suggest that synthesis of anionic peroxidases is repressed and that of cationic peroxidases is induced in the cultured cells.

EXPERIMENTAL

Tobacco cells (*Nicotiana tabacum* cv. Hicks 2) were grown as described [1]. Tobacco plants were grown in a greenhouse for three months after germination. All other methods were as described previously [1].

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THE CONSTITUTION OF ISOCENTDAROL, A SESQUITERPENEDIOL FROM *CEDRUS DEODARA**

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Key Word Index—*Cedrus deodara*; Pinaceae centdarol; isocentdarol; sesquiterpene diol; spasmolytic agent.

The isolation of the spasmolytic constituents [1, 2] from the hexane-soluble extractive of the wood of *Cedrus deodara* and the structure elucidation of centdarol [3] was reported in earlier communications. The present paper deals with chemical studies on isocentdarol.

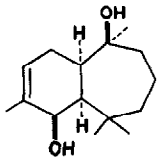
Isocentdarol. $C_{15}H_{26}O_2$ (M^+ 238), showed IR bands at 3344, 1037 (OH), 817 cm^{-1} (C=CH) and, like centdarol, exhibited PMR signals for three tert. C–Me, a vinylic Me, a carbinol H, two OH and a vinylic H. Acetylation yielded a monoacetate, $C_{17}H_{28}O_3$ ($M-H_2O$ *m/e* 262), whose PMR spectrum showed an acetoxyl singlet at 2.07 ppm and a downfield shift by 1.22 ppm of the carbinol H indicating the presence of a secondary OH group in the molecule.

In the PMR spectrum of isocentdarol on addition of TAI [4], the 2H signal due to OH groups at 2.08 ppm was replaced by a 2H multiplet of carbamate protons at 8.7 ppm with concurrent shifts of the carbinol signal from 4.06 to 5.38 ppm, vinyl H from 5.78 to 5.98 ppm and a tertiary C–Me from 1.26 to 1.66 ppm. Thus the presence of two OH groups in the molecule was confirmed. The PMR spectrum of isocentdarol acetate in presence of TAI, however, showed only 1H carbamate signal at 8.61 ppm without any shift of the vinylic H multiplet but a paramagnetic shift of the tert. C–Me singlet by 0.38 ppm. This demonstrated the position of the secondary OH group as allylic and that of the tertiary OH group on the carbon bearing the tertiary C–Me.

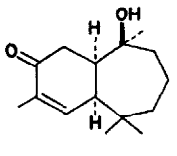
Isocentdarol on chromic acid oxidation, furnished a monoketo derivative, (isocentdarone) $C_{15}H_{24}O_2$ (M^+ 236), which showed enone IR absorption (1670 cm^{-1}) and λ_{max} (245 nm, ε 6162) consistent with the allylic nature of the secondary OH group in the molecule.

Catalytic hydrogenation of isocentdarol yielded a dihydroproduct, $C_{15}H_{28}O_2$ (M^+-18 *m/e* 222), which did not show vinylic Me and vinylic H signals in the PMR spectrum indicating that both were located on the same double bond in isocentdarol.

From the above data it was evident that isocentdarol was an isomer of centdarol (1) differing in the position of the double bond and the secondary OH group. The double bond could be placed at Δ^2 in view of the similar splitting pattern (*dm*. *J* 5 Hz) of the vinylic H signal in the PMR spectra of both isocentdarol and himachalol [5]. The secondary OH group would, therefore, be located at C_4. This was in agreement with large downfield shift (1.18 ppm) of the vinylic H in the PMR spectrum of isocentdarone, which also exhibited a 2H doublet (*J* 3 Hz) at 2.50 ppm and a 1H multiplet at 2.75 ppm assignable to C_5-methylene and C_1-methine protons respectively. The solvent induced shifts in the PMR spectra of isocentdarone (2) in benzene d_6 and pyridine d_5 were also in accord with the proposed assignments.



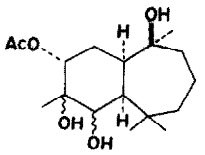
(1)



(2)

In order to confirm the structure, isocentdarol acetate was hydroxylated with OsO_4 to give a triol acetate (3), $C_{17}H_{30}O_5$ which did not show any vinylic Me and H signals in the PMR spectrum but an additional Me on an oxygen-bearing carbon at 1.35 ppm, a carbinol H doublet (*J* 8 Hz) at 3.67 ppm and a methine H (under an acetoxyl group) as a quartet (*J* 11 and 5 Hz) at 4.93 ppm. On reaction with periodate the triol acetate (3) furnished two major *seco*-products, A and B, which were separated by chromatography on silica gel.

* Part 4 in series, Chemical Examination of *Cedrus deodara* Loud. See ref. [3] for Part 3. CDRI Communication No.



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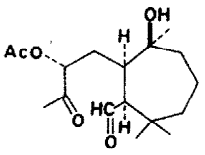
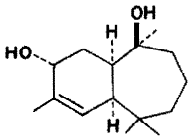


(4)

Seco-product A was obtained as a viscous liquid $C_{17}H_{28}O_5$ (M^+-H_2O *m/e* 294), and was identified as IV from its IR absorption at 1750, 1244 (OCOMe), 1720 cm^{-1} (C=O) and PMR signals at 2.16 (*s*, MeCO), 2.2 (*s*, OCOMe), 10.0 ppm (*d*, *J* 3 Hz, CHO). Seco-product B, $C_{17}H_{28}O_6$ (M^+-60 *m/e* 268), was an acid exhibiting IR bands at 3344–2450, 1700 cm^{-1} (bromophenol blue test positive) which must have resulted from further oxidation of the aldehyde (**4**).

The configuration of the secondary OH group was considered to be α since its β (equational) carbinol proton gave rise to a narrow multiplet ($W_{\frac{1}{2}}$ = 7 Hz) in the PMR spectrum due to its eq.–eq. coupling with the C_5 methylene protons. The structure of isocentdarol was, therefore, established as (**5**) (4α,7β-dihydroxyhimachal-2-



(5)

ene) which was also confirmed from its synthesis by SeO_2 oxidation of himachalol.

EXPERIMENTAL

All mp's are uncorrected. The PMR spectra were recorded at 60 MHz in $CDCl_3$ with TMS as internal standard.

Isocentdarol. Mp 165° $[\alpha]_D$ 5.0 (*c*, 1% EtOH), ν_{max}(KBr):3344, 1037 (OH), 817 cm^{-1} (C=CH), PMR (ppm):0.816, 1.01, 1.26 (3H each, *s*, 3 × Me), 1.85 (3H, *s*, C=C–Me), 2.08 (2H, broad *s*, 2 × OH, D_2O exchangeable), 4.06 (1H, *m*, $W_{\frac{1}{2}}$ = 7 Hz –CHO–), 5.78 (1H, *dm J* 5, C=CH), PMR with TAI:0.90, 1.05, 1.66 (3H each, *s*, 3 × Me), 1.83 (3H, *s*, C=C–Me), 5.38 (1H, *m*, CH–O–), 5.98 (1H, *dm J* 5 Hz, C=CH), 8.7 (2H, *m*, –CONHCO–), MS:*m/e* 238 (M^+), 220 (M^+-18), 202 (M^+-18-18), 187, 177, 159, 149, 135, 132, 109, 69, 55, 43 (Found: C, 75.10, H, 11.47 $C_{15}H_{26}O_2$ requires C, 75.57; H, 11.00%).

Isocentdarol acetate. Isocentdarol (200 mg) in C_5H_5N (1 ml) and Ac_2O (1 ml) were reacted 18 hr and, after the usual work up, the product (220 mg) was crystallised from C_6H_6–hexane, mp 92°, ν_{max} (KBr):3400, 1022 (OH), 1756, 1252 (OCOMe), 846 cm^{-1} (C=CH), PMR (ppm):0.833, 1.03, 1.23 (3H, *s*, 3 × Me), 1.73 (3H, *s*, C=C–Me), 2.07 (3H, *s*, OCOMe), 5.28 (1H, *m*, –CH–OAc) 5.91 (1H, *dm J* 6 Hz, C=CH). PMR with TAI:0.883, 1.01, 1.61 (3H, *s*, 3 × Me), 1.73 (3H, *s*, C=C–Me). 2.07 (3H, *s*, OCOMe), 5.28 (1H, *m*, CHO-Ac), 5.91 (1H, *dm J* 6 Hz, C=CH), 8.61 (1H, *m*, CONHCO), MS:*m/e* 262 (M^+-18), 220 (M^+-60), 202, 187, 177, 159, 145, 132, 127, 119, 109, 93, 69 (Found C, 72.61; H, 10.40 $C_{17}H_{28}O_3$ requires C, 72.30; H, 10.0%).

Isocentdarone. Isocentdarol (50 mg) was treated with CrO_3–C_5H_5N complex (containing *ca* 70 mg CrO_3) for 3 hr at room temp. The product (48 mg) showed one major spot on TLC (in C_6H_6 + 6% MeOH), and chromatography on Si gel yielded the pure product as a viscous liquid, ν_{max} (Neat):1670 (C=O in 6 mem ring), λ_{max} 245 nm (ε6162), PMR (ppm):0.9, 1.1, 1.21 (3H each, *s*, 3 × Me), 1.83 (3H, *t*, *J* 1.5 Hz, C=C–Me), 2.50 (2H, *d*, *J* 3 Hz, –CH_2–), 2.75 (1H, *m*, –CH–), 6.96 (1H, *dq*, *J* 6.0 and 1.5 Hz, C=C–H), MS:*m/e* 236, 234, 218, 209, 175, 165, 161, 149, 121, 109, 95, 69, 43.

Dihydroisocentdarol. Isocentdarol (50 mg) was hydrogenated in presence of PtO_2 (15 mg) in EtOAc for 4 hr. The product showed one major and two minor spots on TLC (C_6H_6 + 4% MeOH). On crystallisation from C_6H_6–hexane it furnished a dihydroderivative, mp 121°, PMR (ppm): 0.93, 1.083, 1.31 (3H each, *s*, 3 × Me), 3.48 (1H, *m*, –CHO–) MS:*m/e* 222 (M^+-18), 107, 189, 155, 137, 127, 109, 71.

Osmylation of isocentdarol acetate. Isocentdarol acetate (100 mg) was dissolved in C_5H_5N (2 ml) and allowed stand with OsO_4 (100 mg) for 40 hr, then diluted with H_2O, shaken with $NaHSO_3$ (100 mg) for 2 hr and finally extracted with EtOAc. The EtOAc soln on evaporation furnished a triol acetate (III) which was purified by chromatography on Si gel to give a viscous liquid (60 mg), ν_{max}:3438, 1729 and 1248 cm^{-1}, PMR (ppm): 1.10, 1.17 (3H each, *s*, 2 × Me), 1.3, 1.35 (3H each, *s*, –OC–Me), 2.11 (3H, *s*, OCOMe). 3.67 (1H, *d*, *J* 8 Hz, –CHO–), 4.93 (1H, *dd*, *J* 11 and 5 Hz, CHOAc). MS:*m/e* 281 (M^+-18-15), 268, 254 (M^+-60), 236, 221, 218, 203, 193, 175, 149, 133, 109, 95, 70, 43.

$NaIO_4$ cleavage of the triol acetate (III). The triol acetate (75 mg) dissolved in EtOH (2 ml) was treated with aq $NaIO_4$ (100 mg in 0.5 ml H_2O) for 5 hr, then worked up as usual. The product (65 mg) showed one major (A, R_f 0.38) and one minor (B, R_f 0.07) spot on TLC (C_6H_6 + 6% MeOH) which were then separated by chromatography on Si gel. Product A was obtained as a viscous liquid, ν_{max} Neat:3520, 1750, 1720, 1244 cm^{-1}, PMR (ppm):1.05, 1.125, 1.17 (3H each, *s*, 3 × Me), 2.16 (3H, *s*, –COMe), 2.2 (3H, *s*, OCOMe), 5.1 (1H, *t*, *J* 7 Hz, CH–OAc), 10.0 (1H, *d J* 3 Hz, –CHO); MS:*m/e* 294 (M^+-18), 252 (M^+-60), 234, 219, 209, 191 (base peak), 137, 109, 95, 81, 69. Product B was obtained as colourless needles mp 165° from C_6H_6–hexane, ν_{max} (KBr):3344–2450, 1740, 1700, 1260, 1230, 850 cm^{-1}. PMR in acetone d_6 (ppm): 1.01, 1.083 (3H each, *s*, 2 × Me), 1.10 (6H, *s*, 2 × Me), 2.10 (3H, *s*, OCOMe), 2.15 (3H, *s*, OCOMe), 5.13 (1H, *dd*, *J* 7 and 5.5 Hz, CHOAc). MS:*m/e* 268 (M^+-60), 253, 235, 225, 207, 195, 179, 161, 109, 95.

SeO_2 oxidation of himachalol. Himachalol (250 mg) was refluxed with SeO_2 (150 mg) in EtOH (5 ml) for 2 hr. The reaction mixture was filtered through SiO_2 and evaporated. The residue which showed 6 spots (a–e) on TLC (C_6H_6 + 8% MeOH) was chromatographed over SiO_2. The $CHCl_3$–EtOAc (1:1) eluate furnished pure product d which crystallised from C_6H_6–hexane as a colourless needless mp 165°, identical in all respects with isocentdarol.

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