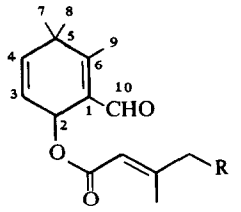
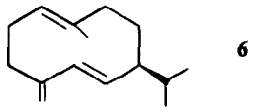


3: R = OAc
4: R = OH
5: R = H



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EXPERIMENTAL

IR in CCl_4; ^{1}H-NMR in $CDCl_3$, δ-values; MS at 70 eV. The air dried plant material (collected in Guatemala by Dr. R. King, voucher RMK 7295) was extracted with Et_2O–petrol (1:2) and the extracts first separated by column chromatography (Si gel, act. grade II) and further by TLC (Si gel GF 254) using Et_2O–petrol mixtures. 30 g roots afford 8 mg **1** (Et_2O–petrol, 1:20), 20 mg **2** (Et_2O–petrol, 1:3), 15 mg **3** and 5 mg **4**, while 110 g aerial parts yielded 10 mg **6**, 4 mg **5** (Et_2O–petrol, 1:3), 25 mg **3** (Et_2O–petrol, 1:3) and 10 mg **4** (Et_2O–petrol, 1:1).

Tetradehydrocarquejol methyl ether (**1**). Colourless oil, IR: C=C 1650, 950; aromatic ring 1580, 1470, 1260 cm^{-1}. MS: M$^+$ *m/e* 162.105 (100%) (calc. for $C_{11}H_{14}O$ 162.105); —$^{\cdot}CH_3$ 147 (65); 147 —CO 119 (54).

2-Isobutyryloxy-2H-1,6-dehydrocarquejol acetate (**2**). Colourless oil. IR: CO_2R 1740; OAc 1740, 1240; C=CH_2 1645, 900 cm^{-1}. MS: M$^+$ *m/e* 278 (0.1%); —AcOH 218.131 (2) (calc. for $C_{14}H_{18}O_2$ 218.131), —Me_2 C=C=O 148 (100); $C_3H_7CO^+$ 71 (73); $MeCO^+$ 43 (92).

Isoferulol-(4-acetoxysenecioate) (**3**). Colourless oil, IR: OAc 1755, 1220; C=C CO_2R 1720, 1660; CHO 2760, 1685 cm^{-1}. MS: M$^+$ *m/e* 306.147 (3%) (calc. for $C_{17}H_{22}O_5$ 306.147); —$^{\cdot}CH_3$ 291 (0.5); 291 —AcOH 231 (17); —O=C=C(Me) CH_2OAc 166 (44); $HOCH_2C(Me)$ =$CHCO^+$ 99 (100).

Isoferulol-(4-hydroxysenecioate) (**4**). Colourless oil, IR: OH 3620; C=C CO_2R 1720, 1660; CHO 2760, 1685 cm^{-1}. MS: M$^+$ *m/e* 264 (1%); —$^{\cdot}$ Me 249.113 (10) (calc. for $C_{14}H_{17}O_4$ 249.113); —O=C=C (Me)CH_2OAc 166 (65); $HOCH_2C(Me)$ =$CHCO^+$ 99 (100).

Isoferulol senecioate (**5**). Colourless oil, IR: C=C CO_2R 1720, 1650; CHO 1690 cm^{-1}. MS: M$^+$ *m/e* 248.141 (1%) (calc. for $C_{15}H_{20}O_3$ 248.141); —$^{\cdot}$ Me 233 (1.5); —O=C=CMe_2 166 (22); $C_4H_7CO^+$ 83 (100).

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AHD-VALTRATE, A NEW VALEPOTRIATE FROM *CENTRANTHUS RUBER*

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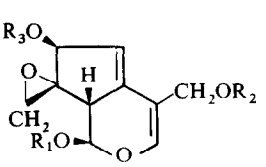
Key Word Index—*Centranthus ruber*; Valerianaceae; valepotriates; AHD-valtrate; IVHD-valtrate.

INTRODUCTION

Work conducted in recent years has shown that *Centranthus ruber* DC contains several valepotriates found earlier in *Valeriana* i.e. valtrate (**1**), didrovaltrate (**2**), acevaltrate (**3**) and IVHD-valtrate (**4**) [1, 2]. The structure of **4** was elucidated by Stahl and Schild [3], the sites of the acyloxy groups remaining, however, unspecified. These authors also mention another valepotriate of unindentified structure and with R_f value close to that of IVHD-valtrate. Studies conducted on *C. ruber* led to the isolation of two compounds with R_f values similar to that of IVHD-valtrate, which we supposed to be the latter compound and the unknown one reported by Stahl and Schild. We now report the results from our investigations on the structure of these compounds, designated here as CV_1 and CV_2.

RESULTS AND DISCUSSION

Compound CV_1 is a colourless, crystalline substance, mp 107–108° (pentane). The chromatographic spot of this substance turns blue when treated with ben-



$R_1 = R_3 = Me_2CHCH_2CO$
$R_2 = MeCO$

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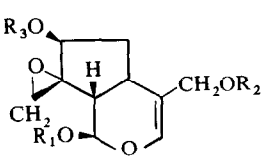

$R_1 = R_2 = Me_2CHCH_2CO$
$R_3 = MeCO$

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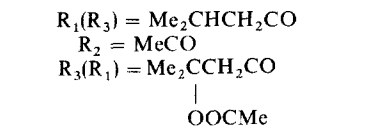

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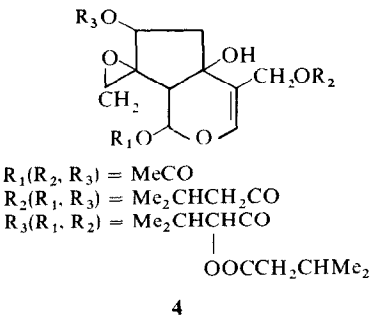

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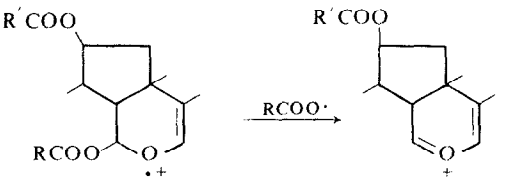

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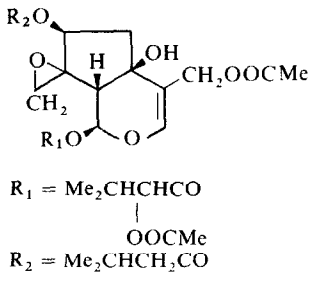

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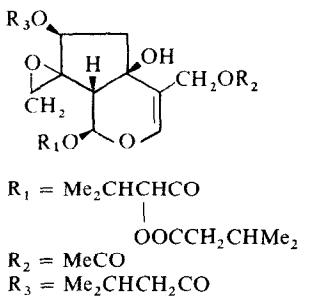

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zidine reagent indicating the presence of an OH group at C-5 or a cleaved epoxide ring [4]. The lack of absorption at 256 nm in the UV spectrum shows that this iridoid does not contain the conjugated valtrate chromophore. The IR spectrum exhibits in addition to the intensive ester carbonyl absorption maxima at 1730–1760 cm^{-1} peaks due to isolated double bonds (1665 cm^{-1}) and OH groups (3450–3600 cm^{-1}). These data point to similarity between CV_1 and IVHD-valtrate.

The MS yields most information. The M^+ of comparatively low abundance is at *m/e* 498 which shows that the compound has 3 methylene groups less than IVHD-valtrate (MW 540). In agreement with this observation are the first 3 peaks at *m/e* 413 (24%), 397 (34%) and 396 (100%) of high abundance in the spectrum of CV_1 which in the spectrum of IVHD-valtrate are of the same relative abundance and appear at *m/e* 455, 439 and 438 respectively. H_2O and CH_2O are similarly eliminated from a series of fragments, which points to the presence of OH and epoxide functions [5]. This information strongly suggests that CV_1 has the same skeleton as IVHD-valtrate but differs from it in the acyloxy substituents which summarily contain 3 methylene groups less. The peaks at *m/e* 413, 397 and 396 (M^+-85, M^+-101 and M^+-102) indicate the presence of isovaleroxy groups. Another peak of high abundance (*m/e* 339) can be ascribed to the loss of an acetoxyisovaleroxy fragment from the M^+. The poor elimination of acetic acid indicates that the acetoxy moiety is not in the same position as in the acetoxyisovaleroxy one of acevaltrate since the MS of the latter exibits an abundant peak at M^+-MeCOOH [5]. Thus in CV_1 the acetoxy group must be attached to the second carbon atom in the isovaleroxy moiety similar to IVHD-valtrate. The loss of acetic acid and an acetoxy group from *m/e* 339 shows that the third acyloxy group is an acetoxy one, and the low percentage of the two ions indicates that it is at C-11 [5]. It can be concluded from these data that valepotriate CV_1 is analogous to IVHD-valtrate the 3 acyloxy groups being acetoxy at C-11, isovaleroxy and α-acetoxyisovaleroxy at C-1 and C-7.

The PMR spectrum of CV_1 ($CDCl_3$) supports this assumptions. It is very similar to the PMR spectrum of IVHD-valtrate. The difference is that instead of the 3 isovaleroxy moieties in IVHD-valtrate in the case of CV_1 there are only two (4H signals at 2.2δ and two signals for 12H at 0.98δ and 1δ). There are also two 3 proton singlets centered at 2.05δ and 2.15δ due to acetoxy groups instead of a single acetoxy group resonance at 2.05δ. Therefore, there are two acetoxy groups in the CV_1 molecule one at C-11 (2.05δ) and the other attached to the isovaleric fragment more deshielded than in acevaltrate (1.97δ). These data together with the lack of absorption at 1.5δ of Me groups neighbouring acetoxy ones and the MS permit the conclusion that the isovaleroxy group has an acetoxy substituent at its second carbon atom, as with IVHD-valtrate

The MS indicates that there is an acetoxy group at C-11. The following considerations are in support of the assumed sites of the isovaleroxy and acetoxyisovaleroxy groups. The C-7 proton resonates at almost the same place as in didrovaltrate (4.85δ against 4.92δ), which shows that in both cases there is at C-7 an acyloxy group. The C-1 proton absorption appears at considerably weaker fields (6.08δ) than the signal of the same proton in didrovaltrate (5.81δ) and valtrate (5.96δ). This shift could in part be due to the effect of the OH group at C-5 and in part to the adjacent β-acetoxyisovaleroxy group moreover that no such shift is observed for the signal of the C-7 proton. The MS fragmentation affords clear indications for the localization of the α-acetoxyisovaleroxy group. The didrovaltrate type valepotriates eliminate the substituent at C-1 predominantly as a radical which leads to a stable even-electron ion **5** while the elimination of the substituent at C-7 occurs mainly as a molecule of the corresponding acid. CV_1 yields an intensive peak at *m/e* 339 due to elimination of an acetoxyisovaleroxy radical and not of the corresponding acid. On the other hand the isovaleroxy group is eliminated mainly as an acid which is in accordance with its location at C-7. Thus it is the α-acetoxyisovaleroxy group which is attached at C-1.

Structure **6** and the name acetoxy-hydroxy-didrovaltrate (AHD-valtrate) for the valepotriate CV_1 are proposed on the grounds of the mentioned results. In all hitherto known iridoids the proton at C-1 is always of α-configuration while those at C-5 and C-9 are of β-configuration. If it is assumed that the same holds also for **6** one can draw the following conclusions regarding the remaining asymetric centres in AHD-valtrate.

The considerable chemical shift difference of the two protons at C-6 (2.84δ and 1.89δ) shows that the two deshielding substituents in the neighbourhood of C-6 (the OH group at C-5 and the acyloxy one at C-7) are *cis* to each other and in accordance with the above assumption the substituent at C-7 should be of β-configuration.

$J_{1,9}$ is 2, 3 Hz and as was shown earlier [6] the dihydropyran ring in didrovaltrate exists in two half-chair conformations in *ca* equal concentrations. With **6**, however, the conformer with the bulky OR substituent at C-1 in the axial position predominates (*ca* 80%). The increase of concentration of the latter can be explained by the presence at C-5 of an OH group which should exert a stabilizing effect via hydrogen bonding with the carbonyl function of the axial, but not equatorial acyloxy substituent. The IR spectrum of AHD-valtrate taken in $CHCl_3$ at high dilutions supports, albeit ambiguously, this assumption, since intramolecular hydrogen bonding is also possible with the acyloxy group at C-7. Hydrogen bonding between the glucoside residue and the OH group at C-5 is also possible in the glucoside iridoids in which the same change of configuration was observed. On the grounds of this information the stereochemistry of AHD-valtrate can be assumed to be analogous to the one of the valepotriate as demonstrated in formula **6**.

The valepotriate CV_2 spectral characteristics were found to resemble closely those of AHD-valtrate. The comparison of the UV, PMR and MS of the former with those of IVHD-valtrate shows that CV_2 is identical with IVHD-valtrate. The considerations regarding the sites of the acyloxy groups in the newly isolated valepotriate AHD-valtrate also provide a possibility for specifying the sites of the acyloxy groups in IVHD-valtrate. The MS of IVHD-valtrate indicates the presence of an acetyl group at C-11 and an isovaleroxyisovaleryl group at C-1. Consequently the isovaleroxy group must be at C-7. This is confirmed by the same chemical shift of the C-7 proton of IVHD-valtrate, didrovaltrate and AHD-valtrate. The stereochemical considerations regarding AHD-valtrate including the conformations of the dihydropyran ring are valid for UVHD-valtrate whose structure can, therefore be assumed to be represented by **7**.

EXPERIMENTAL

IR spectra were taken in KBr and $CHCl_3$. UV spectra were recorded in EtOH solns. The PMR spectra of CD_3Cl solns were determined at 100 MHz. MS were measured at 70 eV by direct inlet. The total $CHCl_3$ extract of *C. ruber* (ground dry roots) taken down to the consistence of a thick syrup was treated with a 10-fold excess of petrol which pptd the more polar substances. The filtrate was concd under red. pres. to dryness and the residue was separated using prep-TLC on Si gel G with petrol–Me_2CO–EtOAc (100.8:8). Benzidine reagent revealed the presence of valtrate (R_f 0.60), didrovaltrate (R_f 0.47) acevaltrate (R_f 0.36), IVHD-valtrate (CV_2) with R_f 0.20 and AHD-valtrate (CV_1) with R_f 0.12. Extraction of the last two bands afforded IVHD-valtrate (0.4%) and AHD-valtrate (0.05%) both with respect to dry wt. Final purifications was accomplished by prep-TLC using CH_2Cl_2–Me_2CO–EtOAc (50:1:1).

AHD-valtrate. PMR: 6.67 (1H, *s*); 6.08 (1H, *d*, $J_{1,9}$ = 2,3 Hz); 4.95 (1H, *q*); 4.8 (1H, *d*); 4.7–4.8 (2H, *q*); 2.9 (1H, *d*); 2.8–3.12 (2H, *q*); 2.84 (1H, *q*) 2.6 (1H, *s*); 1.89 (1H, *q*); 2.2 (4H, *m*); 2.15 (3H, *s*); 1 (6H, *d*); 0.98 (6H, *d*). IR. ν_{max}^{KBr} cm^{-1}. 1245, 1380, 1470, 1665, 1730–1760, 2880, 2960, 3020, 3300–3600.

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