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NEW SESQUITERPENES FROM *SENECIO OXYODONTUS**

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Key Word Index—*Senecio oxyodontus*; Compositae; new bisabolene derivatives.

Abstract—The South African plant, *Senecio oxyodontus*, contained in addition to known compounds several new sesquiterpenes, which were all of the bisabolene type. The structures were elucidated by spectroscopic methods and some chemical transformations. The constituents were closely related to those from one other South African *Senecio* species and in contrast to most *Senecio* species which contain very different structural types, mainly of the furanoeremophilanes type.

INTRODUCTION

A considerable number of South African *Senecio* species have been investigated [1] but the chemotaxonomical situation remains complicated. While most species contain furanoeremophilanes [1], there are several species which contain other sesquiterpenes [1]. Therefore it seems necessary to investigate many more species, in order to determine whether separation of this big genus is possible from the chemical viewpoint and how such a classification will correlate with morphological data. We have now looked at the constituents of *S. oxyodontus*, which grows in Natal.

RESULTS AND DISCUSSION

The roots of *S. oxyodontus* contained the pentaynene **1** and an unidentified sesquiterpene, which appeared to be a new compound. However, the amount of material was not sufficient to establish the structure. In addition *p*-hydroxyacetophenone and several sesquiterpenes, which were all related to bisabolene, were also isolated. The first compound, isolated from the less polar fractions, had the molecular formula $C_{21}H_{26}O_5$. The IR spectrum showed that the yellow coloured oil most probably was a quinone (1660, 1635 cm^{-1}), which in addition had an unsaturated ester group. The ^1H-NMR spectrum indicated that it was an angelate and that the last oxygen function was a methoxy group. The remaining NMR signals and double resonance experiments showed that the structure of the compound must be **2** (Table 1). The absolute configuration at C-8 remains to be established, as it does for the other structures given below. The more polar fractions contained a complex mixture, which could be separated only with difficulty to provide four further bisabolene derivatives which were closely related to **2**. One compound was clearly the corresponding hydroquinone **4**, since oxidation afforded a product which was identical with **2**. The ^1H-NMR spectral data, which are summarized in Table 1, were in agreement with structure **4**. The ester **4** gave, by partial acetylation, the monoacetate **5**. We have named the 3-*O*-desmethyl compound of **4** senecioodontol. Another ester, which was a dimethoxy compound, most probably was **6**. The positions of the methoxyls followed from comparison of the NMR spectral data with those of **4** (Table 1). As in similar cases, one would expect a definite shift of the signals of the vinyl protons, if a hydroxyl was replaced by a methoxy group. Furthermore the dimethoxy derivatives could not be acetylated under mild conditions as in the case of **4** and in the IR spectrum a hydrogen bonded OH-bond was visible. Compound **6** could not be separated completely from another compound. However, this second compound could be reduced by sodium borohydride and the NMR spectral data (Table 2) of the natural compound together with the reduction products were in good agreement with structures **9**, **11**, and **12**. The latter compound (**12**), formed only in very small amounts, could not be separated from the main alcohol **11**. The relative stereochemistry at C-1, C-3 and C-4 followed from the observed NMR coupling constants and the result of the borohydride reduction. From Dreiding models it is likely that hydride attack is favoured from the back side. As the NMR spectral data show that the main alcohol had an equatorial hydroxyl this was only in agreement with the given relative configuration.

From the most polar fractions a diangelate was isolated, which was obtained pure only in the form of its diacetate. The NMR spectrum (Table 1) indicated that we were most probably dealing with the diester **7**. This assumption was established by oxidation which afforded quinone **3**. Therefore the second angelate group had to be placed as in **7**.

The aerial parts contained in addition to **13** and **14** the bisabolene derivatives **2** and **4**.

With regard to the constituents of *S. oxyodontus*, it is of interest that a compound very similar to those described here has been isolated previously from *S. abrotanifolius* L. [2]. Compound **10** is obviously closely related to **9**, while **9** and **4** are most probably formed from a common precursor. While bisabolene derivatives are widespread in the Compositae, the 8-angelates have not been observed in other genera. Therefore these compounds may be of chemotaxonomical importance.

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* Part 139 in the series 'Naturally Occurring Terpene Derivatives'; for part 138 see: Bohlmann, F. and Zdero, C. (1978) *Phytochemistry* **17**, 1135.

Table 1. ^{1}H-NMR spectral data of compounds **2–8**

	2	**3**	**4**	**5**	**6**	**7**	**8**
6-H	6.64 *s*	6.80 *s*	6.38 *s*	6.55 *s*	6.37 *s*	6.48 *s*	7.07 *s*
8-H	5.66 *dd*	5.64 *dd*	5.36 *dd*	5.27 *dd*	5.40 *dd*	5.55 *dd*	5.57 *dd*
9-H	2.46 *t*	2.43 *t*	2.28 *m*	2.39 *m*	2.40 *m*	2.37 *m*	2.30 *m*
10-H	5.08 *t*(*br*)	5.05 *t*(*br*)	5.11 *t*(*br*)	5.10 *t*(*br*)	5.13 *t*(*br*)	5.08 *t*(*br*)	5.06 *t*(*br*)
12-H	1.58 *s*(*br*)	1.57 *s*(*br*)	1.56 *s*(*br*)	1.56 *s*(*br*)	1.57 *s*(*br*)	1.52 *s*(*br*)	1.52 *s*(*br*)
13-H	1.67 *s*(*br*)	1.66 *s*(*br*)	1.67 *s*(*br*)	1.67 *s*(*br*)	1.68 *s*(*br*)	1.63 *s*(*br*)	1.63 *s*(*br*)
14-H	5.55 *s*(*br*)	5.59 *s*(*br*)	5.33 *s*(*br*)	5.36 *s*(*br*)	5.38 *s*(*br*)	5.34 *s*(*br*)	5.40 *s*(*br*)
14′-H	5.43 *s*(*br*)	5.51 *s*(*br*)	5.18 *d*	5.21 *s*(*br*)	5.22 *s*(*br*)	5.17 *s*(*br*)	5.21 *s*(*br*)
15-H	1.95 *s*	1.98 *s*	2.19 *s*	2.10 *s*	2.18 *s*	2.03 *s*	2.00 *s*
OAng (8)	6.07 *qq*	6.08 *qq*	6.17 *qq*	6.20 *qq*	6.18 *qq*	6.25 *qq*	6.06 *qq*
	1.96 *dq*	1.98 *dq*	2.03 *dq*	2.03 *dq*	2.04 *dq*	2.05 *dq*	1.97 *dq*
	1.88 *dq*	1.89 *dq*	1.95 *dq*	1.94 *dq*	1.96 *dq*	2.03 *dq*	1.89 *dq*
OCH$_3$	4.02 *s*	—	3.84 *s*	3.88 *s*	3.84 *s*	—	—
					3.77 *s*	—	—
OAng(3)	—	6.34 *q*(*br*)	—	—		6.06 *qq*	6.25 *qq*
		2.05 *s*(*br*)				1.97 *dq*	2.03 *dq*
		2.06 *d*(*br*)				1.89 *dq*	2.00 *dq*
OH	—	—	7.27 *s*	7.94 *s*	7.30 *s*	7.92, 7.28 *s*	—

J(Hz): 8,9 = 7; 8,9′ = 5; 8,14 = 1; 9,10 = 7; in **2**: 8,9 = 8,9′ = 7; OAng: 3′,4′ = 7; 3′,5′ = 4′,5′ = 1.5.

Table 2. ^{1}H-NMR spectral data of compounds **9**, **11** and **12**

	9	**11**		**12**
1-H	2.60 *dddd*		2.18 *m*	
2-H	2.05 *m*		2.0 *m*	
3-H	3.45 *d*(*br*)	3.17 *d*(*br*)		3.12 *d*(*br*)
5-H	—	3.84 *ddd*		4.17 *s*(*br*)
6α-H	2.39 *m*		1.78 *m*	
6β-H	2.87 *dd*			
8-H	5.17 *dd*	5.18 *dd*		5.23 *dd*
9-H	2.36 *m*		2.37 *m*	
10-H	5.04 *t*(*br*)		5.06 *t*(*br*)	
12-H	1.60 *s*(*br*)	1.61 *s*(*br*)		1.59 *s*(*br*)
13-H	1.68 *s*(*br*)		1.68 *s*(*br*)	
14-H	5.17 *s*(*br*)		5.10 *s*(*br*)	
14′-H	4.99 *s*(*br*)	4.94 *s*(*br*)		4.93 *s*(*br*)
15-H	1.41 *s*	1.46 *s*		1.43 *s*
OAng	6.08 *qq*		6.06 *qq*	
	1.92 *dq*		1.98 *dq*	
	1.88 *dq*		1.88 *dq*	

J(Hz)· 2,3 = 5: 8,9 = 7; 8,9′ = 7; 9,10 = 7; **9**: 1,2α = 6: 1,2β = 13, 1,6α = 2, 1,6β = 13, 6α,6β = 13; **11**: 5,6α = 5.5: 5,6β = 10, 5,OH = 9.5.

EXPERIMENTAL

^{1}H-NMR spectra were measured at 270 Hz (CDCl$_3$, TMS as internal standard, δ-values), optical rotations were determined in CHCl$_3$. The air dried plant material of *S. oxyodontus* DC, collected in Natal, voucher 77/249, was extracted with Et$_2$O–petrol (1:2). The extracts were first separated by CC (Si gel, act. grade II) and then several times by TLC (Si gel, GF 254) using Et$_2$O–petrol mixtures as solvents. Roots (360 g) afford 5 mg **1**, 15 mg of a hydrocarbon $C_{15}H_{24}$, 30 mg **4** (Et$_2$O–petrol, 1:3), 5 mg **6** (Et$_2$O–petrol, 1:3), 10 mg **9** (Et$_2$O–petrol, 1:3), 30 mg **4** (Et$_2$O–petrol, 1:1), 50 mg **7** (Et$_2$O–petrol, 1:1) and 5 mg *p*-hydroxyacetophenone. Aerial parts (750 g) yielded 10 mg **13**, 2 mg **14**, 7 mg **2** and 40 mg **6**.

3-O-*Methyl-2.5-dehydrosenecioodontol* (**2**). Yellow coloured oil, IR $\nu_{max}^{CCl_4}$ cm^{-1}. C=CCO$_2$R 1710; quinone 1660, 1635. MS *m/e* (rel. int): 358.178 (M$^+$, 1) (calc. for $C_{21}H_{26}O_5$ 358.178); 258 (M$^+$ − C$_4$H$_7$CO$_2$H, 9), 243 (258 − CH$_3$, 11). 83 (C$_4$H$_7$CO$^+$, 100); 55 (83 − CO, 61).

$$[\alpha]_{24^\circ}^{\lambda} = \frac{589 \quad\quad 578 \quad\quad 546\text{ nm}}{+12.4 \quad +13.7 \quad +16.8^\circ}(c = 0.6).$$

5 mg **2** in 2 ml MeOH on reduction with 10 mg Na BH$_4$ afford 4 mg **4**, identical with natural **4**.

3-O-*Methyl senecioodontol* (**4**). Colourless oil, IR $\nu_{max}^{CCl_4}$ cm^{-1}: OH3620, 3320; C=CCO$_2$R 1720, 1700, 1650. MS *m/e* (rel. int.): 360.194 (M$^+$, 5) (calc. for $C_{21}H_{28}O_5$ 360.194); 260.141 (M$^+$ − C$_4$H$_7$CO$_2$H, 42) ($C_{16}H_{20}O_3$ 260.141); 245 (260 − ·CH$_3$, 26): 191 (260 − C$_5$H$_9$; 100); 83 (C$_4$H$_7$CO$^+$, 55); 55 (83 − CO, 58).

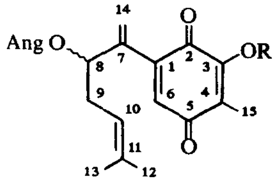
10 mg **4** were heated in 2 ml Ac$_2$O at 70°. After evap. under vacuum the residue yielded by TLC 8 mg **5**, colourless oil, IR $\nu_{max}^{CCl_4}$ cm^{-1}: OH 3600, 3320; Ph OAc 1760; C=CCO$_2$ R 1720, 1690, 1650. MS *m/e* (rel. int.): 402.204 (M$^+$, 0.5) (calc. for $C_{23}H_{30}O_6$ 402.204); 302 (M$^+$ − C$_4$H$_7$CO$_2$H, 8); 260 (302 − H$_2$C=C=O, 26); 245 (260 − ·CH$_3$, 9); 191 (260 − C$_5$H$_9$, 38); 83 (C$_4$H$_7$CO$^+$, 95); 55 (83 − CO, 100); 43 (CH$_3$CO$^+$, 62).

5 mg **4** in 2 ml Et$_2$O were stirred with 50 mg MnO$_2$ for 10 min. After TLC 4 mg **2** were obtained, identical with the natural product.

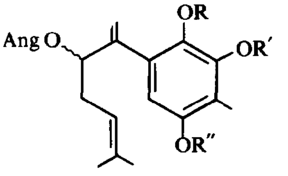
2,5-*Di-O-methyl senecioodontol* (**6**). Colourless oil, IR $\nu_{max}^{CCl_4}$ cm^{-1}: OH 3540 (hydrogen bonded): C=CCO$_2$ R 1720, 1700, 1650. MS *m/e* (rel. int.): 374.209 (M$^+$, 2) (calc. for $C_{22}H_{30}O_5$ 374.209); 274 (M$^+$ − C$_4$H$_7$CO$_2$H, 12): 259 (274 − ·CH$_3$, 8); 232.146 (332 − C$_4$H$_7$CO$_2$H, 3) (calc. for $C_{15}H_{20}O_2$ 232.146), 205 (274 − C$_5$H$_9$, 40), 83 (C$_4$H$_7$CO$^+$, 100), 55 (83 − CO, 47). 3-O-*Angeloyl senecioodontol* (**7**). Colourless oil, IR$_{max}^{CCl_4}$ cm^{-1}: OH 3600, 3420; C=CCO$_2$ R 1715, 1640. MS *m/e* (rel. int.): 428.220 (M$^+$ 2) (calc. for $C_{25}H_{32}O_6$ 428.220); 328 (M$^+$ − C$_4$H$_7$CO$_2$H, 16); 246 (M$^+$ − H$_2$C=CHC(Me)=C=O, 40); 231 (246 − CH$_3$, 14); 83 (C$_4$H$_7$CO$^+$, 100); 55 (83 − CO, 35).

$H_3C[C{\equiv}C]_5CH{=}CH_2$

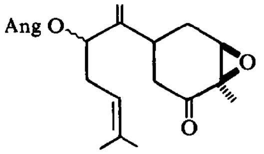
1



2 R = CH_3 **3** R = Ang



	R	R′	R″
4	H	Me	H
5	H	Me	Ac
6	H	Me	Me
7	H	Ang	H
8	Ac	Ang	Ac



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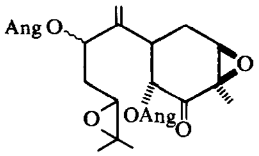

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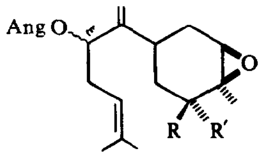
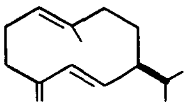


11 R = OH, R′ = H **12** R = H, R′ = OH



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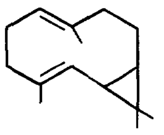

14

10 mg **7** in 2 ml AC_2O were heated for 45 min under reflux. After evap. under vacuum the residue was separated by TLC (Et_2O–petrol, 1:1). 8 mg **8** were obtained, colourless oil, IR $\nu_{max}^{CCl_4}$ cm^{-1}: PhOCOR 1775, 1230; C=CCO$_2$ R 1720, 1650.

$$[\alpha]^{\lambda}_{24^\circ} = \frac{589}{+41.3}\ \frac{578}{+43.3}\ \frac{546}{+50.2}\ \frac{436\ \text{nm}}{+94.2^\circ}\ (c = 2.8).$$

MS m/e (rel. int.): 512 (M^+, 0.1); 412.189 ($M^+ - C_4H_7CO_2H$, 6) (calc. for $C_{24}H_{28}O_6$ 412.189); 370 (412 − $H_2C{=}C{=}O$, 3); 330 (412 − $H_2C{=}CHC(Me){=}C{=}O$, 8); 288 (330—$H_2C{=}C{=}O$, 9); 83 ($C_4H_7CO^+$, 100); 55 (83 − CO, 66). 5 mg **7** in 2 ml Et_2O were stirred with 50 mg MnO_2 for 10 min. After TLC (Et_2O–petrol, 1:3) 4 mg of **3** were obtained, yellow coloured oil, IR $\nu_{max}^{CCl_4}$ cm^{-1}; PhOCOC=C 1740; C=CCO$_2$ R 1720, 1650; quinone 1675, 1660. MS m/e (rel. int.): 426.204 (M^+, 1) (calc. for $C_{25}H_{30}O_6$ 426.204).

8-Angeloyloxy-3,4-dihydro-3,4-epoxy-β-bisabolen-5-one (**9**). Colourless oil, IR $\nu_{max}^{CCl_4}$ cm^{-1}: $\rangle$C=O, C=CCO$_2$R 1720, 1650. MS m/e (rel. int.): 332.199 (M^+, 2) (calc. for $C_{20}H_{28}O_4$ 332.199); 232 ($M^+ - C_4H_7CO_2H$, 42); 83 ($C_4H_7CO^+$, 100).

To 8 mg **9** in 2 ml MeOH 20 mg $NaBH_4$ were added. After 5 min diluted H_2SO_4 was added and the reaction products were separated by TLC (Et_2O–petrol, 1:1). 5 mg **11** and 1 mg **12**, not free from **11**, were obtained. Compound **11**: Colourless oil, IR $\nu_{max}^{CCl_4}$ cm^{-1}: OH 3600; C=CCO$_2$R 1720, 1650. MS m/e (rel. int.): 334.215 (M^+, 1) (calc. for $C_{20}H_{30}O_4$ 334.214); 265 ($M^+ - C_5H_9$, 3); 234 ($M^+ - C_4H_7CO_2H$, 2); 83 ($C_4H_7CO^+$, 100); 55 (83 − CO, 37).

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