 3.9, 2.4
			H-3ax	1.07	ddd	−13.7, 13.7, 4.4
C-4	43.89	s				
C-5	52.86	d	H-5ax	1.54	dd	11.9, 1.9
C-6	20.83	t	H-6eq	2.16	dddd	−13.8, 5.8, 1.9, 1.9
			H-6ax	2.02	dddd	−13.8, 12.2, 11.9, 5.7
C-7	31.90	t	H-7eq	2.86	ddd	−17.0, 5.7, 1.9
			H-7ax	2.76	ddd	−17.0, 12.2, 5.8
C-8	135.35	s				
C-9	145.79	s				
C-10	38.36	s				
C-11	125.62	d	H-11	7.16	d	8.1
C-12	126.08	d	H-12	6.94	dd	8.1, 1.8
C-13	136.99	s				
C-14	128.94	d	H-14	6.85	d	1.8
C-15	39.71	t	H-15	3.30	ddd	6.9, 1.5, 1.2
C-16	137.55	d	H-16	5.94	ddt	16.9, 9.9, 6.9
C-17	115.61	t	H-17*Z*	5.08	ddt	16.9, −2.1, 1.2
			H-17*E*	5.03	ddt	9.9, −2.1, 1.5
C-18	28.70	q	Me-18	1.31	s	
C-19	184.51	s				
C-20	23.13	q	Me-20	1.09	s	

12) and δ_H 6.85 (H-14), whereas that at δ_C 135.35 (C-8) was linked to protons at δ_H 7.16 (H-11), δ_H 2.86 (H-7eq), and δ_H 2.16 (H-6eq), and that at δ_C 136.99 (C-13) was linked to protons at δ_H 7.16 (H-11) and δ_H 3.30 (H-15). The sp^3 quaternary carbon at δ_C 43.89 (C-4) showed connectivities with Me-18 and H-5 whereas the carbon at δ_C 38.36 (C-10) showed connectivities with Me-20, H-5, and aromatic H-11. This data (Table 1) led to proposal of the structure **1**.

Structure **1** was confirmed by observation of long range couplings in the ^{1}H-^{1}H long range COSY between the aromatic H-12 and methylene H-15 and between the aromatic H-14 and both methylenes H-7 and H-15. A cross peak observed between Me-20 and H-1ax indicated that they were in a trans-diaxial relative disposition (2). Assignment of the ethylenic methylene protons at C-17 arose from the values of their $^{3}J_{H\text{-}H}$ coupling constant with H-16, which was 16.9 Hz for H-17*Z* and 9.9 Hz for H-17*E*. Axial methylene protons were assigned on the basis of the large value of their vicinal ^{3}J trans-diaxial couplings (12–14 Hz).

Information on the relative stereochemistry was deduced from nOe data. NOe effects were measured between H-5 and both H-7ax (2%) and Me-18 (9%), and between H-11 and both H-1eq (9%) and H-12 (19%). Me-20 showed significant nOes with H-6ax (4%) and H-11 (3%). Irradiation of H-12 resulted in the enhancement of H-16 (7%), while that of methylene H-15 showed enhancement of H-12 (5%), H-14 (5%), and H-16 (8%). No nOe was measured between Me-18 and Me-20. The results implied that H-5 and Me-20 were in a trans rela-

tive disposition, Me-20 was β, Me-18 was α-equatorial, and the carboxyl group at C-19 was β-axial, as shown in Figure 1.

(5 g) which was further chromatographed on Si gel (200 g) and eluted with the same solvent system to yield staudtienic acid [**1**] (80 mg) after recrystallization from petroleum ether.

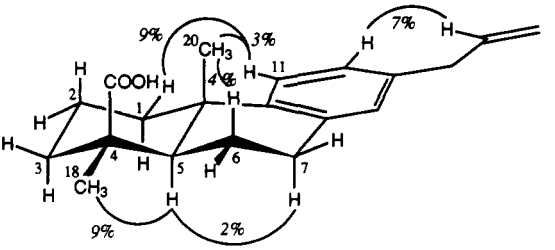

FIGURE 1. The nOe data for staudtienic acid [**1**].

EXPERIMENTAL

GENERAL METHODS.—^{1}H- and ^{13}C-nmr spectra ($CDCl_3$) were taken on an AC 300 Bruker spectrometer operating at 300 MHz and 75 MHz, respectively. The ir spectrum was recorded on a Perkin-Elmer 881 ir spectrophotometer, and the optical rotation was measured on a Perkin-Elmer 141 polarimeter. Ei and ci ms were obtained with a Nermag Sidar V 3.0 mass spectrometer and the hrms with a V.G. Analytical MM ZAB-HF mass spectrometer.

PLANT MATERIAL.—The stem bark of *S. kamerunensis* was collected at Njombe in the Littoral province in Cameroon in March 1988. Voucher material documenting the collection was identified by the Director of National Herbarium, Yaounde, Cameroon and is on deposit there.

EXTRACTION AND ISOLATION.—Dried ground stem bark (15.8 kg) was successively extracted in a Soxhlet extractor with *n*-hexane, EtOAc, and MeOH. Concentration of the EtOAc extract gave 550 g of material, 250 g of which was re-extracted with C_6H_6 to give 42 g of a soluble fraction which was chromatographed on Si gel (500 g). Elution with C_6H_6/Et_2O gave a fraction

STAUDTIENIC ACID [**1**].—$C_{20}H_{26}O_2$; mp 155–156° (petroleum ether); $[\alpha]^{21}D$ −134.3° (MeOH, c=0.1); ir (KBr) ν max cm^{-1} 3077, 2960, 2935, 1697, 1655, 1642, 1499, 1476, 1442, 1410, 1383, 1270, 1196, 1179, 911, 850, 820; eims (70 eV, 200°) *m/z* (%) $[M]^+$ 298 (29), 283 (100), 237 (82), 198 (11), 196 (10), 195 (9), 183 (10), 181 (30), 157 (14), 155 (13), 142 (10), 141 (17), 129 (18), 128 (14), 115 (14), 91 (7), 69 (5), 55 (7), 41 (20); cims (NH_3) *m/z* (%) $[M+NH_4]^+$ 316 (100); hrms obs. 298.1931 (calcd for $C_{20}H_{26}O_2$, 298.1933); ^{13}C and ^{1}H nmr see Table 1.

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