concd to 200 ml under red. pres. and extracted with hot distilled H_2O. The H_2O soluble portion was treated successively with $CHCl_3$ and EtOAc, concd and chromatographed on silica gel. Elution with MeOH yielded an amorphous compound which crystallized from MeOH and when further purified by HPLC afforded crystals, mp 188–189° (Found: C, 48.42; H, 5.15. $C_{11}H_{14}O_8$ requires C, 48.17; H, 5.11%); $[\alpha]_D^{20}$ +162° (H_2O); slightly bitter in taste. Compound 1 is soluble in H_2O, sparingly soluble in cold EtOH, and insoluble in Et_2O. It gave no colour with NaOH or $FeCl_3$ soln, did not absorb Br_2–H_2O but gave a positive Molisch test. IR ν_{max}^{KBr} cm^{-1}: 3550–3320, 3100, 1662, 1610, 1240, 1150–1130, 780, 770 and 840; ^1H NMR (90 MHz) (D_2O): δ3.7–3.8 (*m*, 4H, H-2′, H-3′, H-4′, H-5′), 3.98 and 4.05 (2H, H-6′), 5.1 (1H, H-1′), 6.8 (*d*, 1H, H-5), 8.32 (*d*, 1H, H-6) and 8.5 (*s*, 1H, H-2); MS *m/z*: 275 $[M+1]^+$, 183, 163, 162, 145, 141, 86, 85, 84, 73, 60, 57 and 55.

Glucoside tetra-acetate. Compound 1 on acetylation (Ac_2O–pyridine) and recrystallization from MeOH gave a glucoside tetra-acetate; MS *m/z* (rel. int.): 442 $[M]^+$, 169 (100), 331 (87), 109 (62), 211 (30), 271 (22), 42 (13) and 112 (11).

Acid hydrolysis of 1. Acid hydrolysis (6% methanolic H_2SO_4, 5 hr) gave only a small quantity of white amorphous aglycone from the EtOAc extract, which gave a red colour with $FeCl_3$. MS *m/z*: 112 $[M]^+$; IR ν_{max}^{KBr} cm^{-1}: 1662 and 1610 (diagnostic bands of γ-pyrone). The remaining aq. layer reduced Fehlings soln and Tollen's reagent, and the sugar was identified as D-glucose by co-PC in *n*-BuOH–HOAc–H_2O (4:1:5), EtOAc–pyridine–H_2O (5:2:7), *n*-BuOH–pyridine–H_2O (6:4:3) and EtOAc–HOAc–H_2O (5:2:2).

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3-BENZYL-4-CHROMANONES FROM *MUSCARI COMOSUM*

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Key Word Index—*Muscari comosum*; Liliaceae, 3-benzyl-4-chromanones; homoisoflavanones; 5-hydroxy-3-(*p*-hydroxybenzyl)-7,8-dimethoxy-4-chromanone; 5,8-dihydroxy-3-(*p*-hydroxybenzyl)-7-methoxy-4-chromanone; 5,7-dihydroxy-3-(*p*-hydroxybenzyl)-6-methoxy-4-chromanone.

Abstract—From the bulbs of *Muscari comosum* two novel 3-benzyl-4-chromanones, 7-*O*-methyl-3,9-dihydropunctatin and 8-*O*-demethyl-7-*O*-methyl-3,9-didropunctatin, were isolated.

INTRODUCTION

The bulbs of *Muscari comosum* have been shown to be a rich source of both triterpene glycosides [1] and free triterpenes [2]. One of these latter compounds, eucosterol, was found for the first time in some *Eucomis* species of the Liliaceae family [3] which were also shown [4] to contain some members of a new class of natural compounds, 3-benzyl(idene)-4-chromanones (or 'homoisoflavanones'). This prompted us to investigate the occurrence of this type of compound in *M. comosum*. This study led us to isolate two novel 3-benzyl-chromanones, namely 7-*O*-methyl-3,9-dihydropunctatin **1** and 8-*O*-demethyl-7-*O*-methyl-3,9-dihydropunctatin **2**, in addition to the already known [5] 3,9-dihydroeucomnalin **3**. The structures of **1** and **2** were elucidated by spectral analysis and chemical correlation.

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RESULTS AND DISCUSSION

Compound **1** possesses the molecular formula $C_{18}H_{18}O_6$ (high-resolution mass spectrum). In the ^1H NMR spectrum (Table 1) the signals of the –(2)CH_2–(3)CH–(9)CH_2– grouping were clearly seen; they were easily assigned by comparison to the reported chemical shift values for similar groupings in 3-benzyl-4-chromanones [4]. The presence of a hydroxytropylium

Table 1. ^{1}H NMR (270 MHz) chemical shifts in DMSO-d_6*

Compound	C-2	C-3	C-5	C-6	C-7	C-8	C-9	C-2', C-6'		C-3', C-5'	C-4'
1	4.16 *m* 4.34 *m* AB of ABX	3.0 *m*	12.06† *s*	6.22 *s*	3.84 *s*	3.61 *s*	2.63 *m* 3.0 *m*	7.04	*J* = 8.54 AA'BB'	6.70	9.26† *s*
2	4.12 *m* 4.20 *m* AB of ABX	3.0 *m*	11.83† *s*	6.19 *s*	3.84 *s*	8.16† *s*	2.62 *m* 3.0 *m*	7.05	*J* = 8.5 AA'BB'	6.72	9.26† *s*
3	4.06 *m* 4.23 *m* AB of ABX	3.0 *m*	12.24† *s*	3.69 *s*	10.48 *s*	5.97 *s*	2.60 *m* 3.0 *m*	7.04	*J* = 8.46 AA'BB'	6.72	9.26† *s*

*All chemical shifts are given in δ (ppm) relative to TMS. Coupling constants are given in Hz.
†Protons exchange with D_2O

Table 2. ^{13}C NMR (67.88 MHz) chemical shifts of **1**, **2** and **3** in DMSO-d_6*

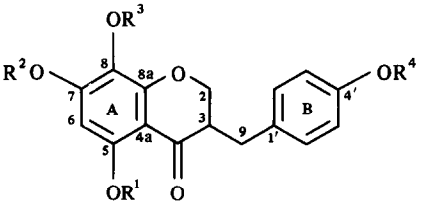
Carbon	1	2	3
2	69.08	68.81	68.83
3	45.70	45.94	45.60
4	198.51	198.54	198.38
4a	101.67	101.64	101.24
5	159.07†	155.87†	155.31†
6	92.78	92.49	128.99‡
7	160.85†	156.83†	159.40†
8	128.68‡	126.28‡	94.66
8a	153.34†	148.02†	157.85†
9	31.12	31.08	31.07
1'	125.93‡	127.98‡	127.94‡
2', 6'	129.92	129.80	129.84
3', 5'	115.15	115.16	115.18
4'	155.59†	155.81†	155.79†
OMe	60.44	55.99	59.89
OMe	56.19		

*Chemical shifts are given in δ (ppm) relative to TMS. The assignments are based on on- and off-resonance spectra and on comparison to data from ref. [4].
†, ‡Interchangeable values.

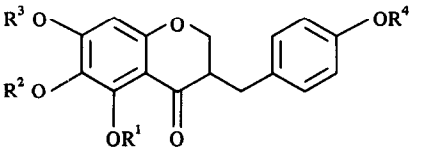
Table 3. Nuclear Overhauser effects measured on **1** in DMSO-d_6*

Irradiation	Observed	
δ6.22 (H-6)	*a*	δ 3.84 (7-OMe)
	b	12.06 (5-OH)
12.06 (5-OH)	*c*	6.22 (H-6)
3.84 (7-OMe)	*d*	6.22 (H-6)
	e	3.61 (8-OMe)

*The NOE difference FIDs were obtained by gated decoupling



	R^1	R^2	R^3	R^4
1	H	Me	Me	H
2	H	Me	H	H
4	Me	Me	Me	Me
5	H	H	Me	H



	R^1	R^2	R^3	R^4
3	H	Me	H	H
6	Me	Me	Me	Me

fragment (*m/z* 107) in the mass spectrum and the ^{1}H NMR signals of an aromatic AA'BB' system (δ6.70 and 7.04, *J* = 8.5 Hz; protons at C-2', C-3', C-5' and C-6') indicate the B-ring substitution pattern. The lowfield signal due to a hydroxyl proton (δ12.06) is assigned to the strongly hydrogen-bonded 5-hydroxyl group [5]. Two methoxyl groups are attached to the A ring (δ3.85 and 3.61), which also carries the proton responsible for the singlet at δ6.23. According to the above data, the UV spectrum of **1** (EtOH) exhibited a main absorption at 288 nm (log ε4.2), which undergoes a bathochromic shift of 30 nm upon addition of aluminum chloride, as expected considering the presence of the 5-hydroxyl [6]; addition of sodium acetate does not cause a similar shift, according to the absence of a hydroxyl group at the 7-position [6].

The attachment sites of the two methoxyl groups at the A ring were identified by examining the ^{13}C NMR

spectrum of **1** (Table 2) and observing that in the fully-coupled spectrum the methine carbon of the A ring (δ92.78) appears as a doublet ($J^1_{C,H}$ = 163 Hz) further split by a $J^3_{C,H}$ = 6.6 Hz. This coupling through three bonds can only occur between the 6-carbon and the 5-hydroxyl proton. Accordingly, upon addition of D_2O, in the fully-coupled spectrum the signal appears as a simple doublet [7]. Thus the 6-position of the A ring does not carry a substituent. As a consequence, the methoxyl groups are attached at positions 7 and 8. Further support for structure **1** was achieved from NOE experiments (Table 3). Results *a*, *b* and *c* accord only to the presence of a proton at the 6-position.

Compound **2** possesses the molecular formula $C_{17}H_{16}O_6$ (high-resolution mass spectrum). ^1H and ^{13}C NMR data are summarized in Tables 1 and 2, respectively. The ^1H NMR spectrum displayed the signals of the –(2)CH_2–(3)CH–(9)CH_2– grouping and of the AA'BB' system of the B-ring protons. The B-ring substitution pattern was also deduced from the appearance of the hydroxytropylium peak (*m/z* 107) in the mass spectrum. The δ11.83 singlet in the ^1H NMR spectrum must be due to the 5-hydroxyl proton, involved in a strong hydrogen bond. UV absorption (293 nm; EtOH) undergoes a bathochromic shift of 30 nm upon addition of aluminum chloride (presence of the 5-hydroxyl). In the fully-coupled ^{13}C-spectrum of **2** the A-ring methine carbon (δ92.49) appears to be coupled to the 5-hydroxyl proton ($J^3_{C,H}$ = 6.5 Hz). The OMe group must be at C-7 and the third hydroxyl group at C-8 since the UV absorption maximum is not shifted upon addition of sodium acetate (absence of the 7-hydroxyl).

Both **1** and **2** were permethylated by treatment with dimethyl sulphate–potassium carbonate in acetone and yielded the same fully methylated derivative. As expected, mp and ^1H NMR spectra in $CDCl_3$ and C_6D_6 of these were identical to those described for compound **4**, obtained by permethylation of 3,9-dihydropunctatin [8].

Compound **3**, mp 207–209°, $C_{17}H_{16}O_6$ (high-resolution mass spectrum), exhibited an ^1H NMR spectrum (Table 1) which closely resembled those reported for 3,9-dihydroeucomnalin (≡3,9-dihydroautumnalin, **3**) [5] and for 3,9-dihydropunctatin **5** [8]. However, compound **3** and 3,9-dihydroeucomnalin were shown to be identical by the fact that the methine carbon of the A ring appears in the fully-coupled ^{13}C spectrum as a simple doublet. This was confirmed by conversion (dimethyl sulphate–potassium carbonate in acetone) into the fully methylated derivative **6**, whose mp and ^1H NMR spectra in $CDCl_3$ and in C_6D_6 were identical to those described for permethylated 3,9-dihydroeucomnalin [5] and different from those described for permethylated 3,9-dihydropunctatin [8]. The as yet unreported ^{13}C-spectrum of **3** is summarized in Table 2.

EXPERIMENTAL

Isolation of 3-benzylchroman-4-ones. Fresh bulbs (1 kg) of *M. comosum* Mill. (Liliaceae) (collected in the autumn in Puglia, Italy, and authenticated by the Botanical Garden of the University of Naples) were homogenized in a mechanical stirrer, freeze-dried and extracted in a Soxhlet apparatus with petrol (12 hr) and then with Et_2O (12 hr). The Et_2O extract was evapd (3 g) and chromatographed on a silica gel (90 g) column with hexane containing increasing proportions of Et_2O. The fraction (2 g) eluted with Et_2O was chromatographed on a silica gel (60 g) column with $CHCl_3$–EtOAc. The fraction (0.5 g) eluted with $CHCl_3$–EtOAc (19 . 1) was chromatographed on a silica gel (15 g) column with C_6H_6–EtOAc. Five fractions were collected: *a* (50 mg), *b* (75 mg), *c* (150 mg), *d* (85 mg), and *e* (200 mg) (increasing polarity order).

Prep. TLC (silica gel, C_6H_6–Et_2O (7 . 3), 2 runs) of fraction *a* yielded compound **1** (30 mg) as a vitreous solid. EIMS, 70 eV, *m/z* (rel. int.). 330.1113 ($[M]^+$; calc. for $C_{18}H_{18}O_6$ 330.1103) (40), 107 (100).

Crystallization of fraction *e* from $CHCl_3$ gave compound **2** (60 mg), mp 172–174°. EIMS, 70 eV, *m/z* (rel. int.): 316.0959 ($[M]^+$; calc for. $C_{17}H_{16}O_6$ 316.0947) (45); 107 (100).

Crystallization of fraction *c* from $CHCl_3$ gave compound **3** (80 mg), mp 209°. EIMS, 70 eV, *m/z* (rel. int.)· 316.0962 ($[M]^+$; calc. for $C_{17}H_{16}O_6$ 316.0947) (45); 107 (100).

Methyl derivatives **4** *and* **6**. Separate methylation of samples of **1** and **2** with Me_2SO_4–K_2CO_3 in dry Me_2CO (room temp, 24 hr) [9] gave Me derivative **4**, mp 99–100°, in both cases The product was identical (^1H NMR in $CDCl_3$ and in C_6D_6; mp) to the methylation product of 3,9-dihydropunctatin [5].

Methylation of **3** using the above conditions gave **6**, mp 75–76°, identical (mp; ^1H NMR in $CDCl_3$ and in C_6D_6) to the Me derivative of 3,9-dihydroeucomnalin [8].

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