Phytochemistry, Vol. 21, No. 3, pp. 681–683, 1982.
Printed in Great Britain.

0031-9422/82/030681-03$03.00/0

CACALOL DERIVATIVES FROM *SENECIO LYDENBURGENSIS**

FERDINAND BOHLMANN and MARINGANTI BAPUJI

Institute for Organic Chemistry, Technical University of Berlin, D-1000 Berlin 12, West Germany

(*Received* 26 *May* 1981)

Key Word Index—*Senecio lydenburgensis*; Compositae; sesquiterpenes; cacalol derivatives; cacalohastin derivatives.

Abstract—An investigation of *Senecio lydenburgensis* afforded eight new cacalol and cacalohastin derivatives. Their structures were deduced from the molecular formulae and ^{1}H NMR spectra.

In continuation of our chemical investigations of species belonging to the tribe Senecioneae we have now studied the constituents of *Senecio lydenburgensis* Hutch. et. Burtt Davy (= *S. verdoorniae* R. A. Dyer), a typical Transvaal high-veldt species. The roots afforded in addition to cacalol (**1**) [1], the esters **2** [2] and **3** [3] as well as the acetate **4**, whose structures followed from the ^{1}H NMR data, which were similar to those of the corresponding alcohol **3** except that the H-3 signal was shifted downfield. Furthermore, cacalohastin (**11**) and the angelate **14** were present. The structure of the latter compound again followed from the ^{1}H NMR data, by comparison with the data of closely related compounds (Table 1). Dehydrocacalohastin (**15**) and the derivatives **16** [3], **17** [4], **18** [3] and **19** [4] were also isolated. The aerial parts gave germacrene D, β-farnesene, nerolidol, cycloartenol, the cacalol derivatives **5** [2], **6–10** and the cacalohastin derivatives **12** [3] and **13**. The structure of **13** clearly followed from the ^{1}H NMR data (Table 1), which were similar to those of **12**. The ^{1}H NMR spectra of **6–10** (Table 1) showed the presence of cacalol derivatives with an oxygen function at C-2 and C-14, while the phenolic hydroxyl was esterified with propionic acid, as could be seen from the chemical shifts of the corresponding quartet and triplet. The stereochemistry of the oxygen function at C-2 followed from the couplings of H-2. Though the relative position of the ester groups at C-2 and C-14 in **8** could not be established with certainty, the observed chemical shifts favoured the proposed structure.

The compounds isolated from *S. lydenburgensis* showed that this species is probably related to the senecioid group of South African species like *S. inornatus* and *S. affinis* [3], which have similar constituents.

EXPERIMENTAL

The air-dried plant material, collected in February 1981 in Transvaal (voucher 81/171, deposited in the National Botanic Research Institute, Pretoria) was extracted with Et_2O–petrol (1:2) and the resulting extracts were separated by column chromatography (Si gel) and repeated TLC (Si gel). Known compounds were identified by comparing their ^{1}H NMR spectra with those of authentic material. The roots (50 g) afforded 2 mg **1**, 2 mg **2**, 12 mg **3**, 12 mg **4** (Et_2O–petrol, 1:3), 1.5 mg **11**, 1.5 mg **14** (Et_2O–petrol, 1:1), 3 mg **15**, 3 mg **16**, 30 mg **17**, 2 mg **18** and 2 mg **19**, while the aerial parts (60 g) gave 4 mg germacrene D, 4 mg β-farnesene, 5 mg nerolidol, 30 mg cycloartenol, 15 mg **5**, 6 mg **6** (Et_2O–petrol, 1:3), 2 mg **7** (Et_2O–petrol, 1:1), 14 mg **8** (Et_2O–petrol, 1:1), 3 mg **9** (Et_2O–petrol, 3:1), 2 mg **10** (Et_2O–petrol, 3:1), 4 mg **12** and 2 mg **13** (Et_2O–petrol, 1:1).

3β-Acetoxy-14-angeloyloxycacalol propionate (**4**). Colourless gum, IR $\nu_{max}^{CCl_4}$ cm^{-1}: 1775 (PhOCOR), 1745, 1250 (OAc), 1720, 1650 (C=CCO$_2$R); MS *m/z* (rel. int.): 442 [M]$^+$ (3)($C_{25}H_{30}O_7$), 386 [M − O=C=CHMe]$^+$ (30), 342 [M − HOAng]$^+$ (8), 286 [386 − HOAng]$^+$ (54), 283 [342 − OAc]$^+$ (26), 226 [286 − HOAc]$^+$ (100), 211 [226 − $^·$Me]$^+$ (60), 83 [C_4H_7CO]$^+$ (46), 55 [83 − CO]$^+$ (48).

2α,14-Diacetoxycacalol propionate (**6**). Colourless gum, IR $\nu_{max}^{CCl_4}$ cm^{-1}: 1770 (PhOCOR), 1740, 1250 (OAc); MS *m/z* (rel. int.): 402 [M]$^+$ (0.1), 342.147 [M − HOAc]$^+$(14) ($C_{20}H_{22}O_5$),286 [342 − O=C=CHMe]$^+$ (88), 226 [286 − HOAc]$^+$ (32), 211 [226−$^·$Me]$^+$ (100), 57 [EtCO]$^+$ (33).

2β,14-Diacetoxycacalol propionate (**7**). Colourless gum, IR $\nu_{max}^{CCl_4}$ cm^{-1}: 1770 (PhOCOR), 1740, 1240 (OAc); MS *m/z* (rel. int.): 402.168 [M]$^+$ (1) ($C_{22}H_{26}O_7$), 342 [M − HOAc]$^+$ (18), 286 [342 − O=C=CHMe]$^+$ (74), 226 [286 − HOAc]$^+$ (45), 211 [226 − Me]$^+$ (100), 57 [EtCO]$^+$ (58).

14-Acetoxy-2α-isovaleryloxy-cacalol propionate (**8**). Colourless gum, IR $\nu_{max}^{CCl_4}$ cm^{-1}: 1770 (PhOCOR), 1740 (OAc, CO$_2$R); MS *m/z* (rel. int.): 342.147 [M − HO$_2$CR]$^+$ (20), 286 [342 − O=C=CHMe]$^+$ (100), 226 [286 − HOAc]$^+$ (33), 211 [226 − Me]$^+$ (58).

14-Acetoxy-2α-hydroxy-cacalol propionate (**9**). Colourless gum, IR $\nu_{max}^{CCl_4}$ cm^{-1}: 3690 (OH), 1780 (PhOCOR), 1750, 1240 (OAc); MS *m/z* (rel. int.): 360.157 [M]$^+$ ($C_{20}H_{24}O_6$), 304 [360 − O=C=CHMe]$^+$ (20), 244 [304 − HOAc]$^+$ (100), 226 [244 − H_2O]$^+$ (20), 211 [226 − Me]$^+$ (20), 57 [EtCO]$^+$ (64).

2α-Hydroxy-14-isobutyryloxy-cacalol propionate (**10**). Colourless gum, IR $\nu_{max}^{CCl_4}$ cm^{-1}: 3620 (OH), 1775 (PhOCOR), 1740, (CO$_2$R); MS *m/z* (rel. int.): 388.189 [M]$^+$ (2) ($C_{22}H_{28}O_6$), 332 [M − O=C=CHMe]$^+$ (6), 300 [M − HO$_2$CR]$^+$ (8), 244 [332 − HO$_2$CR]$^+$ (100), 71 [C_3H_7CO]$^+$ (14), 57 [EtCO]$^+$ (32).

14-Propionyloxycacalohastin propionate (**13**). Colourless gum IR $\nu_{max}^{CCl_4}$ cm^{-1}: 1770 (PhOCOR), 1735 (CO$_2$R); MS *m/z* (rel. int.): 356.162 [M]$^+$ ($C_{21}H_{24}O_5$), 300 [356 − O=C=CHMe]$^+$ (33),

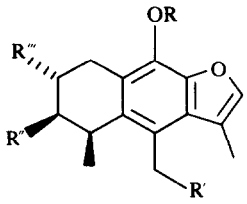
*Part 387 in the series "Naturally Occurring Terpene Derivatives". For part 386, see Bohlmann, F., Zdero, C., Robinson, H. and King, R. M. (1982) *Phytochemistry* **21**, 465.

Table 1. ^{1}H NMR spectral data of compounds **4**, **6**–**10**, **13** and **14** (400 MHz, $CDCl_3$, TMS as internal standard)

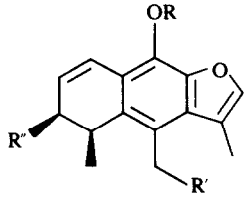
	4	**6**	**7**	**8**	**9**	**10**	**13**	**14**
H-1	2.97 *ddd*	3.30 *br dd*	3.13 *br dd*	3.28 *br dd*	3.26 *ddd**	3.26 *br dd*	6.60 *dd*	6.52 *dd*
H-1′	2.82 *ddd*	2.57 *dd*	2.81 *dd*	2.57 *dd*	2.50 *dd*	2.50 *dd*		
H-2	2.10 *m*	5.36 *dddd*	5.24 *dddd*	5.39 *dddd*	4.34 *dddd*	4.35 *m*	6.00 *ddd*	5.83 *br d*
H-3	5.11 *ddd*	2.1 *m*	2.1 *m*	2.1 *m*	2.07 *br d*	2.07 *br d*	2.57 *brd*	4.88 *m*
H-3′		1.90 *ddd*	1.96 *m*	1.89 *ddd*	1.87 *ddd*	1.90 *ddd*	2.26 *ddd*	—
H-4	3.60 *dq*	3.69 *ddq*	3.53 *ddq*	3.58 *ddq*	3.58 *ddq*	3.60 *m*	3.39 *br dd*	3.48 *m*
H-12	7.31 *q*	7.32 *q*	7.33 *q*	7.33 *q*	7.33 *q*	7.33 *q*	7.35 *q*	7.36 *q*
H-13	2.30 *d*	2.29 *d*	2.31 *d*	2.29 *d*	2.30 *d*	2.30 *d*	2.32 *d*	2.33 *d*
H-14	5.45 *s*	5.46 *d* 5.33 *d*	5.47 *d* 5.34 *d*	5.46 *d* 5.33 *d*	5.47 *d* 5.35 *d*	5.47 *d* 5.35 *d*	5.44 *d* 5.36 *d*	5.44 *s*
H-15	1.19 *d*	1.28 *d*	1.31 *d*	1.28 *d*	1.29 *d*	1.27 *d*	1.12 *d*	1.13 *d*
OCOEt	2.71 *q*	2.71 *q*	2.71 *q*	2.71 *q*	2.73 *q*	2.73 *q*	2.73 *q*	2.72 *q*
	1.32 *t*	1.31 *t*	1.32 *t*	1.30 *t*	1.35 *t*	1.34 *t*	1.34 *t*	1.33 *t*
OAc	2.11 *s*	2.08 *s* 2.08 *s*	2.09 *s* 2.05 *s*	2.08 *s*	2.10 *s*	—	—	—
OCOR	6.07 *qq*	—	—	2.21 *d*	—	2.35 *qq*	2.37 *q*	6.08 *qq*
	1.94 *dq*	—	—	2.15 *m*	—	1.17 *d*	1.15 *t*	1.96 *dq*
	1.85 *dq*	—	—	1.09 *d*	—			1.87 *dq*

*$J_{1,3} = 1$.

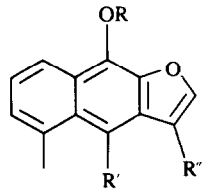
J (Hz): 4.15 = 7, 12,13 ~ 1; compound **4**: 1,1′ = 16.5; 1,2 = 4; 1,2′ = 6; 1′,2 = 1,2′ = 8; 2,3 = 10; 2′,3 = 6; 3,4 = 5; compounds **6** and **8**–**10**: 1,1′ = 17; 1,2 = 7; 1′,2 = 10; 2,3 = 3.5; 2,3′ = 12; 3,3′ = 12; 3,4 = 2.5; 3′,4 = 5; 14,14′ = 12.5; compound **7**: 1,1′ = 17; 1,2 = 5; 1′,2 = 5; 2,3 = 5; 14,14′ = 12.5; compound **13**: 1,2 = 10; 1,3 = 2.5; 2,3 = 8; 2,3′ = 3; 3,3′ = 15; 3,4 ~ 5; 14,14′ = 12.5; compound **14**: 1,2 = 10: 1,3 = 2.7: OAng: 3′,4′ = 7; 3′,5′ = 4′,5′ = 1.5; OiVal: 2′,3′ = 3′,4′ = 3′,5′ = 7; OiBu: 2′,3′ = 2′,4′ = 7; OProp: 2′,3′ = 7.5.



	1	2	3	4	5	6	7	8	9	10
R	H	Prop		Prop		Prop		Prop		Prop
R′	H	H	OAng	OAng	OAc	OAc		OAc		OiBu
R″	H	H	OH	OAc	H	H		H		H
R‴	H	H	H	H	H	αOAc	βOAc	αOiVal	αOH	αOH



	11	12	13	14
R	Me	Prop	Prop	Prop
R′	H	OAc	OProp	OAng
R″	H	H	H	OH



	15	16	17	18	19
R	Me	Me	Me	Prop	Prop
R′	Me	CHO	CHO	CH_2OAc	CH_2OAng
R″	Me	CH_2OH	CH_2OAc	Me	Me

266 [330 − HO_2CR]$^+$ (34), 211 [226 − Me]$^+$ (100), 57 [EtCO]$^+$ (20).

14-*Angeloyloxy-3β-hydroxycacalohastin propionate* (**14**). Colourless gum, IR $\nu_{max}^{CCl_4}$ cm^{-1}: 3620 (OH), 1770 (PhOCOR), 1720 (C=CCO_2R); MS *m/z* (rel. int.): 398 [M]$^+$ (1) ($C_{23}H_{28}O_6$), 342 [M − O=C=CHMe]$^+$ (3), 242 [342 − HOAng]$^+$ (30), 83 [C_4H_7CO]$^+$ (54), 55 [83 − CO]$^+$ (100).

Acknowledgements—We thank Dr. B. de Winter and Miss M. Welman for their help during plant collection and identification of the species, and the Deutsche Forschungsgemeinschaft for financial support.

REFERENCES

1. Romo, J. and Joseph-Nathan, P. (1964) *Tetrahedron* **20**, 2331.
2. Bohlmann, F. and Zdero, C. (1978) *Phytochemistry* **17**, 1161.
3. Bohlmann, F., Zdero, C., Berger, D., Suwita, A., Mahanta, P. K. and Jeffrey, C. (1979) *Phytochemistry* **18**, 79.
4. Bohlmann, F. and Zdero, C. (1978) *Phytochemistry* **17**, 565.