Phytochemistry, Vol. 25, No. 1, pp. 181–184, 1986.
Printed in Great Britain.

0031-9422/86 $3.00 + 0.00

NEO-CLERODANE DITERPENOIDS FROM *TEUCRIUM POLIUM* SUBSP. *CAPITATUM*

PILAR FERNÁNDEZ, BENJAMÍN RODRÍGUEZ, GIUSEPPE SAVONA* and FRANCO PIOZZI*

Instituto de Química Orgánica, CSIC., Juan de la Cierva 3, 28006 Madrid, Spain; *Istituto di Chimica Organica dell 'Università, Archirafi 20, 90123 Palermo, Italy

(*Revised received* 28 *June* 1985)

Key Word Index—*Teucrium polium* subsp. *capitatum*; Labiatae; diterpenoids; new neo-clerodane derivatives; 7-deacetylcapitatin; picropolinol; 20-epi-isoeriocephalin.

Abstract—From the aerial part of *Teucrium polium* subsp. *capitatum* three new neo-clerodane diterpenoids, 7-deacetylcapitatin, picropolinol and 20-epi-isoeriocephalin, have been isolated, together with the previously known diterpenes picropolin, picropolinone, 19-acetylgnaphalin and teucjaponin B. The structures of 7-deacetylcapitatin [19-acetoxy-4α,18 : 15,16-diepoxy-7α-hydroxy-6-keto-neo-cleroda-13(16),14-dien-20,12*S*-olide], picropolinol [18,19-diacetoxy-15,16-epoxy-4α,6α-dihydroxy-7-keto-neo-cleroda-13(16),14-dien-20,12*S*-olide] and 20-epi-isoeriocephalin [19-acetoxy-4α,18 : 15,16-diepoxy-6α-hydroxy-7-keto-neo-cleroda-13(16),14-diene-(20-*O*-acetyl)-20*R*,12*S*-hemiacetal] were established by chemical and spectroscopic means and, in the case of 7-deacetylcapitatin and picropolinol, by correlation with known compounds.

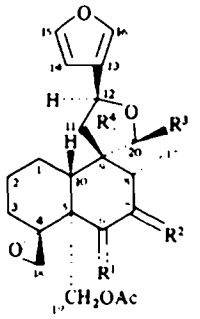
INTRODUCTION

The diterpenoids of *Teucrium polium* and its subspecies *aureum*, *capitatum* and *polium* have been the subject of a number of investigations [1–9]. Now, a re-examination of the acetone extract of the aerial part of *T. polium* subsp. *capitatum* (L.) Arcangeli led to the isolation of four previously known neo-clerodane diterpenoids, picropolin (1) [1–4], picropolinone [4], 19-acetylgnaphalin [4, 10] and teucjaponin B [10, 11], and three new diterpenoids, 7-deacetylcapitatin (2), picropolinol (3) and 20-epi-isoeriocephalin (4), whose structures and absolute configurations have been established.

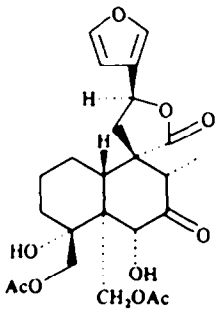
RESULTS AND DISCUSSION

The first of the new diterpenoids isolated from *T. polium* subsp. *capitatum*, 7-deacetylcapitatin (2), had a molecular formula of $C_{22}H_{26}O_8$. Its ^1H and ^{13}C NMR spectra (Tables 1 and 2, respectively) showed signals almost identical with those found in the ^1H and ^{13}C NMR spectra of capitatin (5), a neo-clerodane diterpenoid previously isolated from this plant, the structure and absolute configuration of which have been firmly established by X-ray diffraction analysis [5]. In fact, the only differences between the ^1H and ^{13}C NMR spectra of the new diterpenoid and capitatin (5) were the absence in the former of an acetyl group and also the higher field resonance of the proton geminal to the C-7 secondary hydroxyl group (δ4.58 *d*, J = 6.3 Hz), which in capitatin (5) is geminal to an acetoxyl group (δ5.50 *d*, J = 6 Hz) [5]. This was in agreement with the C-6, C-7 and C-8 resonances in capitatin (5, δ198.3, 74.6 and 40.9, respectively) [5] and in the new diterpenoid (2, δ206.7, 73.7 and 44.3, respectively, see Table 2). Thus, structure 2 can be attributed to this new compound. In agreement with this conclusion, acetic anhydride–pyridine treatment of 2 yielded a substance identical in all respects with capitatin (5) [5]. Moreover, sodium borohydride reduction of the new diterpenoid (2), picropolin (1) [1] and picropolinone [4] gave the same compound (6), thus rigorously confirming [1, 4, 5] a C-12*S* configuration and a neo-clerodane backbone [12] for all these diterpenoids. These structural features were also in agreement with the sign of the Cotton effect ($\Delta\varepsilon_{297}$ +4.87) showed by 7-deacetylcapitatin (2). This was identical with that of eriocephalin ($\Delta\varepsilon_{294}$ +2.53), a diterpenoid whose neo-clerodane absolute configuration is well known [13]. Irradiation of the Me-17 protons of compound 2 caused NOE enhancements in the signals of the H-14 and H-16 protons (2% and 3%, respectively) but no effect was observed in the signal of the C-12 proton. This is indicative of a C-12*S* configuration in neo-clerodan-20,12-olides [14].

Another new diterpenoid, picropolinol (3), had a molecular formula of $C_{24}H_{30}O_{10}$ and its IR spectrum showed absorptions of hydroxyl groups (ν_{OH} 3570, 3485, 3380 cm^{-1}), one of which was probably a tertiary alcohol (ν_{OH} 3570 cm^{-1}, sharp). The ^1H and ^{13}C NMR spectra of this compound (3, see Tables 1 and 2, respectively) were very similar to those of picropolin (1) [1, 4, 5], showing identical signals of a β-substituted furan ring, a C-20, C-12 lactone, a C-17 methyl group, a C-7 ketone function, a C-6α hydroxyl group and a C-19 methylenacetoxy group. In fact, the differences between the ^1H and ^{13}C NMR spectra of picropolinol (3) and picropolin (1) [1, 4, 5] were consistent with the presence in the former of a 4α-hydroxy-18-acetoxy structural moiety (δ_{H_A}-18 4.42 *d*, δ_{H_B}-18 4.59 *d*, J_{gem} = 11.7 Hz, two acetoxyl groups at δ2.15 *s* and 1.99 *s*; $\delta_{C\text{-}4}$ 75.5 *s*, $\delta_{C\text{-}18}$ 66.4 *t*, two acetoxyl groups at δ171.4 *s*, 169.7 *s*, 21.0 *q* and 20.9 *q*, Tables 1 and 2) instead of the 4α,18-oxirane ring of picropolin (1, δ_{H_A}-18 2.57 *d*, δ_{H_B}-18 3.23 *dd*, $J_{18A,18B}$ = 3.3 Hz, $J_{18B,3}$ = 2.5 Hz, only an acetoxyl signal at δ2.17 *s*; $\delta_{C\text{-}4}$ 65.6 *s*, $\delta_{C\text{-}18}$ 48.8 *t*, only an acetoxyl group at δ169.9 *s* and 21.4 *q*)



	R^1	R^2	R^3	R^4
1	αOH,βH	O	O	
2	O	αOH,βH	O	
4	αOH,βH	O	H	OAc
5	O	αOAc,βH	O	
6	αOH,βH	αOH,βH	O	
7	αOH,βH	O	OAc	H



3

[1, 5]. In complete agreement with the above assumption, treatment of picropolin (1) with glacial acetic acid opened [15] the oxirane ring yielding a compound identical in all respects with natural picropolinol. This somewhat unusual opening of the epoxide implies an attack of the anion on the primary centre, as in the case of the treatment of tafricanin A epoxide with hydrochloric acid [16]. Thus, this new diterpenoid possesses the structure and absolute stereochemistry depicted in formula 3.

The last of the new diterpenoids has structure 4 and is the C-20 epimer of isoeriocephalin (7), a substance previously isolated from *T. lanigerum* and whose structure and absolute configuration were firmly established [17]. This conclusion was supported by the following facts: (i) a strong NOE enhancement (13%) was observed in the signal of the C-20 hemiacetalic proton when the protons of the Me-17 group were irradiated. Since this effect was not observed in isoeriocephalin (7), it was clear that compound 4 possessed a C-20*R* stereochemistry, in which the Me-17 and C-20 protons are on the same side of the plane defined by the C-20,C-12 hemiacetal ring. (ii) NOE experiments also established a C-12*S* configuration for compound 4, because irradiation of the Me-17 protons caused NOE enhancements on the signals of the H-14 (6%) and H-16 (4%) protons and not in the signal of the C-12 proton [14]. (iii) The ^1H and ^{13}C NMR spectra of

Table 1. ^1H NMR data* of compounds 2–4 and 6 ($CDCl_3$, TMS as int. standard)

	2	3	4	6
H-6β	-	4.34 *dd*†	3.97 *dd*†	3.45 *dd*
H-7β	4.58 *dd*†	–	–	3.90 *t*
H-8β	2.30 *dq*	2.50 *dq*	2.46 *dq*	‡
H-10β	‡	2.36 *dd*	‡	‡
H_A-11	2.53 *dd*	2.52 *dd*	2.05 *dd*	~2.40‡
H_B-11	2.88 *dd*	2.74 *dd*	2.61 *dd*	~2.40‡
H-12	5.62 *dt*	5.46 *t*	5.08 *dd*	5.45 *t*
H-14	6.33 *dd*	6.38 *dd*	6.41 *dd*	6.38 *dd*
H-15	7.45 *t*	7.45 *t*	7.40 *t*	7.43‡
H-16	7.42 *ddd*	7.47 *m*	7.44 *m*	7.43‡
Me-17	0.83 *d*	1.24 *d*	1.28 *d*	1.22 *d*
H_A-18	2.42 *d*§	4.42 *d*	2.61 *d*§	2.47 *d*§
H_B-18	2.16 *dd*‖	4.59 *d*	3.32 *dd*‖	3.17 *dd*‖
H_A-19	4.71 *d*	4.40 *d*	4.17 *d*	4.83 *dd*
H_B-19	4.99 *d*	4.74 *d*	4.66 *d*	5.37 *d*
H-20	–		5.98 *s*	
OAc	2.15 *s*	2.15 *s*	2.08 *s*	2.10 *s*
	-	1.99 *s*	1.92 *s*	—
OH¶	3.65 *d*	4.04 *d*	3.64 *d*	-
	—	3.65 *s*	-	
J (Hz)				
1α, 10β	‡	11.2	‡	‡
1β, 10β	‡	5.2	‡	‡
6β, 7β			-	3.6
6β, 8β	—	1.3	1.6	
7β, 8β	6.3	—	-	3.6
8β, 17	7.5	6.6	6.8	7.0
11A, 11B	13.0	14.1	13.4	‡
11A, 12	1.4	8.0	10.6	8.4
11B, 12	9.2	8.0	7.1	8.4
14, 15	1.8	1.8	1.8	1.8
14, 16	0.9	0.9	0.8	1.0
15, 16	1.8	1.8	1.8	‡
16, 12	1.4	<0.3	<0.3	<0.3
18A, 18B	4.0	11.7	3.5	3.6
18B, 3	2.2	0	2.1	1.8
19A, 19B	13.1	12.5	11.1	12.6
19A, 6β	-	0	0	1.2
OH, 6β¶	—	4.2	2.2	–
OH, 7β¶	4.6	-		-

*Spectral parameters were obtained by first order approximation. All these assignments have been confirmed by double resonance experiments.

†Collapsed into *d* after addition of D_2O.

‡Overlapped signal.

§*Exo* hydrogen respect ring B.

‖*Endo* hydrogen respect ring B.

¶Disappeared after addition of D_2O.

compound 4 (Tables 1 and 2, respectively) and isoeriocephalin (7) [17] were very similar but showed remarkable differences in the δ value of the Me-17 protons (4: δ 1.28 *d*; 7: δ 1.45 *d*) and in the chemical shifts of the C-1, C-8–C-13, C-17 and C-20 carbon atoms [δ (4) – δ (7): 0.8 (C-1), 1.8 (C-8), 0.5 (C-9), – 3.0 (C-10), 1.6 (C-11), 0.4 (C-12), – 2.7 (C-13), – 1.1 (C-17) and 1.8 (C-20)]. These differences were almost identical with those found between teulanigin and 20-epi-teulanigin, two C-20 epimeric neo-clerodane-(20-*O*-acetyl)-20,12*S*-hemiacetals recently

Table 2. ^{13}C NMR chemical shifts of compounds 2–4 (TMS as int. standard)

C	2*	3†	4†
1	21.9 *t*‡	21.7 *t*	24.0 *t*
2	25.1 *t*	23.4 *t*	25.5 *t*
3	31.4 *t*	29.9 *t*	32.8 *t*
4	61.3 *s*	75.5 *s*	64.9 *s*
5	53.0 *s*	50.7 *s*	50.5 *s*
6	206.7 *s*	78.4 *d*	77.1 *d*
7	73.7 *d*	205.8 *s*	206.1 *s*
8	44.3 *d*	49.2 *d*§	52.4 *d*
9	49.7 *s*	56.4 *s*	57.2 *s*
10	46.2 *d*	48.6 *d*§	49.8 *d*
11	45.3 *t*	45.8 *t*	46.9 *t*
12	72.4 *d*	71.7 *d*	72.4 *d*
13	127.3 *s*	124.8 *s*	124.0 *s*
14	108.5 *d*	107.8 *d*	108.6 *d*
15	144.9 *d*	144.5 *d*	143.6 *d*
16	139.3 *d*	139.7 *d*	139.6 *d*
17	12.4 *q*	9.1 *q*	9.6 *q*
18	48.7 *t*	66.4 *t*	52.2 *t*
19	62.8 *t*	62.0 *t*	61.1 *t*
20	176.3 *s*	173.9 *s*	99.4 *d*
OAc	170.6 *s*	171.4 *s*	170.3 *s*
		169.7 *s*	169.1 *s*
	21.2 *q*	21.0 *q*	21.6 *q*
	—	20.9 *q*	20.2 *q*

*Pyridine-d_5.
†$CDCl_3$.
‡SFORD multiplicity.
§These assignments may be reversed.

isolated by us [18] from *T. lanigerum*. (iv) Finally, the absolute configuration of neo-clerodane [12] for 20-epi-isoeriocephalin (4) was in agreement with its CD curve, which showed a positive Cotton effect ($\Delta\varepsilon_{282}$ +1.29) such as some 6-substituted-7-keto steroids [19]. Furthermore, on biogenetic grounds, compound 4 is probably a neo-clerodane, like the other diterpenoids co-occurring in the same species.

EXPERIMENTAL

Mps are uncorr. For general details on methods see refs [7, 10, 13, 14]. Plant materials were collected in June 1984 near Arganda, Madrid, Spain, and voucher specimens were deposited in the Herbarium of the Faculty of Pharmacy, 'Complutense' University, Madrid.

Extraction and isolation of the diterpenoids. Dried and finely powdered *T. polium* subsp. *capitatum* aerial parts (3.2 kg) were extracted with Me_2CO (25 l.) at room temp. for a week. The extract (140 g) was chromatographed on a silica gel column (Merck, No. 7734, deactivated with 15% H_2O, 2 kg) eluted with *n*-hexane, *n*-hexane–EtOAc mixtures and pure EtOAc. Elution with *n*-hexane–EtOAc (1:1) gave a mixture of five compounds and elution with pure EtOAc yielded two more substances. These mixtures were separately re-chromatographed on silica gel columns eluted with $CHCl_3$–MeOH (32:1) yielding the following compounds in order of chromatographic polarity: 20-epi-isoeriocephalin (4 23 mg), 19-acetylgnaphalin (1.5 g) [4, 10], teucjaponin B (50 mg) [10, 11], picropolinone (1.4 g) [4], 7-deacetylcapitatin (2, 2.5 g), picropolinol (3, 60 mg) and picropolin (1, 3 g) [1].

The previously known diterpenoids, picropolin (1), picropolinone, 19-acetylgnaphalin and teucjaponin B, were identified by their physical (mp, $[\alpha]_D$) and spectroscopic (IR, ^{1}H and ^{13}C NMR, MS) data and by comparison (TLC, mmp) with authentic samples.

7-Deacetylcapitatin (2). Mp 197–200° (from Me_2CO–*n*-hexane); $[\alpha]_D^{22}$ +176.3° ($CHCl_3$; *c* 1.056); CD nm ($\Delta\varepsilon$): 338 (0), 297 (+4.87), 230 (0) (MeOH; *c* 0.083); IR ν_{max}^{KBr} cm^{-1}: 3510, 3170, 3150, 3130, 3080, 3060, 2970, 2890, 1770, 1735, 1710, 1510, 1450, 1385, 1260, 1190, 1045, 1025, 940, 880, 823, 740; ^{1}H NMR (300 MHz, $CDCl_3$): see Table 1; ^{13}C NMR (20.15 MHz, pyridine-d_5): see Table 2; EIMS (direct inlet) 75 ev, *m/z* (rel. int.): 418 [M]$^+$ (2), 360 (3), 358 (2), 345 (7), 328 (7), 256 (5), 206 (8), 179 (15), 123 (21), 105 (15), 95 (36), 94 (57), 91 (24), 81 (36), 67 (15), 53 (18), 43 (100). (Found: C, 62.96; H, 6.41. $C_{22}H_{26}O_8$ requires: C, 63.15; H, 6.26%.)

Acetylation of 2 *to produce capitatin* (5). Ac_2O–pyridine treatment of 2 (200 mg) at room temp. for 24 hr yielded a compound (200 mg) which after crystallization from EtOH was identical in all respects (IR, ^{1}H and ^{13}C NMR, MS, TLC) with capitatin (5: mp 164–166°; $[\alpha]_D^{22}$ +136.4° ($CHCl_3$; *c* 0.510) [5]).

Sodium borohydride reduction of picropolin (1), *picropolinone and 7-deacetylcapitatin* (2) *to give compound* 6. Reduction of 1 [1], picropolinone [4] and 7-deacetylcapitatin (2) with $NaBH_4$ in the usual manner quantitatively yielded the same compound (6): mp 155–159° and 192–198° (from EtOAc); $[\alpha]_D^{19}$ +56.5° ($CHCl_3$; *c* 0.384); IR ν_{max}^{KBr} cm^{-1}: 3520, 3460, 3150, 3130, 3060, 2950, 2870, 1760, 1730, 1505, 1380, 1260, 1240, 1165, 1025, 1000, 920, 875, 800; ^{1}H NMR (90 MHz, $CDCl_3$): see Table 1; EIMS (direct inlet) 75 eV, *m/z* (rel. int.): 420 [M]$^+$ (1), 360 (2), 347 (1), 342 (2), 269 (19), 179 (32), 133 (22), 105 (21), 96 (32), 95 (48), 94 (29), 91 (27), 81 (41), 67 (18), 55 (20), 43 (100). (Found: C, 62.75; H, 6.93. Calc. for $C_{22}H_{28}O_8$: C, 62.84; H, 6.71%.) Identical in all respects with the previously described compound [1, 5].

Picropolinol (3). Mp 202–205° (from EtOAc–*n*-hexane); $[\alpha]_D^{20}$ +6.7°, $[\alpha]_{365}^{20}$ −11.0° ($CHCl_3$; *c* 0.163); CD nm ($\Delta\varepsilon$): 325 (0), 290 (−0.31), 260 (−0.05) (MeOH; *c* 0.037); IR ν_{max}^{KBr} cm^{-1}: 3570, 3485, 3380 (br), 3150, 3120, 2950, 2880, 1763, 1735 (br), 1507, 1460, 1370, 1315, 1255, 1240, 1190, 1140, 1050, 1020, 995, 910, 875, 800; ^{1}H NMR (300 MHz, $CDCl_3$): see Table 1; ^{13}C NMR (75.4 MHz, $CDCl_3$): see Table 2; EIMS (direct inlet) 75 eV, *m/z* (rel. int.): 478 [M]$^+$ (0.6), 460 (5), 418 (12), 400 (3), 358 (5), 345 (19), 306 (23), 299 (14), 208 (10), 179 (29), 161 (12), 133 (13), 105 (13), 95 (32), 94 (33), 91 (16), 81 (30), 67 (12), 55 (14), 43 (100). (Found: C, 60.33; H, 6.26. $C_{24}H_{30}O_{10}$ requires: C, 60.24; H, 6.32%.)

Picropolinol (3) *from picropolin* (1). Picropolin (1, 200 mg) in glacial HOAc (10 ml) was refluxed for 1 hr [15]. Evaporation of the solvent gave a residue (225 mg) which was crystallized from EtOAc–*n*-hexane. This compound was identical in all respects (mp, mmp, $[\alpha]_D$, CD, ^{1}H and ^{13}C NMR, MS, TLC) with natural picropolinol (3).

20-Epi-isoeriocephalin (4). Mp 225–228° (decomp.; from EtOAc–*n*-hexane); $[\alpha]_D^{22}$ +63.1° ($CHCl_3$; *c* 0.215); CD nm ($\Delta\varepsilon$): 318 (0), 282 (+1.29), 244 (0) (MeOH; *c* 0.017); IR ν_{max}^{KBr} cm^{-1}: 3480, 3140, 3120, 3050, 3020, 2990, 2960, 2860, 1745 (br), 1715, 1510, 1475, 1370, 1250, 1130, 1045, 1030, 1000, 945, 883, 875, 800; ^{1}H NMR (300 MHz, $CDCl_3$): see Table 1; ^{13}C NMR (75.4 MHz, $CDCl_3$): see Table 2; EIMS (direct inlet) 75 eV, *m/z* (rel. int.): 462 [M]$^+$ (2), 402 (12), 385 (3), 384 (4), 359 (100), 343 (40), 329 (20), 313 (30), 256 (36), 232 (44), 220 (50), 203 (42), 175 (52), 163 (92), 121 (60), 105 (65), 95 (98), 93 (64), 91 (76), 81 (98), 79 (92), 67 (64), 55 (64), 43 (98). (Found: C, 62.21; H, 6.60. $C_{24}H_{30}O_9$ requires: C, 62.32; H, 6.54%.)

Acknowledgements—We thank Dr. J. Borja, Department of Botany, Faculty of Pharmacy, Madrid, for the botanical classifi-

cation of the plant material, Miss M. D. Casado and Mrs. M. Plaza, Madrid, for recording the ^1H and ^{13}C NMR spectra. This work was supported in part by the 'Comisión Asesora de Investigación Científica y Técnica', Spain, and in part by the National Research Council, C.N.R., Italy.

REFERENCES

1. Brieskorn, C. H. and Pfeuffer, T. (1967) *Chem. Ber.* **100**, 1998.
2. Popa, D. P., Tkhuk An, F. and Salei, L. A. (1977) *Khim. Prir. Soedin.* 49.
3. Malakov, P. Y., Papanov, G. Y. and Mollov, N. M. (1979) *Z. Naturforsch.* **34b**, 1570.
4. Márquez, C. and Valverde, S. (1979) *J. Chem. Soc. Perkin Trans.* 1, 2526.
5. Márquez, C., Rabanal, R. M., Valverde, S., Eguren, L., Perales, A. and Fayos, J. (1980) *Tetrahedron Letters* **21**, 5039.
6. Márquez, C., Rabanal, R. M., Valverde, S., Eguren, L., Perales, A. and Fayos, J. (1981) *Tetrahedron Letters* **22**, 2823.
7. Eguren, L., Perales, A., Fayos, J., Savona, G., Paternostro, M., Piozzi, F. and Rodriguez, B. (1981) *J. Org. Chem.* **46**, 3364.
8. Malakov, P. Y., Papanov, G. Y. and Ziesche, J. (1982) *Phytochemistry* **21**, 2597.
9. Malakov, P. Y. and Papanov, G. Y. (1983) *Phytochemistry* **22**, 2791.
10. Martínez-Ripoll, M., Fayos, J., Rodríguez, B., García-Alvarez, M. C., Savona, G., Piozzi, F., Paternostro, M. and Hanson, J. R. (1981) *J. Chem. Soc. Perkin Trans.* 1, 1186.
11. Miyase, T., Kawasaki, H., Noro, T., Ueno, A., Fukushima, S. and Takemoto, T. (1981) *Chem. Pharm. Bull.* **29**, 3561.
12. Rogers, D., Unal, G. G., Williams, D. J., Ley, S. V., Sim, G. A., Joshi, B. S. and Ravindranath, K. R. (1979) *J. Chem. Soc. Chem. Commun.* 97.
13. Fayos, J., Martinez-Ripoll, M., Paternostro, M., Piozzi, F., Rodriguez, B. and Savona, G. (1979) *J. Org. Chem.* **44**, 4992.
14. Fayos, J., Fernández-Gadea, F., Pascual, C., Perales, A., Piozzi, F., Rico, M., Rodriguez, B. and Savona, G. (1984) *J. Org. Chem.* **49**, 1789.
15. Fürst, A. and Scotoni, R. (1953) *Helv. Chim. Acta* **36**, 1332.
16. Hanson, J. R., Rivett, D. E. A., Ley, S. V. and Williams, D. J. (1982) *J. Chem. Soc. Perkin Trans.* 1, 1005.
17. Fernández-Gadea, F., Rodríguez, B., Savona, G. and Piozzi, F. (1984) *Phytochemistry* **23**, 1113.
18. Hueso-Rodríguez, J. A., Fernández-Gadea, F., Pascual, C., Rodríguez, B., Savona, G. and Piozzi, F. (1986) *Phytochemistry* **25**, 175.
19. Crabbé, P. (1968) *Applications de la dispersion rotatoire optique et du dichroisme circulaire optique en Chimie Organique*, p. 221. Gauthier-Villars, Paris.