required: 560.4077. ^{1}H NMR (C_5D_5N): δ 0.59 (3H, *s*), 0.73 (3H, *s*), 0.88 (3H, *d*, $J = 6.6$ Hz), 0.89 (3H, *d*, $J = 6.6$ Hz), 0.99 (3H, *d*, $J = 6.8$ Hz), 1.08 (3H, *d*, $J = 6.6$ Hz), 4.01 (1H, *m*, 3-H), 4.05–4.32 (4H, m, 2′-H, 3′-H, 4′-H, and 5′-H), 4.39 (1H, *dd*, $J = 11.5$ and 5.3 Hz, 6′-H), 4.60 (1, *dd*, $J = 11.5$ and 2.4 Hz, 6′-H), 5.30 (3H, *m*, 7-H, 22-H, and 23-H). ^{13}C NMR (C_5D_5N): Table 1.

Compound **3**. Colourless plates, $[\alpha]_D^{22}$ +19.8° (EtOH; *c* 0.2), IR ν_{max}^{KBr} cm^{-1}: 3360 (OH), 1640 and 1530 (CONH), 1460, 1080. EIMS *m/z* (rel. int.): 276 $[C_{18}H_{46}N]^+$ (57), 258 (28), 180 [glu]$^+$ (10). FABMS *m/z* (rel. int.): 778 $[M_{II}+Na]^+$ (18), 750 $[M_I+Na]^+$ (25), 576 $[M_{II}-glu+H]^+$ (12), 548 $[M_I-glu+H]^+$ (26), 294 $[C_{18}H_{49}NO]^+$ (10), 276 $[C_{18}H_{47}N]^+$ (13). ^{1}H NMR (C_5D_5N): δ 0.89 (3H × 2, *br t*), 1.29 (*ca* 42H), 1.63 (3H, *s*), 2.04 (2H, *br t*), 2.19 (4H, *br t*), 3.90 (1H, *m*), 4.04 (1H, *br t*), 4.1–4.8 (9H, *m*), 4.94 (1H, *d*, $J = 7.6$ Hz, anomeric H), 5.28 (1H, *m*), 6.00 (2H, *br t*), 6.02 (2H, *m*), 8.39 (1H, *d*, $J = 7.8$ Hz, CONH). ^{13}C NMR (C_5D_5N): δ14.0 × 2 (*q*), 16.0 (*q*), 22.7 × 2 (*t*), 25.7 (*t*), 28.0 (*t*), 28.2 (*t*), 29.5 × 3 (*t*), 30.1 × 10 (*t*), 32.1 × 2 (*t*), 33.0 (*t*), 35.5 (*t*), 39.9 (*t*), 54.4 (*d*), 62.4 (*t*), 69.5 (*t*), 71.2 (*d*), 72.0 (*d*), 72.3 (*d*), 74.6 (*d*), 77.9 × 2 (*d*), 105.6 (*d*), 124.0 (*d*), 131.5 (*d*), 132.2 (*d*), 135.5 (*s*), 175.5 (*s*).

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p-HYDROXY ACETOPHENONE DERIVATIVES FROM *DIOSCOREA BULBIFERA*

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Key Word Index—*Dioscorea bulbifera*; Dioscoreaceae; bulbs; *p*-hydroxy acetophenone derivatives.

Abstract—From the bulbs of *Dioscorea bulbifera*, two new *p*-hydroxy acetophenone derivatives, namely 4-hydroxy-[2-*trans*-3′,7′-dimethyl-octa-2′,6′-dienyl]-6-methoxyacetophenone and 4,6-dihydroxy-2-*O*-(4′-hydroxybutyl)acetophenone have been isolated.

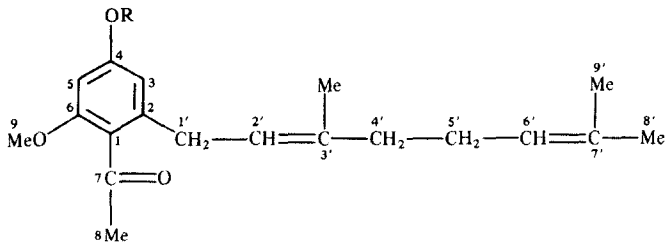
INTRODUCTION

The genus Dioscorea comprises 600 tropical and subtropical species; three species are distributed in the Pyrenees, Balkan Penins and Caucasus [1]. *Dioscorea bulbifera* is common throughout India ascending up to 6000 ft in the Himalayas. Its bulbs are used to treat piles, dysentry, syphilis and are applied to ulcers [2]. Poisonous glucosides have already been reported from bulbs of Dioscorea [3]. This paper describes the isolation of *p*-hydroxy acetophenone derivatives from *D. bulbifera*; their structures were established by spectroscopic methods.

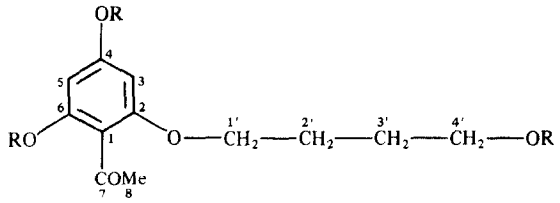
RESULTS AND DISCUSSION

A series of conventional extraction and separation procedures yielded compounds **1** and **2**. Homogeneity and purity of these compounds was established by chromatography.

Compound **1** shows a $[M]^+$ in the mass spectrum at *m/z* 302 in agreement with the formula $C_{19}H_{26}O_3$. Its UV spectrum is characteristic of acetophenone derivatives. Acetylation of **1** yielded a monoacetate (**1a**), showing the presence of one hydroxyl group in the molecule. The bathochromic shift (10 nm) induced in the UV spectrum



1 R = H
1a R = Ac



2 R = H
2a R = Ac

of **1** on addition of sodium acetate to an ethanolic solution and no shift with aluminium chloride, is indicative of the presence of an –OH group *para* to a –COMe group [4, 5].

Compound **1** possessed one methoxy group [^{1}H NMR δ 3.59 (*s*, 3H)] and one 3′:7′-dimethyl-octa-2′:6′ dienyl group [^{1}H NMR δ 1.60 (3H, *s*), 1.65 (3H, *s*), 1.79 (3H, *s*), 2.05 (4H *br m*), 3.30 (2H, *d*, J = 6.2 Hz), 5.10–5.15 (1H, *br t*, J = 7 Hz), 5.17–5.28 (1H, *br q*, J = 1.0 and 7.1 Hz). The multiplicity and J values of the 2′ vinylic proton suggested a *trans* configuration for the 2′ double bond. The ^{1}H NMR spectrum also gave two signals in the aromatic region, [δ 5.70 (*d*, 1H, J = 2.5 Hz) and 5.85 (*d*, 1H, J = 2.4 Hz)]. These two protons are *meta* coupled as indicated by the spectrum. The compound, therefore, is *p*-hydroxy acetophenone having methoxy and 3′,7′-dimethyloctadienyl groups as substituents. These two substituents either must be present at positions C-2 and C-6 or C-3 and C-5.

The protons at C-2 and C-6 are deshielded (*ortho* to carbonyl group), so they should resonate at higher δ value (δ 7.75 and 7.73 ppm) [7], and protons at C-3 and C-5 are shielded so they should resonate at lower δ value (δ 5.68 and 5.82 ppm) [8]. Since the protons in the ^{1}H NMR of **1** occur at δ5.70 and 5.85 the substituents must be present at C-2 and C-6. The position of substituents at the other positions was further confirmed by the ^{1}H NMR data of the corresponding acetate (**1a**), which suggested that the two aromatic protons must be present at C-3 and C-5 because such protons showed a considerable downfield shift (from δ 5.70–6.02 and 5.85–6.20) upon acetylation of a phenolic hydroxyl group [4].

Compound **1** was thus established to be 4-hydroxy-2-[3′,7′-dimethyl-octa-2′,6′-dienyl]-6-methoxyacetophenone. This structure was further supported by its mass spectrum and ^{13}C NMR spectrum.

Compound **2** has a $[M]^+$ at m/z 240 in agreement with the formula $C_{12}H_{16}O_5$. Its UV spectrum was similar to that of **1**. The shift induced in its UV spectrum on addition of sodium acetate [12 nm], as well as on addition of $AlCl_3$/HCl (20 nm) , indicated the presence of a free hydroxyl group at *ortho* and *para* position with respect to the –COMe group [4]. Acetylation of **2** yielded a triacetate (**2a**) showing the presence of three hydroxyl groups.

The ^{1}H NMR of **2** was consistent with a tetrasubstituted aromatic ring with an acetate group, one *O*-hydroxybutyl residue and two phenolic hydroxyl groups as substituents. The structure of the hydroxybutyl side chain was established unambiguously by ^{1}H NMR. There are two $-OCH_2$ groups in the side chain. One shows up as a triplet of 2H and the other is represented by two diastereotopic protons with different chemical shifts. The latter must be associated with a $-CH_2OH$ group, since in very pure NMR, a direct coupling of the two diastereomeric oxymethylene protons with the hydroxy protons is observed [9]. The other $-OCH_2$ is therefore directly linked to the acetophenone ring by an aromatic ether linkage. The broad triplets for $-O-CH_2-CH_2-CH_2-CH_2OH$ were observed at δ 1.79 (2H, *br t*), and (1.59, 2H *br t*). Again, the appearance of *meta* coupled aromatic protons as doublets at lower δ value (δ 5.65 and 5.80) ppm indicated that the compound is a 2, 4, 6-trisubstituted acetophenone [8]. Compound **2** was thus established to be 4, 6-dihydroxy-2-*O*-(4′-hydroxybutyl)acetophenone; its structure was further supported by ^{13}C NMR.

EXPERIMENTAL

Mps: uncorr. Analytical TLC was carried out on silica gel G [Merck 7731] with (i) EtOAc, (ii) MeOH–$CHCl_3$ (1:1) unless otherwise stated. CC was done on silica gel 60 [Merck 7734]. UV spectra were recorded in EtOH, IR as KBr disks. ^{1}H NMR spectra were measured at 90 MHz in $CDCl_3$ soln, unless otherwise specified, using TMS as int. std. ^{13}C NMR were recorded at 25.05 MHz in C_5D_5N soln.

Table 1. ^{1}H NMR of compounds **1**, **1a**, **2** and **2a** (90 MHz, $CDCl_3$) (δ, ppm)

H	1	1a	2	2a
3	5.70 *d* (2.4 Hz)	6.02 *d* (2.5 Hz)	5.65 *d* (2.5 Hz)	6.00 *d* (2.5 Hz)
5	5.85 *d* (2.4 Hz)	6.20 *d* (2.5 Hz)	5.80 *d* (2.5 Hz)	6.31 *d* (2.5 Hz)
8	2.45 *s*	2.40 *s*	2.48 *s*	2.35 *s*
1′	3.30 *d* (6.2 Hz)	3.31 *d* (6.2 Hz)	4.30 *t*	4.31 *t*
2′	5.17–5.28 (*br q*, J = 7.1, 1.0 Hz)	5.17–5.28 (*br q*, J = 1.0, 7.1 Hz)	1.79 *t*	1.80 *t*
3′	—	—	1.59 *t*	1.62 *t*
4′	2.05 (*br m*)	2.06 (*br m*)	H_A4′ 3.65 *dd* (11.25, 3.40 Hz)	4.29 *dd* (4.79, 4.45)
			H_B4′ 3.58 *dd* (11.25, 7.35 Hz)	4.19 *dd* (11.80, 5.80)
5′	2.05 (*br m*)	2.06 (*br m*)	—	—
6′	5.10–5.15 (*br t*, J = 7.0 Hz)	5.10–5.15 (*br t* J = 7.0 Hz)	—	—
8′	1.60 *s*	1.62 *s*	—	—
9′	1.65 *s*	1.65 *s*	—	—
10′	1.79 *s*	1.80 *s*	—	—
Ph–OH	7.50	—	7.90	—
Ph–OH	—	—	13.10	—
–CH_2OH	—	—	2.62 *br t* (6.2 Hz)	—
Ph–OMe	3.59 *s*	3.61 *s*	—	—
Ph–OAc	—	2.16 *s*	—	2.11 *s*
Ph–OAc	—	—	—	2.21 *s*
–CH_2OAc	—	—	—	2.02 *s*

Plant material. D. bulbifera bulbs were collected in Nainital, India in January 1986 (a herbarium specimen of the plant is on file at the Botanical Survey of India, Allahabad).

Extraction and separation. Dried and ground bulbs (1 kg) were soxhlet extracted with EtOH. Extracts was sepd into H_2O sol. and H_2O insol. fractions. The H_2O insol. portion was sepd by flash CC and then eluted with different solvents of increasing polarity. Elution with MeOH–$CHCl_3$ (1:4) yielded **1** (900 mg) and elution with MeOH–$CHCl_3$ (2:3) yielded **2** (40 mg).

Compound **1**. Mp 225°, homogenous on TLC, R_f 0.71 (solvent i), 0.72 (solvent ii). Found C 75.49%, H 8.60%, calculated for $C_{19}H_{26}O_3$, C 75.5%, H 8.62%. UV λ_{max}^{EtOH} nm: 220, 285; +$AlCl_3$/HCl: 240: 287; +NaOAc: 230, 289. IR ν_{max}^{KBr} cm^{-1}: 3200, 2900, 2825, 1660, 1600, 1530, 1450, 1380, 1137, 1105, 880, 825, 780. ^{1}H NMR [90 MHz, $CDCl_3$] see Table 1. ^{13}C NMR; δ_c 160.1 (*s*, C-4), 120.2 (*s*, C-1), 162.40 (*s*, C-2), 167.90 (*s*, C-6), 113.23 (*d*, C-5), 116.31 (*d*, C-3), 184.70 (*s*, Me–CO–), 28.90 (*q*, Me–CO), 29.01 (*t*, C-1′), 128.52 (*d*, C-2′), 136.10 (*s*, C-3′), 41.10 (*t*, C-4′), 27.90 (*t*, C-5′), 127.22 (*d*, C-6′), 135.70 (*s*, C-7′), 17.52 (*q*, C-8′), 17.10 (*q*, C-9′), 16.40 (*q*, C-10′), 56.29 (O–Me). EIMS, *m/z* (rel. int. %): 302 $[M]^+$, 287 $[M-Me]^+$ (5), 271 $[M-31]^+$ (100), 233 $[M-C_5H_9]^+$ (40), 210 (10), 165 $[M-C_{10}H_{17}]^+$ (90), 150 [165 −Me] (50), 104 (35), 91 (15), 76 (25). Acetylation of **1** (40 mg) yielded **1a**, mp 213°. Found: C 73%, H 8%, calculated for $C_{21}H_{28}O_4$, C 73.25%, H 8.13%. IR ν_{max}^{KBr} cm^{-1}: 1760, 1260 (acetate), 1655 (C=O), 1600, 1520 (aromatic), 1180, 1010, 880, 820 cm^{-1}. MS *m/z*: 344 $[M]^+$. ^{1}H NMR see Table 1.

Compound **2**. Mp 280°, homogeneous on TLC, R_f = 0.25 [solvent (ii)]. Found: C 60%, H 6.7%, calculated for $C_{12}H_{16}O_5$, C 60%, H 6.66%. UV λ_{max}^{EtOH}: 230, 290; +$AlCl_3$/HCl 240, 287; +NaOAc 242, 287. IR ν_{max}^{KBr} cm^{-1}: 3380, 3200, 2918, 2850, 1650, 1540, 1450, 885, 825, 780. ^{1}H NMR see Table 1. MS *m/z* 240 $[M]^+$. ^{13}C NMR: δ_c 161.0 (*s*, C-4), 119.2 (*s*, C-1), 163.10 (C-2), 162.50 (*s*, C-6), 114.51 (*d*, C-5), 116.90 (*d*, C-3), 182.90 (*s*, COMe), 29.0 (*q*, COMe), 72.9 (*t*, OCH_2), 69.1 (*t*, OCH_2), 34.2 (*t*, C-2′), 32.9 (*t*, C-3′). Acetylation of **2** yielded **2a**. Found: C 59.2%, H 6.01%, calculated for $C_{18}H_{22}O_8$ C 59%, H 6%. IR ν_{max}^{KBr} cm^{-1}: 1760, 1680, 1600, 1580, 1370, 880, 810. ^{1}H NMR see Table 1. MS *m/z* 366 $[M]^+$.

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