Pergamon

PII: S0031-9422(97)00552-9

Phytochemistry, Vol. 47, No. 6, pp. 1153–1155, 1998

Printed in Great Britain
0031-9422/98 $19.00+0.00

CASSANE DITERPENES FROM *CAESALPINIA BONDUCELLA*

SONIA PETER, WINSTON F. TINTO,* STEWART MCLEAN,† WILLIAM F. REYNOLDS†* and MARGARET YU†

Laboratory of Bioorganic Chemistry, Department of Biological and Chemical Sciences, University of the West Indies, Cave Hill Campus, Barbados; † Department of Chemistry, University of Toronto, Toronto, Ontario, M5S 1A1, Canada

(*Received* 13 *May* 1997)

Key Word Index—*Caesalpinia bonducella*; Caesalpiniaceae; roots; cassane diterpenes; caesaldekarin C.

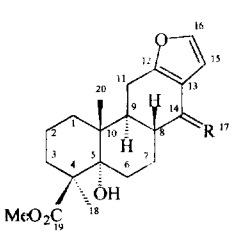
Abstract—Two new cassane diterpenes, named caesaldekarins F and G, were isolated and identified from the roots of *Caesalpinia boducella*. The recently reported caesaldekarin C was also isolated from the roots of this plant. The structures of caesaldekarins F and G were established by the use of 2D NMR spectroscopy. © 1998 Elsevier Science Ltd. All rights reserved

INTRODUCTION

Caesalpinia bonducella Flem. is a plant that is extensively used in Caribbean folk medicine [1]. Previous investigations of the seed of this plant resulted in the isolation and structure elucidation of α-, β-, γ-, δ- and ε-caesalpin, and caesalpin F [2–9]. Subsequently, the stereochemistry of α-, β- and δ-caesalpin were determined by chemical interconversions and by comparison of their ^{13}C NMR spectra with that of ε-caesalpin [9, 10]. We have investigated the roots of *C. bonducella* and report here the isolation of three cassane diterpenes (**1**–**3**). Compound **1** was recently isolated from *C. major* and named caesaldekarin C [11], while compounds **2** and **3** are designated caesaldekarin F and caesaldekarin G, respectively.

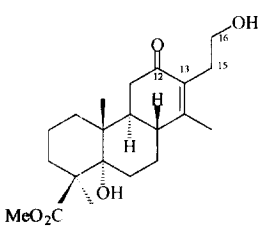
RESULTS AND DISCUSSION

The ethanol extract of the roots of *C. bonducella* were separated into hexane-soluble and dichloromethane-soluble fractions. The hexane extract was subjected to silica gel flash chromatography to afford **1** and **2**, while flash chromatography of the dichloromethane extract, followed by HPLC, gave **3**. Compound **1** had IR bands at 3400 and 1717 cm^{-1}, characteristic of hydroxyl and ester functionalities, respectively. The ^1H NMR spectrum had resonances due to two quaternary methyls at δ 1.20 and 0.82, a secondary methyl at δ 1.02 (*d*, $J = 6.6$ Hz) and a methyl ester at δ 3.69. The presence of a 1,2-disubstituted furan was evident from signals at δ 7.20 (1H, *d*, $J = 2.5$ Hz, H-α) and 6.19 (1H, *d*, $J = 2.5$ Hz, H-β). An analysis of the COSY, HMQC and HMBC spectra led to structure **1** for this compound; it was identified as caesaldekarin C by comparison of its ^1H and ^{13}C NMR spectra with literature data [11]. However, a proton at δ 1.59 assigned as H-3α from the HMBC experiment, showed long-range correlation to a carbon at δ 18.7 in addition to C-1, C-4, C-5 and C-19, while a proton at δ 1.48 which was shown to be directly attached to the carbon at δ 18.7 (HMQC), had long-range correlations to C-1, C-4 and C-10. These observations indicated that the resonances for C-3 and C-7 in **1** should be reversed (Tables 1 and 2) [11].



1 R = H, α-CH_3

2 R = CH_2



3

Caesaldekarin F (**2**) had the molecular formula $C_{21}H_{28}O_4$, based on HR-EI mass spectral analysis. The IR spectrum had absorptions at 3401 and 1717 cm^{-1} due to hydroxyl and ester carbonyl groups, respectively. The ^1H NMR spectrum of **2** was similar to that of **1**, however, the secondary methyl in **1** was replaced by exomethylene protons at δ 5.09 and 4.89 in **2**. The HMQC spectrum of **2** revealed that the exomethylene protons were directly attached to a carbon at δ 103.9. The HMBC spectrum showed correlations from a quaternary methyl at δ 1.21 to an ester carbonyl at δ 177.4 (C-19), in addition to a quaternary sp^3-oxygenated carbon at δ 76.61 (C-5), a quaternary carbon

* Authors to whom correspondence should be addressed.

Table 1. ^{1}H NMR data of compounds **1–3** (500 MHz, $CDCl_3$)

H	1	2	3
1α	1.43 (*m*)*	1.42 (*m*)	1.35 (*m*)
1β	1.52 (*m*)	1.51 (*m*)	1.42 (*m*)
2α	1.48 (*m*)	1.49 (*m*)	1.49 (*m*)
2β	1.90 (*m*)	1.91 (*m*)	1.89 (*m*)
3α	1.59 (*m*)	1.58 (*m*)	1.57 (*m*)
3β	1.95 (*m*)	1.93 (*m*)	1.95 (*m*)
6α	1.85 (*m*)	1.87 (*m*)	1.86 (*m*)
6β	2.30 (*m*)	2.40 (*ddd*, 14.8, 14.8, 5.2)	2.49 (*ddd*, 14.5, 14.5, 5.3)
7α	1.51 (*m*)	1.69 (*m*)	1.47 (*m*)
7β	1.80 (*m*)	2.16 (*m*)	2.09 (*m*)
8	1.79 (*m*)	2.26 (*m*)	2.35 (*m*)
9	2.20 (*ddd*, 10.7, 10.7, 7.5)	2.19 (*ddd*, 11.1, 11.1, 5.6)	2.27 (*ddd*, 10.5, 10.5, 4.0)
11α	2.50 (*dd*, 16.1, 7.5)	2.63 (*dd*, 16.7, 5.6)	2.38 (*dd*, 15.8, 4.0)
11β	2.33 (*dd*, 16.1, 10.7)	2.45 (*dd*, 16.7, 11.1)	2.06 (*dd*, 15.8, 10.5)
14	2.62 (*m*)	—	—
15	6.19 (*d*, 2.5)	6.44 (*d*, 2.1)	2.65 (*dt*, 15.8, 6.6) 2.55 (*dt*, 15.8, 6.6)
16	7.20 (*d*, 2.5)	7.23 (*d*, 2.1)	3.62 (2H, *t*, 6.6)
17	1.02 (*d*, 6.6)	5.09 (*d*, 2.3) 4.89 (*d*, 2.3)	1.95 (*s*)
18	1.20 (*s*)	1.21 (*s*)	1.18 (*s*)
20	0.82 (*s*)	0.87 (*s*)	0.82 (*s*)
OMe	3.69 (*s*)	3.69 (*s*)	3.69 (*s*)

* (Multiplicity and J in Hz).

Table 2. ^{13}C NMR data of compounds **1–3** (125 MHz, $CDCl_3$)*

C	1	2	3
1	32.4	32.0	30.7
2	18.7	18.7	18.4
3	32.1	31.8	31.5
4	49.1	49.0	48.8
5	77.1	76.6	76.1
6	27.9	28.0	28.8
7	24.8	24.6	25.4
8	34.6	35.3	40.5
9	37.6	43.9	43.7
10	41.7	41.8	40.8
11	22.5	22.8	37.6
12	149.5	152.4	201.5
13	122.3	118.7	132.4
14	31.4	142.5	160.3
15	109.5	106.2	29.3
16	140.3	141.4	62.3
17	17.5	103.9	17.9
18	24.0	23.9	23.6
19	177.4	177.4	177.1
20	15.1	15.0	15.0
OMe	51.6	51.6	51.7

* Carbon assignments were based on HMQC and HMBC experiments.

at δ 49.0 (C-4) and a carbon bearing a methylene group at δ 31.8 (C-3). In a NOESY spectrum, correlations between the C-19 methyl ester and the C-10 methyl group, indicated that the C-19 methyl ester was β-oriented (Fig. 1). These results are summarized in Tables 1 and 2 and led to the complete structural assignments for caesaldekarin F (**2**).

Caesaldekarin G (**3**), $C_{21}H_{32}O_5$, had IR absorptions due to hydroxyl (3401 cm^{-1}), ester (1717 cm^{-1}) and α, β-unsaturated ketone (1674 cm^{-1}) functionalities. The ^{1}H NMR spectrum had resonances due to four methyl groups; two of these were quaternary methyls at δ 1.18 and 0.82, while the third was an olefinic methyl at δ 1.95 and the fourth a methyl ester at δ 3.69. The presence of a primary hydroxyl group was revealed by a resonance at δ 3.62 (2H, *t*, 6.6 Hz), which showed COSY cross-peaks to methylene protons at δ 2.65 (*dt*, J = 15.8, 6.6 Hz) and 2.55 (*dt*, J = 15.8, 6.6 Hz). The ^{13}C NMR spectrum had signals for the unsaturated ketone at δ 201.5 with the olefinic carbons at δ 132.4 and 160.3, both of which were quaternary. In the HMBC experiment, the olefinic methyl at δ 1.95 showed long-range correlations to the carbon resonances at δ 132.4 and 160.3 in addition to a secondary carbon at δ 40.5. The C-11 protons also

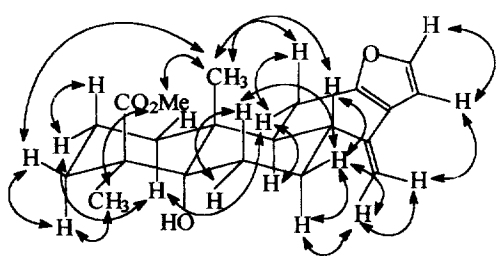


Fig. 1. NOESY correlations for Caesaldekarin F (**2**).

showed long-range correlations to the unsaturated ketone at δ 201.5 which was located at C-12. The complete ^1H and ^{13}C NMR assignments for caesaldekarin G (**3**) are reported in Tables 1 and 2, respectively. This is the first report on the occurrence of cassane diterpenes bearing C-19 methyl ester from *C. bonducella*.

EXPERIMENTAL

General. Mps: uncorr.; ^1H, ^{13}C and 2D NMR (COSY, NOESY, HMQC, HMBC): $CDCl_3$ with TMS as int. standard, Varian UNITY 500; EI-MS: 70 eV; IR: $CHCl_3$; UV: MeOH; Prep. HPLC: 5 μm ODS column, Supelco.

Plant material. Roots of *Caesalpinia bonducella* were collected in the Parish of St. Andrew, Barbados, in February 1995. Identification was verified by Dr C. M. Sean Carrington, Department of Biological and Chemical Sciences, Faculty of Science and Technology, University of the West Indies, where a voucher specimen was deposited.

Extraction and isolation. Air dried, ground roots (1.7 kg) were percolated with 95% EtOH and the solvent evapd *in vacuo* to give a brown viscous syrup (180 g). The extract was dissolved in MeOH–H_2O (9:1) and extracted with petrol to give a viscous syrup (37 g) on evapn of the solvent. The aq. MeOH layer was diluted with H_2O and extracted with CH_2Cl_2 and the solvent evapd to give a brown gum (24 g).

The hexane extract was sepd on silica gel using hexane–Me_2CO (49:1) as eluent to give compounds **1** (20.3 mg) and **2** (32.4 mg). The CH_2Cl_2 extract was sepd over silica gel with hexane–Me_2CO (4:1) to give a fr. (164 mg) which was purified by reversed-phase HPLC using MeOH–H_2O (3:1), to give compound **3** (10.0 mg).

Compound **1**. White solid, mp 137–138° (lit. [11] mp 127–128°); $[\alpha]_D$ +74.2° (*c* 0.39, $CHCl_3$); UV λ_{max}^{MeOH} nm: 222 (log ε 3.78); IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 3400, 1717, 1648, 1602; EIMS (70 eV), *m/z* (rel. int.): 346 $[M]^+$ (67), 328 $[M-H_2O]^+$ (6), 314 $[M-CH_3OH]^+$ (70), 286 $[M-HCO_2Me]^+$ (17); HR-EIMS: 346.2130 calcd for $C_{21}H_{30}O_4$ 346.2144; ^1H NMR: Table 1; ^{13}C NMR: Table 2.

Compound **2**. White crystals (MeOH), mp 151–152° $[\alpha]_D$ +78.5° (*c* 0.21, $CHCl_3$); UV λ_{max}^{MeOH} nm: 216 (log ε 3.72), 236 (log ε 3.78); IR ν_{max}^{CHCl} cm^{-1}: 3401, 1717, 1650, 1602; EIMS (70 eV) *m/z* (rel. int.): 344 $[M]^+$ (100), 326 $[M-H_2O]^+$ (17), 312 $[M-CH_3OH]^+$ (8); HR-EIMS: 344.1981 calcd for $C_{21}H_{28}O_4$ 344.1988; ^1H NMR: Table 1; ^{13}C NMR: Table 2.

Compound **3**. White crystals, mp 148–149°; $[\alpha]_D$ −43.6° (*c* 0.10, $CHCl_3$); UV λ_{max}^{MeOH} nm: 206 (log ε 3.20), 248 (3.30); IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 3401, 1717, 1674, 1653, 1602; EIMS (70 eV) *m/z* (rel. int.): 364 $[M]^+$ (56), 349 $[M-CH_3]^+$ (20) 346 $[M-H_2O]^+$ (40); HR-EIMS: 364.2260 calcd for $C_{21}H_{32}O_5$ 364.2250; ^1H NMR: Table 1; ^{13}C NMR: Table 2.

Acknowledgements—Research in Toronto was funded by grants from the Natural Sciences and Engineering Research Council of Canada. One of us (S.P.) acknowledges the award of a University of the West Indies Postgraduate Scholarship.

REFERENCES

1. Morton, J. F., in *Atlas of Medicinal Plants of Middle America*. Bannerstone House, IL, 1981, p. 279.
2. Ali, M. E. and Khuda, M. Q., *Chemistry and Industry* (London), 1960, 463.
3. Khuda, M. Q., Ali, M. E., *Journal of Scientific and Industrial Pakistan Research*, 1963, **6**, 65.
4. Canonica, L., Jommi, G., Manitto, P., Pagoni, U. M., Pelizzoni, F., *Gazzetta Chimica Italia*, 1966, **96**, 662.
5. Canonica, L., Jommi, G., Manitto, P., Pagoni, U. M., Pelizzoni, F., *Gazzetta Chimica Italia*, 1966, **96**, 687.
6. Canonica, L., Jommi, G., Manitto, P., Pagoni, U. M., Pelizzoni, F., *Gazzetta Chimica Italia*, 1966, **96**, 698.
7. Balmain, A., Connolly, J. D., Ferrari, M., Ghisalberti, E. L., Pagnoni, U. M., Pelizzoni, F., *Chemical Communications*, 1970, 1244.
8. Pascoe, K. O., Burke, B. A., Chan, W. R., *Journal of Natural Products*, 1986, **49**, 913.
9. Balmain, A., Bjåmer, K., Connolly, J. D., Ferguson, G., *Tetrahedron Letters*, 1967, 5027.
10. Connolly, J. D., Orsini, F., Pelizzoni, F., Ricca, G., *Magnetic Resonance in Chemistry*, 1981, **17**, 163.
11. Kitagawa, I., Simanjuntak, P., Mahmud, T., Kobayashi, M., Fujii, S., Uji, T. and Shibuya, H., *Chemical and Pharmaceutical Bulletin*, 1996, **44**, 1157.