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THE SESQUITERPENE CONSTITUENTS OF *MORTONIA HIDALGENSIS**

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Key Word Index—*Mortonia hidalgensis*; Celastraceae; mortonol B; an agarofurane sesquiterpene.

Abstract—The structure of mortonol B, a sesquiterpene constituent of *Mortonia hidalgensis*, was established as 2β-acetoxy-mortonol A. Mortonol B is proposed as a biogenic precursor of mortonin B. Mortonins A and C were also isolated from *M. hidalgensis*.

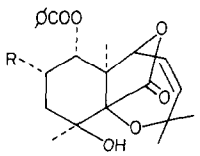
INTRODUCTION

Recently we described the isolation of mortonins A–D from *Mortonia greggii*. The structures **1–3** proposed for them [1, 2], constitute a new type of sesquiterpene which contains a tetrahydro-oxepine nucleus. They can be derived biogenetically from a polyhydroxylated dihydroagarofurane structure, as previously postulated [1, 2].

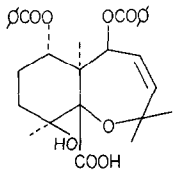
Sesquiterpene compounds with this type of skeleton have been isolated only from *Mortonia greggii*. We thought that other species of *Mortonia* may contain this type of compound, and that its presence could be a chemical guide to distinguish the *Mortonia* genus from other genera of the Celastraceae family. For this purpose we undertook a chemical study of *Mortonia hidalgensis*, a shrub, which was collected near Actopan (Hidalgo). The aerial part of the shrub afforded mortonins A (**1a**) and C (**2**) in 0.004 and 0.33% yields respectively. From the mother liquors of mortonin A, a new compound was obtained, which was shown to be the 2β-acetyl derivative of mortonol A (**4a**) [3] and it was called mortonol B.

RESULTS AND DISCUSSION

Mortonol B (**4b**), mp 216–218°, $[\alpha]_D^{CHCl_3} + 23.45°$ corresponded to $C_{31}H_{34}O_9$. The mass spectrum showed the molecular ion $[M]^+$ at *m/z* 550 and peaks showing the loss of two benzoic acid units and one acetic acid unit. The IR spectrum contained a band at 3550 cm^{-1}, assignable to a tertiary hydroxyl group. In the carbonyl region it presented a sharp band at 1760 and a complex broad absorption centred at 1735 cm^{-1}, which, in addition to the bands at 1605 and 1590 cm^{-1}, confirmed the presence of benzoate esters in mortonol B. The ^1H NMR spectrum of mortonol B showed four singlets at δ 1.30 – 1.75 (Table 1), which were attributed to four quaternary methyl groups. A fifth singlet (3H) observed at δ 1.85, was assigned to the acetate methyl group. The tertiary hydroxyl group is responsible for a signal at δ 2.75 (exchangeable with D_2O). The signals observed at 5.0 (*dd*, *J* = 2, 6 Hz), 5.20 (*ddd* *J* = 6, 11, 10 Hz) and 6.00 (*d*, *J* = 11 Hz) (1 H each), were assigned to the protons attached to the carbon atoms bearing the secondary ester groups. The ^1H NMR spectrum of **4b** also showed aromatic signals of two benzoate esters 7.25–8.2 (10H, *m*). A comparison of the IR, ^1H NMR and



1a R=H
1b R=OAc



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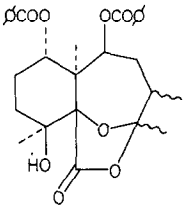

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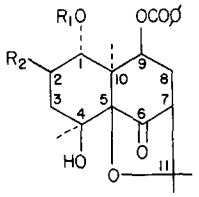
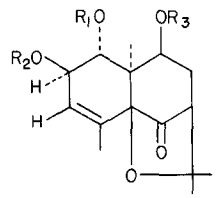


4a R_1=COC_6H_5; R_2=H
4b R_1=COC_6H_5; R_2=OAc
4c R_1=H_1; R_2=OH



5a R_1=R_3=COC_6H_5; R_2=Ac
5b R_1=R_3=COC_6H_5; R_2=H
5c R_1=R_2=R_3=H

*Contribution No. 599. Presented in part at the *Second Chemical Congress of the North American Continent.*

Table 1. ^{1}H NMR chemical shifts of mortonol A and of mortonol B and its derivatives

Compound	H-1	H-2	H-3	H-9	C-4Me	C-10Me	C-11(Me)$_2$	OH	OAc	Aromatic H
Mortonol B (**4b**)	6.0 *d*(11)	5.20 *ddd*(10,11,6)	*	5.0 *dd*(2, 6)	1.75 *s*	1.30 *s*	1.40 *s*	2.75(1H)	1.85 *s*	7.25–8.2(1OH)
4c	4.1 *d*(9)	3.5 *ddd*(9, 10, 5)	*	5.05 *dd*(2, 6)	1.68 *s*	1.10*s*	1.55*s* 1.27 *s*	3.1	—	7.35–8.2(5H)
5a	6.1 *d*(8)	5.5 *dt*(2, 8)	5.60(*m*)	5.1 *dd*(2, 6)	1.80 *br s*	1.25 *s*	1.54 s 1.30 *s*	—	1.85 *s*	7.25–8.2(10H)
5b	5.75 *d* (8)	4.25 *br s* (8)	5.80 *br s*	5.15 *dd* (2, 6)	1.8 *br s*	1.20 *s*	1.50 *s* 1.30 *s*	3.0		7.5–7.85(10H)
Mortonol A (**4a**)	5.97 *dd*(10,5)	*	*	5.15 *dd*(2, 6)	1.8 *s*	0.98 *s*	1.20 *s* 1.26 *s*	2.43	—	7.25–8.2(10H)

The spectra were run in $CDCl_3$, using TMS as int. standard. The coupling constants in Hz are in parentheses.
*Multiplet between 2.0 and 2.7.

Table 2. ^{13}C NMR chemical shifts of mortonols A and B

Carbon no.	Mortonol A	Mortonol B
1	72.57 *d*	72.08 *d*
2	23.93 *t*	68.99 *d*
3	38.54 *t*	44.37 *t*
4	70.58 *s*	70.95 *s*
5	86.11 *s*	85.77 *s*
6	211.98 *s*	211.04 *s*
7	55.23 *d*	55.34 *d*
8	33.50 *t*	33.14 *t*
9	72.26 *d*	72.23 *d*
10	56.02 *s*	55.84 *s*
11	78.08 *s*	78.55 *s*
12	21.20 *q*	22.24 *q*
13	23.54 *q*	23.63 *q*
14	17.09 *q*	17.88 *q*
15	29.59 *q*	29.62 *q*
$\varphi\underline{C}O$	165.33 *s*	165.53 *s*
$\varphi\underline{C}O$	165.41 *s*	164.79 *s*
$Me\underline{C}O$	—	170.21 *s*
$\underline{C}H_3CO$	—	20.76 *q*

^{13}C NMR (Table 2) spectra of mortonol B (**4b**) with those of mortonol A, (**4A**)[3], suggested that mortonol B is an acetyl derivative of mortonol A. The structure **4b** proposed for mortonol B was proved in the following manner.

Dehydration of mortonol B gave the anhydro derivative **5a**, which did not show hydroxyl absorption in the IR spectrum. In the ^1H NMR spectrum it only showed three quaternary methyl groups (Table 1) and a vinylic methyl group as a broad singlet at δ 1.80. A broad signal observed at δ 5.6, was attributed to the vinylic proton. The signal corresponding to H-2, at 5.2 (*ddd* $J = 6$, 11, 10 Hz) in the ^1H NMR spectrum of **4b**, was shifted downfield and transformed into a doublet of triplets in **5a**. The formation of **5a** proved that the tertiary hydroxyl group in mortonol B is at C-4, as in all the sesquiterpene derivatives isolated so far from *Mortonia* species [1, 2]

Saponification of anhydromortonol B, yielded **5c** which showed the 1760 cm^{-1} absorption in the IR spectrum. This band was attributed to a cyclopentanone function. The ^{13}C NMR spectrum (Table 2) of mortonol B, confirmed this assignment, since it showed a carbonyl signal at δ 211.04. The ketonic function must therefore be placed at C-6, as in mortonol A (**4a**).

Partial saponification of mortonol B (**4b**) gave **4c** which showed strong hydroxyl absorption at 3510 and 3560 cm^{-1} in its IR spectrum. Two sharp carbonyl bands at 1760 and 1710 cm^{-1} (equal intensity), and absorption at 1600 and 1590 cm^{-1} suggested the presence of at least one benzoate ester group. The mass spectrum and ^1H NMR spectrum (five aromatic protons at δ 7.4–8.1) confirmed the presence of only one benzoate ester in **4c**. The proton attached to the carbon atom which supports this benzoate ester, appeared at 5.05 (*dd*, $J = 2$, 6 Hz), as in the parent compound (Table 1). The chemical shift and coupling constants shown by this proton suggested that the benzoate group is placed at C-9 and is axially orientated. The doublet observed in **4b** at δ 6.00 is now shifted upfield to δ 4.1 ($J = 9$ Hz) and could be assigned to the C-1 proton. The C-2 proton is responsible for a complex signal centered at δ 3.5. The singlet attributed to the acetate group was absent in the ^1H NMR spectrum of **4c**. The formation of **4c** showed that the acetate and one of the benzoate groups must be placed at C-1 and C-2 of the mortonol B structure, **4b**. In order to find the correct position of the acetate ester, anhydromortonol B (**5a**) was submitted to saponification under very mild conditions. Treatment of a methanolic solution of anhydromortonol B (**5a**) with potassium bicarbonate for 0.5 hr at room temperature, yielded the deacetyl derivative **5b**. Its ^1H NMR spectrum did not show the singlet at δ 1.85, attributed to the acetate ester, but the signals for ten aromatic protons of the two benzoate esters were observed (Table 1). The C-1 and C-9 protons were present, as in the parent compound, at 5.75 (*d*, $J =$ 8 Hz) and 5.15 (*dd*, $J = 2$, 6 Hz). The C-2 proton was shifted upfield to 4.25 (*br d*, $J = 8$ Hz) and must, therefore, be ascribed to the proton bound to the carbon atom which supports the secondary hydroxyl group. The vinylic proton appeared as a broad singlet at δ 5.80. Double resonance experiments showed that H-2 is coupled to H-1 and to the vinyl proton. The vinylic proton was also shown to be coupled to the vinylic methyl group. Partial structure C-$CH(OCOC_6H_5)$–$CH(OH) - CH = C$ (Me)–C, could be deduced from the above data, showing that the acetate in mortonol B must be at C-2.

The coupling constant (11 Hz) found for H-1 of mortonol B (Table 1) suggested a diaxial interaction between H-1 and H-2. Therefore the acetate group at C-2 must be equatorially orientated. The ^1H NMR spectrum in pyridine-d_5 (Table 3) showed a strong solvent-induced shift for H-1 ($\Delta = -0.27$) but H-2 was almost unaffected by the change of solvent. This result confirms [5] the assignment of configurations [5] deduced for C-1 and C-2. In the pyridine-d_5 ^1H NMR spectrum of mortonol B, H-2 was distinctly observed as a *ddd* ($J = 10.6$, 10.6, 4 Hz) due to the diaxial interaction with H-1 and the *aa–ea* interactions with the C-3 methylene.

Mortonol B (**4b**) could be considered a biogenetic

Table 3. ^1H NMR chemical shifts of mortonol B in $CDCl_3$ and pyridine-d_5

Solvent	H-1	H-2	H-9	C-4	C-10	C-11	C-2
$CDCl_3$	6.0 *d*(11)	5.2 *ddd* (11, 6, 10)	5.0 *dd*(2.6)	1.83 *s*	1.27 *s*	1.43 *s* 1.57 *s*	1.77
Pyridine-d_5	6.27 *d*(10.6)	5.35 *ddd*(10.6, 4, 10.6)	5.1 *dd*(2.6)	1.87 *s*	1.13 *s*	1.35 *s* 1.28 *s*	1.50
Δ	−0.27	−0.15	−0.1	+0.04	+0.14		+0.27

precursor of mortonin B (**1b**), according to the biogenetic hypothesis postulated earlier[1, 2].

EXPERIMENTAL

Mps are uncorr. IR spectra were recorded in $CHCl_3$, and UV in 95% EtOH, unless otherwise stated. ^1H NMR and ^{13}C NMR spectra were recorded in $CDCl_3$ using TMS as int. standard and chemical shifts are given in δ. Analyses were determined by Dr. Pasher, Bonn, Germany.

Isolation of the mortonins and of mortonol B. Dried and ground leaves (1 kg) of *M. hidalgensis* collected near Actopan (Hidalgo) in September 1979, were extracted with MeOH under reflux and worked-up in the usual manner[4]. The $CHCl_3$ soluble fraction (43 g) was chromatographed on Si gel. Elution with C_6H_6–EtOAc (7:3) gave mortonin A (**1a**) mp 195–196° (40 mg). The mother liquors of mortonin A were chromatographed on Si gel. Elution with $CHCl_3$–Me_2CO (9 : 1) gave mortonol B (**4b**) (20 mg) mp 216–218° (Me_2CO–*iso*-propyl ether) $[\alpha]_D$ +23.45, UV λ_{max}nm: 230, 203 (ϵ 21 540, 1300), IR ν_{max}cm^{-1}: 3560, 1760, 1730, 1600, 1659. (Found: C, 67.15; H, 6.12; O, 26.50. $C_{31}H_{34}O_9$ requires: C, 67.62; H, 6.22; O, 26.15%.) MS *m/z* : 550 $[M]^+$ 490, 428, 368, 306, 246, 105 (100%) 43. Elution with C_6H_6–EtOAc (1 : 1) gave mortonin C (**2**), (3.3 g) mp 202–204°.

Dehydration of mortonol B. Mortonol B (150 mg) in dry pyridine (1 ml) was treated with $SOCl_2$ (0.3 ml) at 5° for 15 min. After usual work-up, **5a**, (130 mg) was crystallized from Me_2CO–*iso*-propyl ether to constant mp 196–200°. UV λ_{max} nm: 202, 228 (ϵ 13 700, 15 776); IR ν_{max} cm^{-1}: 1760, 1730, 1600, 1585. MS *m/z*:532 $[M]^+$ ($C_{31}H_{32}O_8$ requires $[M]^+$ at *m/z* 532), 410, 382, 350, 288, 228, 105 (100%).

Saponification of mortonol B. Mortonol B (100 mg) in MeOH (10 ml), was treated with $KHCO_3$ (400 mg) for 3 days at room temp. The crude product was separated by prep. TLC to yield compound **4c**, mp 204–206°. UV λ_{max}nm: 228 (ϵ 15230); IR ν_{max} cm^{-1}: 3520, 1760, 1710, 1600, 1580; MS *m/z*: 371 $[M - Me - H_2O]^+$, 353, 249, 231, 105 (100%).

Saponification of anhydromortonol B **5a**. (a) Anhydromortonol B (**5a**) (39 mg) in dry MeOH (10 ml), was treated with $KHCO_3$ (100 mg) for 30 min. Usual work-up gave the desacetyl anhydromortonol B (**5b**) (10 mg) as an oily product. UV λ_{max}nm: 202, 228 (ϵ 13 700, 15 750); IR ν_{max} cm^{-1}: 3450, 1760, 1600, 1580; MS *m/z*: 490 $[M]^+$ ($C_{29}H_{30}O_7$ requires $[M]^+$ at *m/z* 490) 368, 340, 246, 218, 105 (100%). (b) Treatment of anhydromortonol B (**5a**) (32 mg) in MeOH (30 ml) with $KHCO_3$ (100 mg) for 3 days gave the triol **5c**, UV λ_{max} nm: 205 (ϵ 6344); IR ν_{max} cm^{-1}: 3400, 1760.

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