Communications to the Editor

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Studies on Digitalis Glycosides
Structure of Purpnigenin and Purprogenin

In addition to the previously reported purpnin,$^{1)}$ $C_{39}H_{62}O_{13}$, m.p. 282~287°, a new digitanol glycoside, purpronin, $C_{39}H_{60}O_{14}$, m.p. 278~281°, was isolated from the leaves of *Digitalis purpurea* L.

On hydrolysis with acid, purpnin had given, as previously reported,$^{1)}$ an aglycone, purpnigenin (I), $C_{21}H_{32}O_4$, m.p. 239~243°, $[\alpha]_D^{16}$ +21.1° (UV λ_{max}^{EtOH} 279 mμ (log ε 1.79), IR λ_{max}^{Nujol} μ : 2.81, 5.96, 7.32), and 3 moles of *d*-digitoxose, and purpronin gave an aglycone, purprogenin (II), $C_{21}H_{30}O_5$, m.p. 249~252°, $[\alpha]_D^{27}$ +80.0° (UV λ_{max}^{EtOH} 278 mμ (log ε 1.75); IR λ_{max}^{Nujol} μ : 2.98, 5.84, 5.92, 7.40), and 3 moles of *d*-digitoxose. The results of studies on the structure of purpnigenin and purprogenin are herein described.

As purpnigenin and purprogenin show a positive Liebermann reaction, and contain 21 carbon atoms and 3 C-CH_3 groups in their molecules, they seemed to be steroidal aglycones of the digitanol type. While the Oppenauer oxidation of these aglycones afforded Δ^4-3-keto derivatives, they gave negative Rosenheim test. They appeared consequently to contain a Δ^5-3-hydroxy group.

Purpnigenin and purprogenin gave the respective diacetates, m.p. 150~153° and 187~190°, which still showed a hydroxyl band in their infrared spectra. Purpnigenin gave a monoxime, m.p. 276~279°, and purprogenin gave a dioxime, m.p. 247~249°, both of which did not show any carbonyl band in their infrared spectra. From these results it was concluded that purpnigenin contains in addition to one carbonyl group, two acetylable and one non-acetylable hydroxyl groups, and purprogenin contains an additional carbonyl group, along with these groups. Thus the functions of oxygens in these aglycones were clarified.

Wolff-Kishner Reduction of purpnigenin gave monodeoxopurpnigenin (III), $C_{21}H_{34}O_3$, m.p. 216~219°, which was identical in all respects with dideoxopurprogenin obtained similarly by the Wolff-Kishner reduction of purprogenin. These results indicated that purprogenin has the same structure as purpnigenin except for an additional carbonyl group.

Purpnigenin and purprogenin appeared to contain a methyl ketone as the side-chain attached to C-17, since they exhibited absorption bands at 5.96 and 7.32 μ, and at 5.92 and 7.40 μ, respectively, in their infrared spectra. In accordance with this, deoxo derivatives of both aglycones gave propionic acid on oxidation with chromium trioxide-sulfuric acid by the Kuhn-Roth method.$^{2)}$

On the basis of ultraviolet and infrared spectra, the formation of dioxime, and failure of the α-ketol reaction, site of the additional carbonyl group in purprogenin was assumed to be at 1 or 12-position.

While purpnigenin and purprogenin consumed one mole of periodic acid, they gave no α-ketol reaction. These aglycones, therefore, seem to contain an α-glycol group.

The Δ^4-3-keto derivative (IV), $C_{21}H_{30}O_4$, m.p. 203~205° (UV λ_{max}^{EtOH} 241 mμ (log ε 4.20); IR $\lambda_{max}^{CHCl_3}$ μ : 2.94, 5.91, 6.01, 6.20), prepared by the Oppenauer oxidation of purpnigenin, was oxidized with chromium trioxide-acetic acid to give the product (V), $C_{21}H_{28}O_4$, m.p.

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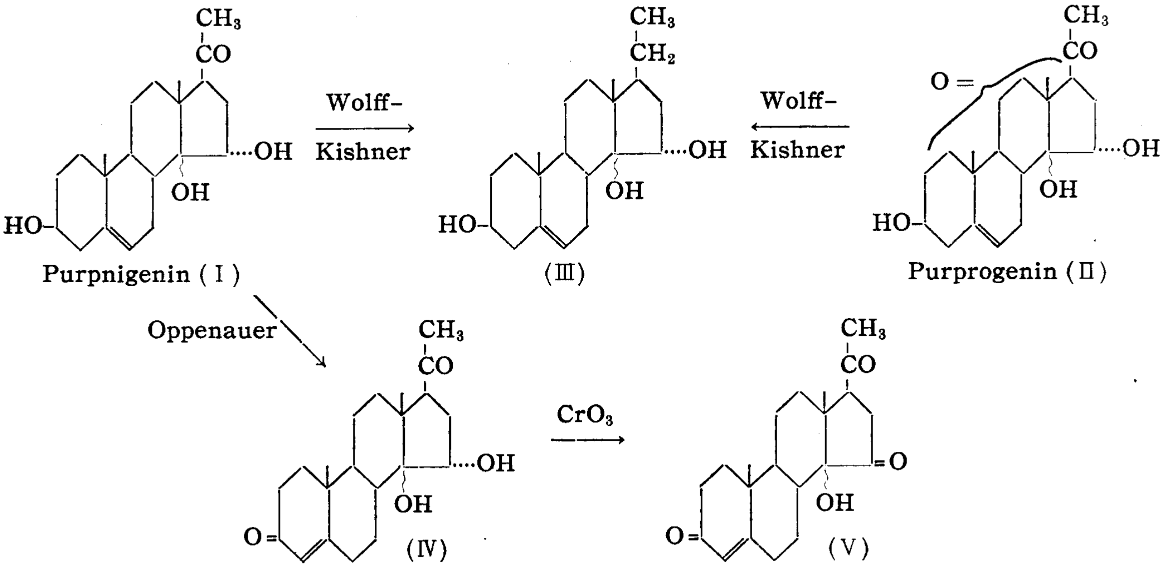
1) D. Satoh, H. Ishii, Y. Oyama, T. Okumura : Yakugaku Zasshi, **75**, 1025, 1573(1955). As a result of later studies, the molecular formula of purpnin should be corrected to $C_{39}H_{62}O_{13}$ in place of previously reported formula of $C_{51}H_{82}O_{19}$.

2) F. Percheron, R. Goutarel : Bull. soc. chim. France, **1957**, 1198.

232~235°, $[\alpha]_D^{21}$ +117.8°(UV λ_{max}^{EtOH} 241 mμ (log ε 4.16); IR $\lambda_{max}^{CHCl_3}$ μ: 3.01, 5.72, 5.90, 6.01, 6.18), which contained a five-membered ring ketone. Since its ultraviolet spectrum and color reaction precluded the presence of a β-diketone, it was highly probable that the newly produced ketone occupies the 15-position, and both purpnigenin and purprogenin contain a 14,15-glycol group. Orientation of the 15-hydroxyl group was inferred to be α, in view of the acetate formation, but that of the 14-hydroxyl group is still to be clarified.

From these results it seems to be appropriate to assign tentative formulae (I) and (II), respectively, to purpnigenin and purprogenin.



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Synthesis of *rac*-Tetrahydrorotundine

The writers have been engaged in the synthesis of rotundine, a main alkaloid of *Stephania rotunda* LOUREIRO, to which the structure of 2-methyl-3,9,10-trimethoxy-6,7-dihydro-11b*H*-benzo[*a*]quinolizine (I) had been forwarded by H. Kondo and Matsuno.[1] Sugasawa and Mizukami[2] recently synthesized *rac*-dihydrorotundine. The corresponding 1,2,3,4-tetrahydro derivative (IX) appeared to be a suitable intermediate for this synthesis, in which case partial dehydrogenation of 1,2,3,4-positions would be possible.

Various procedures for this synthesis were examined and the ring-closure of N-substituted pyridone was tried but only the N-substituted 2-chloropyridinium salt, which

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1) H. Kondo, T. Matsuno: Yakugaku Zasshi, **64A**, 28(1944); **64B**, 113, 274(1944).
2) S. Sugasawa, K. Mizukami: This Bulletin, **6**, 539(1958). cf. K. Mizukami: *Ibid.*, **6**, 312(1958).