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PHOTOOXIDATION OF ERYTHRODIOL

Isao Kitagawa, Kiyoshi Kitazawa, and Itiro Yosioka

Faculty of Pharmaceutical Sciences, Osaka University

Toyonaka, Osaka, Japan

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In the previous communication[1], we reported the formation of 11α,12α-epoxy-oleanolic lactone (III) in a single step via photooxidation of oleanolic acid (I) in an acidic medium, where the participation of the carboxylic function at C_{17} in the probable intermediate (II) occurred. In view of the parallel behavior of the primary alcoholic function in the analogous step (IV), we have been interested in investigating the photooxidation of erythrodiol (V), to which the present paper concerns.

A mixture, revealed by TLC consisting more than six components, was obtained on irradiation*1 of erythrodiol (V) in acidic ethanol for 220 hrs. at room temperature with moderate bubbling of oxygen as described before[1]. Repeated chromatographic separations (column and TLC) of the mixture have furnished two main products at present tentatively designated E-1 (5.8%)*2 and E-2 (5.4%) in addition to the starting compound recovered (13.2%).

On acetylation with acetic anhydride and pyridine at room temperature, E-1 (VI), $C_{30}H_{48}O_3$*3, mp. 259-260.5°, $[\alpha]_D$ -41.5° (c=1.0 in py.); IR*4 (cm^{-1}): 3580 (hydroxyl), 870*5; NMR (τ)*6: seven methyls, 7.12 (2H, singlet, $W_{\frac{1}{2}}^{h}$=3 cps.) 6.54 (2H, AB quartet, J=6 cps., assignable[2,3,4] to -O-$\underline{CH}_2$-$\overset{|}{C}_{(17)}$-), 6.77 (1H, triplet-like, >$C_{(3)}\underline{H}$OH), yielded a monoacetate (VII), $C_{32}H_{50}O_4$, mp. 275-6°, $[\alpha]_D$ -35.9° (c=1.0, in $CHCl_3$); IR: 1725 (acetate), 870; NMR: seven methyls, 8.01 (3H, s., acetyl), 7.16 (2H, s., $W_{\frac{1}{2}}^{h}$=3 cps.), 6.54 (2H, AB q., J=6 cps., -O-$\underline{CH}_2$-$\overset{|}{C}_{(17)}$-), 5.56 (1H, t.-like, >$C_{(3)}\underline{H}$OAc). A singlet (2H) appearing at τ 7.12 or 7.16 in VI or VII is quite reminiscent of the corresponding signals in III[1] (τ 7.05, 2H, s., $W_{\frac{1}{2}}^{h}$=3 cps.) and in eupteleogenin[5] (τ 7.08, 2H, s., $W_{\frac{1}{2}}^{h}$=3 cps.) both ascribed to 11β-H, 12β-H. These physical data mentioned here have led us to formulate E-1 by VI, and the assumption was verified by converting VII to the known epoxy-lactone (VIII)[1] by means of

*1 A 100 W high pressure mercury lamp was used as a light source (Ohsawa Denki Co., Tokyo).
*2 Yield of the pure material isolated.
*3 All the compounds given with chemical formulae afforded the reasonable analytical values.
*4 Taken in KBr pellet unless stated otherwise.
*5 The characteristic IR absorption band found also in III[1] and eupteleogenin[5].
*6 Measured at 100 Mc.

RuO_4 oxidation[4] in CCl_4 (the yield was almost quantitative), thus exemplifying the participation of $C_{(17)}$-CH_2OH during the photooxidative procedure as depicted by IV.

The other product, E-2 (IX), $C_{30}H_{48}O_3$, mp. 268-270.5°, $[\alpha]_D$ -56.3° (c=1.0, py.): IR: 3500 (broad, hydroxyl), 1630 (C=C), 870, gave a diacetate (X), $C_{34}H_{52}O_5$, mp. 245.5-6°, $[\alpha]_D$ -51.1° (c=1.0, $CHCl_3$); IR: 1730 (acetate), 1635 (C=C), 870; NMR: seven methyls, 8.00 (6H, s., two acetyls), 7.30 (1H, d., $C_{(12)}\underline{H}$, $J_{11,12}$=6 cps.), 6.96 (1H, t.-like, $C_{(11)}\underline{H}$, $J_{11,12}$=6 cps., $J_{11,9}$=5 cps.), 6.36 (2H, s., $C_{(17)}$-$C\underline{H}_2OAc$), 5.56 (1H, t., $>C_{(3)}\underline{H}OAc$), 4.62 (1H, m., a vinylic proton) with acetic anhydride and pyridine. The assumption, keeping in mind another possible reaction mechanism as shown by XI (similarly as presented by Corey et al.[6]), in addition to the comparison of the physical properties between E-2 or its acetate and 11α,12α-epoxytaraxerene derivatives[6], have enabled us to forward the structure IX for E-2. The structure IX corresponds to C_{28}-hydroxy derivative of 11α,12α-epoxy-taraxerol, whose constitution had already been established rigorously by Corey et al.[6]

Two compounds E-1 and E-2 elucidated here provide the interesting feature on the photooxidation of erythrodiol especially from the mechanistic viewpoint. The study on the rest of a few minor products in this reaction is now in progress.

Until recently, several oleanane derivatives possessing 13β,28-oxide moiety (cyclamiretins A[7], B[2], saikogenins E[3a], F[3b], priverogenin B[4,8] etc.) have been revealed as the genuine sapogenins. As the potential precursorial compound towards the synthesis of such acid-labile 13β,28-oxide sapogenins, E-1 seems to be interesting one and hence we have explored its more favored synthetic method as is described below.

Thus, oxidation of methyl 3β-O-acetyl-oleanolate (XII) with t-butyl chromate in hot acetic anhydride-acetic acid-CCl_4 mixture afforded an 11-keto derivative (XIII)[9]: IR ($CHCl_3$): 1718 (ester), 1650 ($>C=\overset{|}{C}-C=O$). $LiAlH_4$ reduction of the latter gave 11ξ-hydroxy-erythrodiol (XIV) (not isolated), which in turn was treated with H_2O_2-p-toluenesulfonic acid in t-butanol-CH_2Cl_2[6] yielding two compounds (40% and 13% from XIII respectively), and these two products were proved identical with above-mentioned E-1 (VI) and E-2 (IX) in all respects.

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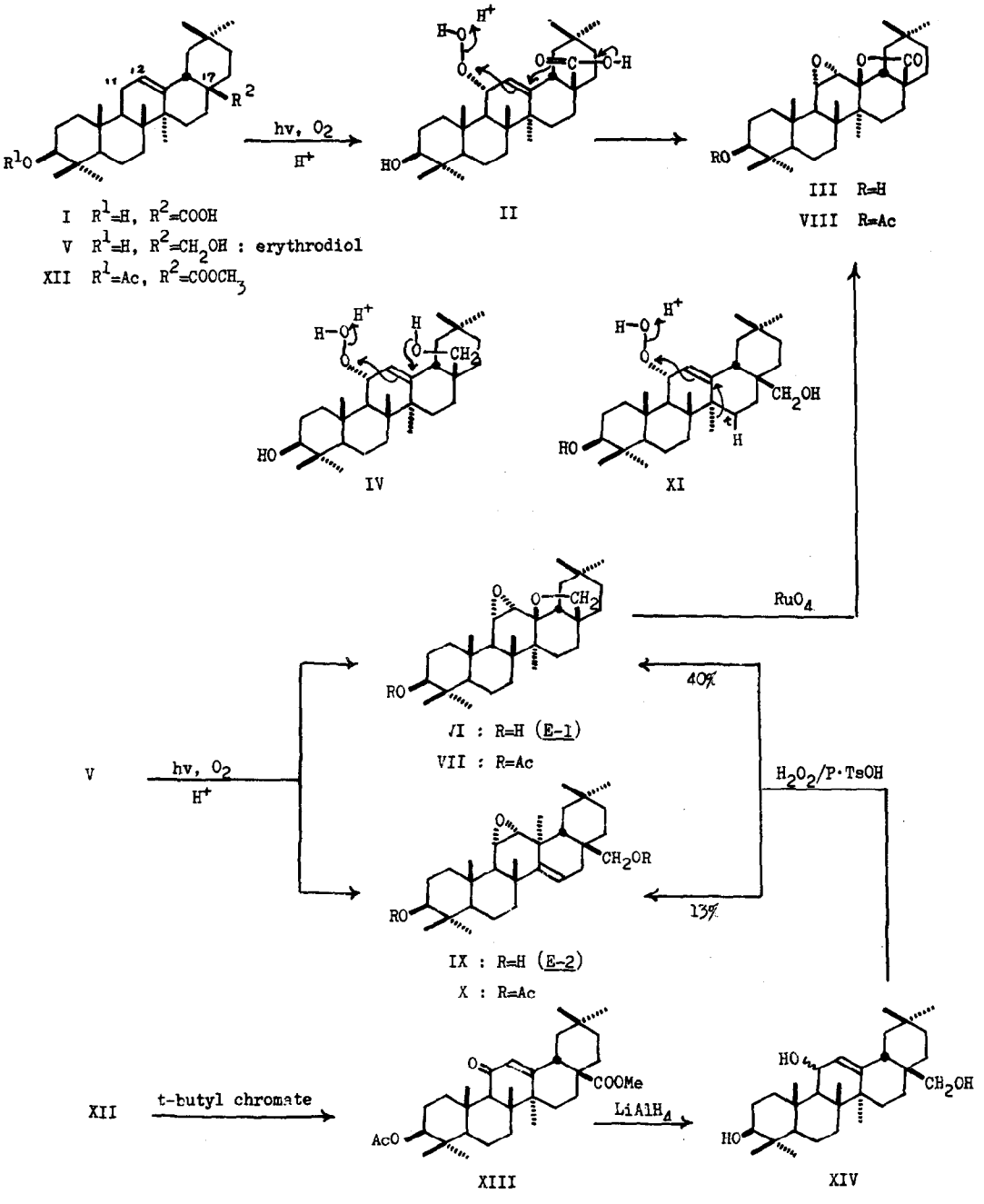
hv, O2
H+
I R1=H, R2=COOH
V R1=H, R2=CH2OH : erythrodiol
XII R1=Ac, R2=COOCH3
II
III R=H
VIII R=Ac
IV
XI
RuO4
40%
VI : R=H (E-1)
VII : R=Ac
V
hv, O2
H+
H2O2/P·TsOH
13%
IX : R=H (E-2)
X : R=Ac
XII
t-butyl chromate
LiAlH4
XIII
XIV

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