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4α,5α-OXIDOEUDESM-11-EN-3α-OL, SESQUITERPENOID OF *CYPERUS ROTUNDUS**

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Key Word Index—*Cyperus rotundus*; Cyperaceae; nutgrass; sesquiterpenoid; eudesmane derivative; 4α,5α-oxidoeudesm-11-en-3α-ol.

Abstract—A novel sesquiterpenic oxido-alcohol has been isolated from the rhizomes of *Cyperus rotundus* and identified as 4α,5α-oxidoeudesm-11-en-3α-ol.

INTRODUCTION

Nutgrass, *Cyperus rotundus*, is a weed which is widespread throughout the Temperate and Tropical Zones. A crude drug, prepared from the rhizomes of this grass, has been used as a remedy for women's diseases in Oriental Medicine. We have hitherto isolated a number of sesquiterpenoids from the crude drug [1] and as a continuation of our studies an investigation was undertaken of its alcohol fraction.

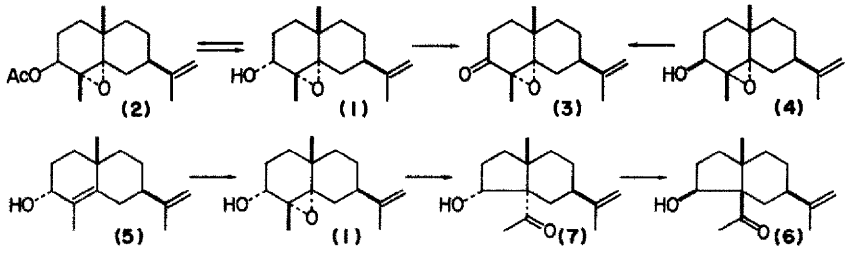
RESULTS AND DISCUSSION

The crude drug of Japanese origin was steam-distilled yielding the essential oil which on alumina chromatography gave the alcohol fraction. Rechromatography of the fraction on silica gel impregnated with silver nitrate furnished a novel sesquiterpenoid. The terpenoid, $C_{15}H_{24}O_2$, had a secondary hydroxyl (ν 3450 cm^{-1}, δ 3.64), a tertiary methyl (δ 1.04), a tertiary methyl on an oxygen-bearing carbon (δ 1.38), and an isopropenyl (ν 3080, 1644, 886 cm^{-1}, δ 1.74, 4.68). On acetylation the terpenoid afforded the monoacetate (**2**) (ν 1739, 1242 cm^{-1}, δ 2.08, 5.03) which had no hydroxyl group, demonstrating that the terpenoid was an oxido-alcohol. Hydrolysis of the acetate (**2**) yielded the original terpenoid. When the terpenoid was subjected to chromic acid oxidation, the oxido-ketone (**3**) (ν 1700 cm^{-1}) was obtained. These data, together with the circumstantial evidence that the terpenoid coexists with cyperol (**5**) [2] and α-cyperone [3] in the same plant, suggested that the terpenoid was cyperol 4,5-epoxide. In this case, the CD data (negative Cotton effect at 303 nm) of the ketone (**3**) indicated the configuration of the 4,5-epoxy ring to be α. 4α, 5α-Oxidoeudesm-11-en-3β-ol (**4**) [4] was then oxidized with chromic acid furnishing 4α, 5α-oxidoeudesm-11-en-3-one (**3**) with which the above oxidoketone was identical. On the basis of the accumulated data together with the NMR evidence that the C-3 carbinyl hydrogen was equatorially situated [1H unresolved band at δ 3.64 ($W_{\frac{1}{2}}$ = 9.5 Hz) for the terpenoid and 1H doublet of doublets at δ 5.03 ($J_1 = J_2 = 6$ Hz) for the acetate (**2**)], the terpenoid was concluded to be 4α, 5α-oxidoeudesm-11-en-3α-ol (**1**).

Previously, we [5] postulated the biogenetic pathway to cyperolone (**6**) from eudesma-4, 11-dien-3β-ol via 4α, 5α-oxidoeudesm-11-en-3β-ol (**4**) in *C. rotundus*. However, the finding of cyperol (**5**) and 4α, 5α-oxidoeudesm-11-en-3α-ol (**1**) in this plant may require the revision of the biogenetic pathway to: cyperol (**5**) → 4α, 5α-oxidoeudesm-11-en-3α-ol (**1**) → the hypothetical hydroxy-methyl ketone (**7**) → cyperolone (**6**). The conversion of the unstable hydroxy-methyl ketone (**7**) into the stable cyperolone (**6**) through reverse aldol–aldol condensations is highly probable [4].

EXPERIMENTAL

Isolation of 4α, 5α-oxidoeudesm-11-en-3α-ol (**1**). Dried rhizomes of *Cyperus rotundus* L. were steam-distilled to give the essential oil as a pale brown liquid in 0.6% yield. The oil was chromatographed over Al_2O_3. After elution with C_6H_6 of the ketone fractions followed by the acetate fractions, successive elution with the same solvent afforded the alcohol fractions which, after combination, were submitted to rechromatography on $AgNO_3$–Si gel (1:9). After elution of cyperol and



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*Part 52 in the series on Sesquiterpenoids.

isocyperol, successive elution with C_6H_6–EtOAc (5:1) followed by crystallization from petrol gave 4α, 5α-oxidoeudesm-11-en-3α-ol (**1**) as colourless needles, mp 61.5° (uncorr). $[\alpha]_D$ +37.3° (*c* 4.72, $CHCl_3$). (Found: C, 76.26; H, 10.02. $C_{15}H_{24}O_2$ requires: C, 76.22; H, 10.24%). MS *m/e*: 236 (M^+). IR $\nu_{max}^{CCl_4}$ cm^{-1}: 3450 (OH), 3080, 1644, 886 (CH_2 =C<), 1038 (epoxide); NMR (60 MHz, CCl_4): δ 1.04 (3H, *s*, C-15), 1.38 (3H, *s*, C-14), 1.74 (3H, *s*, C-13), 3.64 (1H, broad peak, $W_{\frac{1}{2}}$ = 9.5 Hz, C-3), 4.68 (2H, unresolved *s*, C-12).

Acetylation of 4α, 5α-oxidoeudesm-11-en-3α-ol. The oxido-alcohol (**1**) (360 mg) was treated with Ac_2O (0.5 ml) in dry Py (1 ml) at room temp. overnight. Dilution with H_2O, extraction with Et_2O, and working up in the usual way gave the oily product (419 mg) which was chromatographed over Si gel (10 g). Elution with petrol–C_6H_6 (1:1) afforded an oil which on distillation under red press yielded 3α-acetoxy-4α, 5α-oxidoeudesm-11-ene (**2**) as a colourless oil. $[\alpha]_D$ +41.0° (*c* 4.70, $CHCl_3$). IR ν_{max}^{liquid} cm^{-1}: 3096, 1645, 887 (CH_2 =C<), 1739, 1242 (MeCOO-), 1020 (epoxide); NMR (60 MHz, CCl_4): δ 1.06 (3H, *s*, C-15), 1.25 (3H, *s*, C-14), 1.75 (3H, *t*, J = 1 Hz, C-13), 2.08 (3H, *s*, MeCOO-), 4.69 (2H, unresolved *s*, C-12), 5.03 (1H, *dd*, $J_1 = J_2$ = 6 Hz, C-3).

Alkaline hydrolysis of 3-α-acetoxy-4α, 5α-oxidoeudesm-11-ene. The acetate (**2**) (169 mg) in EtOH (2 ml) was treated with ethanolic NaOH (50 mg/1 ml) at room temp. for 1 hr. Extraction with Et_2O and crystallization from petrol yielded the oxido-alcohol (**1**) as colourless needles, mp 61.5–63°. It was identical with the original oxido-alcohol (mp, mmp, IR and NMR comparison).

Chromic acid oxidation of 4α,5α-oxidoeudesm-11-en-3α-ol. The oxido-alcohol (**1**) (52 mg) in dry Py (0.5 ml) was added to CrO_3 (63 mg) in dry Py (0.5 ml) and the mixture was left standing at room temp. overnight. Working up in the customary manner (Et_2O extraction) gave crude crystals (47 mg) which were recrystallized from petrol to furnish 4α, 5α-oxidoeudesm-11-en-3-one (**3**) as colourless needles, mp 50.5–51° (uncorr.) CD (*c* 0.50, dioxane): $[\theta]_{303}^{max}$ −9260. IR ν_{max}^{KBr} cm^{-1}: 3080, 1643, 887 (CH_2 =C<), 1700 (CO in a 6-membered ring), 1414 (CH_2 α to CO); NMR (60 MHz, CCl_4): δ 1.05 (3H, *s*, C-15), 1.32 (3H, *s*, C-14), 1.76 (3H, *t*, J = 1 Hz, C-13), 4.71 (2H, unresolved *s*, C-12). Identical with the oxido-ketone derived from 4α, 5α-oxidoeudesm-11-en-3β-ol (4) (mp, mmp, IR and NMR comparison).

Chromic acid oxidation of 4α, 5α-oxidoeudesm-11-en-3β-ol. The oxido-alcohol (**4**) (24 mg) in dry Py (0.5 ml) was added to CrO_3 (34 mg) in dry Py (0.5 ml) and the mixture was set aside at room temp. overnight. Extraction with Et_2O afforded crude crystals (21 mg) which on crystallization from petrol gave 4α, 5α-oxidoeudesm-11-en-3-one (3) as colourless needles, mp 50.5–51° (uncorr).

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