TWO NEW SESQUITERPENOIDS FROM *CHLORANTHUS GLABER* Makino

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Two new sesquiterpenes, chloranthalactone A (I) and B (II) were isolated from *Chloranthus glaber* Makino and characterized.

We reported previously on the isolation of (-)-dihydropyrocurzerenone and on the detection of its four related compounds by gas chromatography-mass spectrometry from roots of *Chloranthus serratus* Roem. et Schult. (Japanese name : Futarishizuka).[1] Now we want to report on plane structures (I and II) of two new sesquiterpene lactones, named chloranthalactone A and B, from roots of *C. glaber* Makino (Japanese name : Senryo).

Roots of *C. glaber* were provided kindly in January by Mr. S. Ando, who was culturing this plant at his farm in Ibaragi prefecture. The fresh roots were extracted with ether at room temperature. The extracts obtained were chromatographed on silica gel and eluted with mixtures of *n*-hexane and acetone. Chloranthalactone A (I) was eluted with *n*-hexane-acetone (99:1), while chloranthalactone B (II) was eluted with *n*-hexane-acetone (97:3).

Chloranthalactone A (I) was obtained as colorless oil, $bp_{3\ mmHg}$ 143 - 144°, $[\alpha]^{27}_{340}$ - 448.4° (c=0.1), $C_{15}H_{16}O_2$, mass spectrum:*m/e* 228 (10%, M^+), 213 (22% , M^+-CH_3), 91 (100%). $IR\nu_{max}^{CS_2}cm^{-1}$: 1768 (α,β,γ,δ-unsaturated γ-lactone), 1660, 882 (exocyclic methylene). $UV\lambda_{max}^{MeOH}$nm (log ε): 279 (4.10), two double bonds in a linear conjugation system with a lactone carbonyl group. PMR ($CDCl_3$)δ: 0.77 ppm (3H, s, $C_{10}-CH_3$), 1.85 (3H, bs, $C_{11}-CH_3$), 4.75 (1H, m, C_{14}-H), 4.95 (1H, m, C_{14}-H), 6.11 (1H, s, C_9-H).

When allowed to leave in air at room temperature, chloranthalactone A(I) was autoxidized rapidly and transformed into chloranthalactone B (II), which was also obtained from roots of this plant directly, as described above. II is obtained as colorless prisms on recrystallization from acetone, mp 145 - 146°, $[\alpha]_{340}^{27}$ - 1303.3° (c=0.1), $C_{15}H_{16}O_3$, mass spectrum:*m/e* 244 (0.4%, M^+), 105 (100%), 91 (64%). $IR\nu_{max}^{KBr}$ cm^{-1}: 1788, 1680 (an unsaturated γ-lactone),1660, 919, 818 (a vinyl group). PMR ($CDCl_3$)δ: 0.64 ppm (3H, s, C_{10} - CH_3), 1.87 (3H, bs, C_{11} - CH_3), 3.36 (1H, m, C_5-H), 4.11 (1H, s, C_9-H), 4.69 (1H, m, C_{14}-H), 5.01 (1H, m, C_{14} - H). $UV\lambda_{max}^{MeOH}$ (log ε): 226 (4.11), α,β-unsaturated γ-lactone.

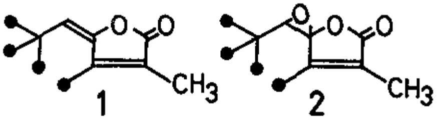
These data indicate the presence of partial structure 1 and 2 in chloranthalactone A (I) and B (II), respectively. On mild treatment with diluted alkali (stirring with 1% KOH in pyridine-water (4:1) under N_2 at room temperature for 5 hr), I was converted into a lactol (III), mp 153 - 154°, $[\alpha]_{300}^{26}$ + 351.4° (c=0.1), $C_{15}H_{18}O_3$, mass spectrum: *m/e* 246 (33%, M^+), 228 (70%, M^+ - H_2O), 121 (40%), 93 (100%). $IR\nu_{max}^{KBr}$ cm^{-1}: 3360 (OH), 1736, 1689 (unsaturated γ-lactone), 1663, 909, 898 (exocyclic methylene). PMR ($CDCl_3$)δ: 0.94 ppm (3H, s, C_{10} -CH_3), 1.82 (3H, bs, C_{11} -CH_3), 3.49 (1H, m, C_5 -H), 4.74 (1H, m, C_{14} -H), 5.01 (1H, m, C_{14} -H).

Oxidation of chloranthalatone A (I) with selenium dioxide gave a monohydroxy derivative (IV), mp 145 -146°, $C_{15}H_{16}O_3$, mass spectrum:*m/e* 244 (50%, M^+), 226 (45%, M^+ -H_2O), 91 (100%). $IR\nu_{max}^{KBr}$ cm^{-1} : 3440 (OH), 1730 (α,β,γ,δ-unsaturated γ-lactone), 1650, 880 (exocyclic methylene). PMR ($CDCl_3$)δ: 0.76 ppm (1H, sextet, J=4, 8, 8 Hz, $C_{2\ exo}$-H), 1.32 (3H, s, C_{10}-CH_3), 1.90 (3H, d, J=2 Hz, C_{11}-CH_3), 2.60 (1H, bd, J=16.5 Hz, C_6-H), 3.12 (1H, d, J=16.5 Hz, C_6-H), 4.93 (1H, s, C_{14}-H), 5.07 (1H, s, C_{14}-H), 5.45 (1H, s, C_9-H). Irradiation at the doublet at 1.90 ppm collapsed the broadened doublet at 2.60 ppm to a sharp doublet and *vice versa*.

Oxidation of the lactol (III) with selenium dioxide provided a hydroxylactol (V), mp 191 - 192.5°, $C_{15}H_{18}O_4$, mass spectrum:*m/e* 262 (2%, M^+), 244 (14%, $M^+ - H_2O$), 229 (9%, $M^+ - H_2O - CH_3$), 226 (8%, $M^+ - 2\times H_2O$), 211 (5%, $M^+ - 2\times H_2O - CH_3$), 121 (100%). $IR\nu_{max}^{KBr}cm^{-1}$: 3330 (OH), 1725, 1705 (unsaturated γ-lactone). PMR (Py-d_5)δ: 0.69 ppm (1H, sextet, J=4, 7, 7 Hz, $C_{2\ exo}$-H), 1.83 (6H, bs, C_{10}-CH_3 and C_{11}-CH_3), 1.76 (1H, d, J=14 Hz, C_9-H), 2.68 (1H, d, J=14 Hz, C_9-H), 3.11 (1H, bd, J=15 Hz, C_6-H), 3.40 (1H, d, J=15 Hz, C_6-H), 5.09 (1H, s, C_{14}-H), 5.10 (1H, s, C_{14}-H).

On prolonged treatment with 12% KOH in ethanol-water (1:1) monohydroxy derivative (IV) underwent retro-aldol cleavage to yield a hydroxyketo derivative (VI), subl. 86°/760 mmHg, $C_{12}H_{16}O_2$, mass spectrum:*m/e* 192 (34%, M^+), 177 (51%, $M^+ - CH_3$), 174 (14%, $M^+ - H_2O$), 133 (100%). $IR\nu_{max}^{KBr}cm^{-1}$: 3400 (OH), 1694 (carbonyl group on a six or more membered ring), 1650, 872 (exocyclic methylene). PMR ($CDCl_3$)δ: 0.79 ppm (1H, sextet, J=4, 8, 8 Hz, $C_{2\ exo}$-H), 1.17 (3H, s, C_{10}-CH_3), 5.10 (1H, s, C_{14}-H), 5.23 (1H, s, C_{14}-H).

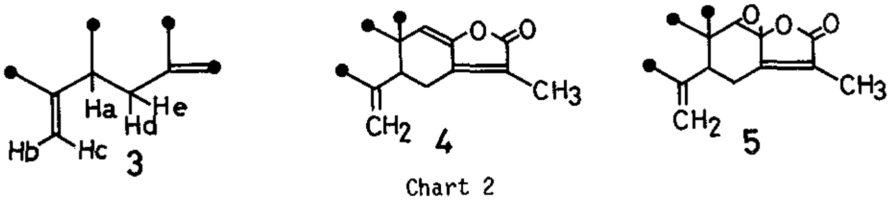
The physicochemical properties of I and II, and the transformation to the hydroxyketo derivative (VI) from I are reminiscent of eremolactone[2] and the presence of the partial structure 1 in chloranthalactone A (I), so far, has been clarified chemically, too.



● denotes carbon

Chart 1

A partial structure 3 was suggested from the experiments of double and triple irradiation in the PMR spectrum of chloranthalactone B (II). A multiplet centered at 3.36 ppm assigned to an allylic proton (Ha) was recognized to collapse to a sharp quartet upon irradiation at the pair of the multiplets at 4.69 and 5.01 ppm due to two vinyl protons (Hb and Hc) of an exocyclic methylene group. Reversely the latter signals were collapsed to a pair of sharp singlets on irradiation at the signal due to Ha. The irradiation on the signal of Ha converted a pair of multiplets (Hd and He) at 2.25 and 2.59 ppm into a pair of broadened doublets. The last signals show the coupling constant of 16 Hz, suggesting the geminal coupling of two hydrogens (Hd and He).



3 4 5

Chart 2

The PMR spectrum of the compound (IV) showed a disappearance of a signal due to Ha in the partial structure 3 and a coupling between a methyl group on the α-position of an α,β,γ,δ-unsaturated γ-lactone system and a hydrogen of an allylic methylene group, suggesting an expansion of the partial structure 1, 2 and 3 to 4 *in* I *and* 5 *in* II.

Treatment of the lactol (III) with traces of *p*-toluenesulfonic acid in refluxing benzene yielded an isomer (VII), subl. 213°/760 mmHg, $C_{15}H_{18}O_3$, mass spectrum: *m/e* 246(46%,M^+), 231(23%,M^+-CH_3), 228(62%,M^+-H_2O), 213 (100%), 185(69%). The PMR spectrum(Py-d_5) showed a singlet at 1.68 ppm due to a methyl group on a double bond in the place of the paired signals of an exocyclic methylene group and an allylic proton in those of the compounds I - III, showing an isomerization of a double bond from the 1,1-disubstituted to the tetrasubstituted. Further, the PMR spectrum of VII showed a quartet at 0.29 ppm

(1H, J=4, 4, 4 Hz) and a sextet at 0.67 ppm (1H, J=4, 8, 8 Hz), indicating the presence of an 1, 2-disubstituted cyclopropane ring in VII. Because no sign of a new construction of a cyclopropane ring in the course of the reaction from I to VII was found, it is thought that I and III should have a cyclopropane ring, in spite of no signals at high field in the PMR spectra.

Chloranthalactone A (I) and B (II) have a tertiary methyl group, as shown in the PMR spectra. The partial structure 4, an 1, 2-disubstituted cyclopropane ring and a tertiary methyl group consume all atoms of chloranthalactone A, $C_{15}H_{16}O_2$, and on building the structure with them, a formula I was proposed for I. On the basis of the physicochemical properties and the reaction conditions, the structure II was proposed for chloranthalactone B (II) and the structures III - VII were proposed for the reaction products, as shown in Chart 3.

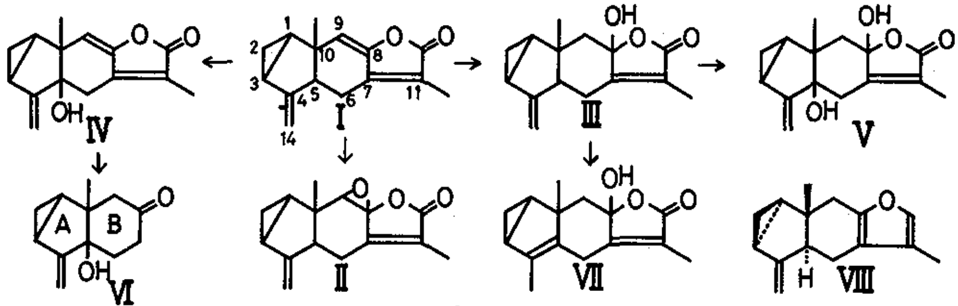


Chart 3

The structure I corresponds to that of an autoxidation product of lindenene (VIII), which is unstable and no derivatives of which were prepared,[3] on excluding the stereochemistry. Every signal of the ^{13}CMR spectrum of chloranthalactone B (II), was assigned reasonably to each carbon in the structure II, as shown in Chart 4, under reference of the data on the derivatives of lindenenol.[4] Evidences for the stereostructural elucidation of I, II and their derivatives are still sought. A correlation between the basic

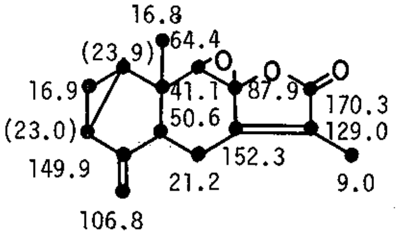


Chart 4

skeleton of I - VII and that of lindenene (VIII) is under investigation.

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