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Crystal structures of two furanosesquiterpenes from *Commiphora sphaerocarpa*

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Abstract

The relative stereochemistry of a furanosesquiterpene, reported previously from myrrh, but isolated here from *Commiphora sphaerocarpa* is determined for the first time as (1(10)*E*,2*R**,4*R**)-2-methoxy-8,12-epoxygermacra-1(10),7,11-trien-6-one. Likewise the stereochemistry of furanodienone was established by NMR and X-ray crystallography as (1(10)*E*,4*E*)-8,12-epoxygermacra-1(10),4,7,11-tetraen-6-one. © 2000 Elsevier Science Ltd. All rights reserved.

Keywords: Commiphora sphaerocarpa; Burseraceae; *C. myrrha*; myrrh; furanosesquiterpenes; X-ray crystallography.

In a previous paper,[1] we reported the constituents of true myrrh, which is the resin of *Commiphora myrrha* (Burseraceae), a tree that occurs widely in Ethiopia and Somalia. We have shown that several compounds which were previously reported to occur in myrrh are not present in true myrrh but originate from adulterant resins of other *Commiphora* species. This is indeed also the case for the two compounds which are the subject of this paper, namely 2-methoxy-8,12-epoxygermacra-1(10),7,11-trien-6-one (**1**)[2] and furanodienone (**2**),[3] which were first reported as occurring in myrrh. These compounds are obtained here from the resin of other *Commiphora* species, namely *C. sphaerocarpa*, *C. holtziana* and *C. kataf.*[1] We report here the crystal structures of the furanosesquiterpenes **1** and **2**.

The resin of *C. sphaerocarpa* (20 g) was pulverised and extracted with petrol for 1 day to yield a light yellow oil (4 g, 20%). The extract (2 g) was then subjected to column chromatography over silica gel and eluted with increasing polarities of *n*-hexane–EtOAc and further purified by preparative TLC to afford compounds **1** (46 mg) and **2** (62 mg). These compounds were finally recrystallized from *n*-hexane/$CHCl_3$ (95:5) and analysed by X-ray crystallography.

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Compound **1**, crystals, mp 83–84°; R_f 0.22 (petrol–C_6H_6–EtOAc, 15:3:1); $[\alpha]_D^{22}$ −26.3 ($CHCl_3$, *c* 1.0); UV λ_{max}^{EtOH} nm (log ε): 211 (3.79); IR ν_{max}^{KBr} cm^{-1}: 1676 (C=O); EIMS *m/z* (rel. int.): 262 $[M]^+$ (100), gave a positive Ehrlich test indicating the presence of a furan ring. Its ^1H and ^{13}C NMR data (Table 1) are virtually identical with those reported for a sesquiterpenoid (mp 92°)[2] from the resins of *C. myrrha*[2] and *C. holtziana*.[4] Brieskorn & Noble (1980)[2] reported neither the optical rotation nor the stereochemistry of this compound, which possesses two stereocentres. We have subjected compound **1** to an X-ray analysis and established its relative configuration as (2*R**,4*R**), vide infra.

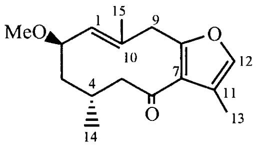
Table 1
^1H NMR (300 MHz) and ^{13}C NMR (75 MHz) spectral data of compounds **1** and **2** in $CDCl_3$

C/H	**1** δ_C	**1** δ_H (int, mult, *J* in Hz)	**2** δ_C	**2** δ_H (int, mult, *J* in Hz)
1	133.1 *d*	5.18 (1H, *br d*, 7.7)	130.5 *d*[a]	5.15 (1H, *br dd*, 6.6, 4.5)
2	74.6 *d*	3.98 (1H, *dt*, 8.8, 2.2)	26.4 *t*	2.19 (1H, *dt*, 12.0, 3.6), 2.32 (1H, *m*)
3	36.9 *t*	1.71 (1H, *m*), 1.96 (1H, *m*)	41.6 *t*	1.89 (1H, *dt*, 11.3, 4.3), 2.47 (1H, *td*, 11.3, 3.6)
4	25.3 *d*	2.40 (1H, *m*)	145.8 *s*	
5	50.5 *t*	2.50 (2H, *m*)	132.4 *d*[a]	5.80 (1H, *br s*)
6	202.8 *s*		189.8 *s*	
7	119.7 *s*		122.1 *s*[b]	
8	151.5 *s*		156.5 *s*	
9	38.3 *t*	3.20 (1H, *m*), 3.53 (1H, *m*)	40.6 *t*	3.68 (2H, *br s*)
10	133.4 *s*		135.4 *s*	
11	126.0 *s*		123.6 *s*[b]	
12	137.4 *d*	6.99 (1H, *br s*)	138.0 *d*	7.05 (1H, *br s*)
13	8.3 *q*	1.88 (3H, *br s*)	9.5 *q*	2.11 (3H, *d*, 1.2)
14	21.9 *q*	1.10 (3H, *d*, 7.0)	19.0 *q*[c]	2.00 (3H, *br s*)
15	18.1 *q*	1.78 (3H, *d*, 1.1)	15.7 *q*[c]	1.30 (3H, *br s*)
OMe	55.5 *q*	3.24 (3H, *s*)		

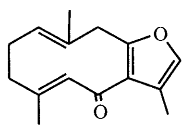
[a] Assignments may be interchangeable.

[b] ^{13}C multiplicities were determined from DEPT spectra.

[c] δ values are in ppm.



1 (*R**, *R**)



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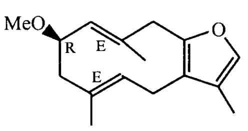

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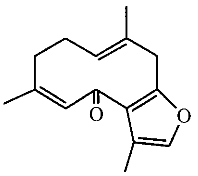

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The crystal structure of **1** established by X-ray diffraction analysis is shown in Fig. 1. The positional coordinates and equivalent isotropic displacement coefficients for the non-hydrogen atoms of **1** have been deposited at Cambridge Crystallographic Data Centre, UK. The results clearly establish a double bond between C_1 and C_{10} with a bond length of 1.321(6) Å. Other relevant bond lengths are C_7–C_8 = 1.358(6) Å, C_{11}–C_{12} = 1.324(6) Å and C_6–O_2 = 1.212(5) Å. For the absolute stereochemsitry of the related compound 2-methoxyfuranodiene (**3**) present in myrrh see the work of Monti et al. (1986).[5]

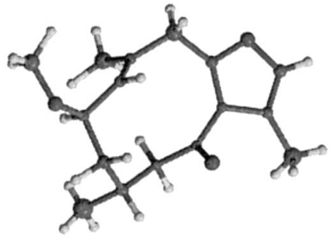

Figure 1. X-Ray structure of compound **1**

A crystal of compound **1** ($C_{16}H_{22}O_3$) of dimensions 0.2×0.4×0.5 mm was mounted on a Nonius CAD-4 diffractometer with graphite-monochromated MoKα ($\lambda = 0.71069$ Å) radiation. The lattice parameters and orientation matrix were determined by a least-squares fit of 25 reflections with $\theta > 12°$. The compound crystallizes in the orthorhombic space group $P2_12_12_1$, with $a = 7.3828(17)$, $b = 9.3909(16)$, $c = 20.879(3)$ Å, $V = 1447.6(5)$ Å^3, $Z = 4$ and with a calculated density of 1.204 kg m^{-3}. The intensity data were collected at 20°C using a ω–2θ scanning procedure to a 2θ limit of 56°. A total of 2047 reflections (2021 independent) were collected. Neither extinction nor absorption corrections were applied to the data. The absorption coefficient was 0.082 mm^{-1}. The crystal structure was solved using direct methods and refined using a full-matrix least-squares procedure. The positions of the H atoms were all located from difference maps. The final R value was 0.059.

Compound **2**, furanodienone, R_f 0.38 (petrol–C_6H_6–EtOAc, 15:3:1), mp 84–86° (lit. 89.5–90.5°[6] and 90.5–91.5°,[7]), $[\alpha]_D^{22}$ ±0 ($CHCl_3$, c 1.0). UV λ_{max}^{EtOH} nm (log ε): 209 (4.00), 242 (3.76); IR ν_{max}^{KBr} cm^{-1}: 1647 (C=O); HRMS: m/z: 230.1306 $[M]^+$ calcd for $C_{15}H_{18}O_2$ 230.1307, and 122.0365 a base peak calcd for $C_7H_6O_2$ 122.0368; EIMS m/z (rel. int.): 230 $[M]^+$ (65), 122 (100), was first reported from *Curcuma zedoaria* (Zingiberaceae),[6,8] and later from *Commiphora abyssinica*[3] and *C. erythraea*.[7] Maradufu (1982)[7] found furanodienone (**2**) to have moderate ixodicidal activity against *Rhipicephalus appendiculatus* tick larvae. Compound **2** gave a positive Ehrlich colour test and its ^{1}H NMR data are consistent with previous reports.[6,7] Hikino et al.[6,8] assigned the configurations 1(10)*E*,4*E*- and 1(10)*E*,4*Z*- to furanodienone (**2**) and isofuranodienone (**4**), respectively, only on the basis of nuclear overhauser effects (NOE).

The crystal structure of **2** from the X-ray work, shown in Fig. 2, confirms the structure proposed by Hikino et al.[6] The positional coordinates and equivalent isotropic displacement coefficients for the non-hydrogen atoms of **2** have been deposited at Cambridge Crystallographic Data Centre, UK. There is a double bond between C_1 and C_{10} with a bond length of 1.326(2) Å. Other essential bond lengths are C_4–$C_5 = 1.337(2)$ Å, C_7–$C_8 = 1.363(2)$ Å, C_{11}–$C_{12} = 1.331(2)$ Å and C_6–$O_2 = 1.216(2)$ Å.

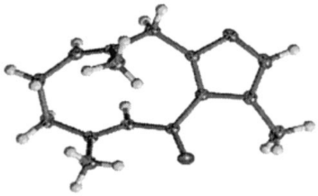

Figure 2. X-Ray structure of compound **2**

A crystal of compound **2** ($C_{15}H_{18}O_2$), with dimensions of 0.3×0.4×0.6 mm was mounted on a Nonius CAD-4 diffractometer with graphite-monochromated MoKα ($\lambda = 0.71069$ Å) radiation. The lattice parameters and orientation matrix were determined by a least-squares fit of 25 reflections with $\theta > 12°$. The compound crystallizes in the monoclinic space group $P2_1/n$, with $a = 7.478(2)$, $b = 15.356(2)$, $c = 10.965(2)$ Å, $\beta = 96.350(2)°$, $V = 1251.4(4)$ Å^3, $Z = 4$ and with a calculated density of 1.222 kg m^{-3}. The intensity data were collected at 20°C using a ω–2θ scanning procedure to a 2θ limit of 56°. A total of 3155 reflections (2883 independent) were collected. Neither extinction nor absorption corrections were applied to the data. The absorption coefficient was 0.080 mm^{-1}. The crystal structure was solved using direct methods and refined using a full-matrix least-squares procedure. The positions of the H atoms were all located from difference maps. The final R value was 0.052. All programs used in the solution,[9] refinement[10] and display[11] of the structures are included in the OSCAIL program package.[12]

As there is no previous report on ^{13}C NMR spectral data of compound **2**, these are now given in Table 1.

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