Tetrahedron Letters No.22, pp. 1765-1766, 1969. Pergamon Press. Printed in Great Britain.

BITTER PRINCIPLES OF PHYSALIS ALKEKENGI VAR FRANCHETI : STRUCTURE OF PHYSALIN B

T. Matsuura and M. Kawai

Department of Synthetic Chemistry, Faculty of Engineering, Kyoto University, Kyoto, Japan

(Received in Japan 20 March 1969; received in UK for publication 31 March 1969)

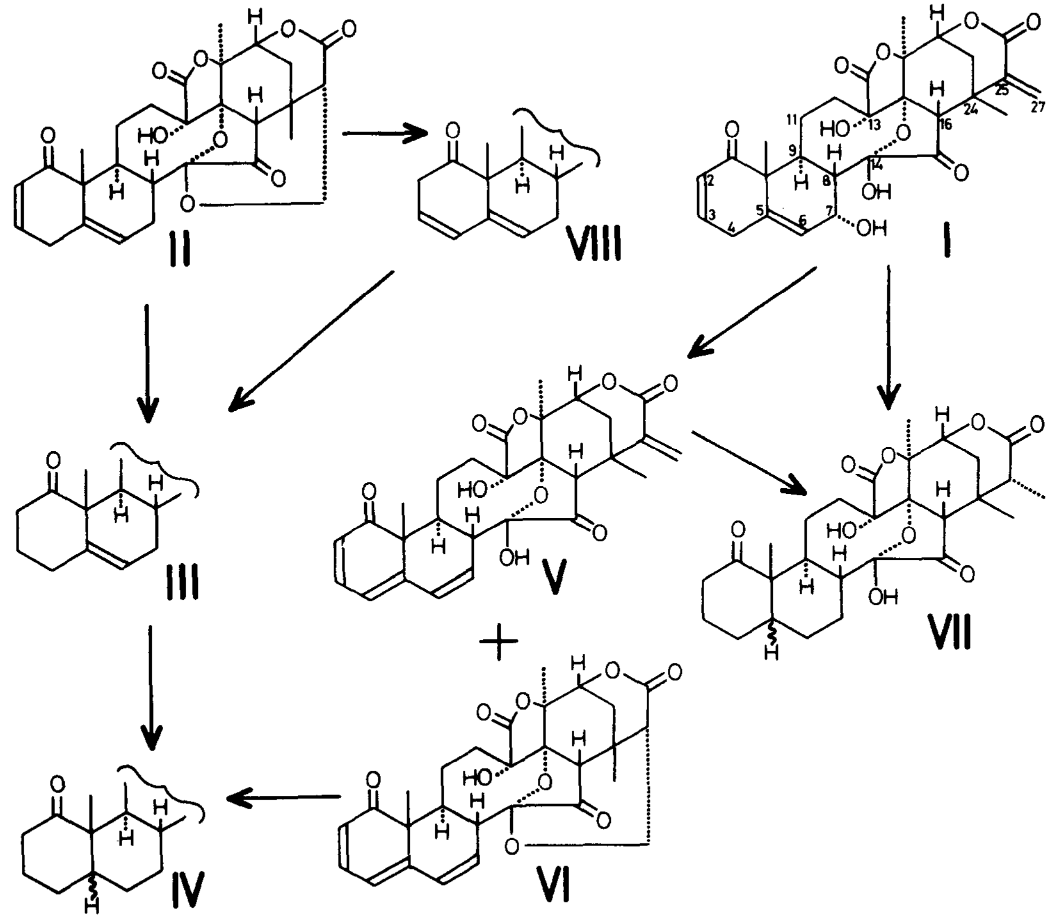
The bitter principles of Physalis Alkekengi var Francheti (Japanese name; Hôzuki), physalin A and physalin B, were isolated and the novel 13,14-seco-16,24-cyclo-C28-steroidal structure (I) was proposed for physalin A.$^{1)}$ In this communication the structure of physalin B is concluded interrelating it to physalin A.

Physalin B ($C_{28}H_{30}O_9 \cdot CH_3COCH_3$, mp. 250°; $C_{28}H_{30}O_9 \cdot CH_3OH$, mp. 271°) (II) exhibited following spectrochemical properties. MS: m/e = 510 (M+); UV: λ_{max} = 222 mμ, ε = 10,000 (α,β-unsaturated carbonyl); IR: 3400 cm^{-1}(OH), 1780, 1758, 1740 cm^{-1} (γ-lactone, five-membered ring ketone, δ-lactone), 1655 cm^{-1}(cyclohexenone); NMR$^{2)}$: δ 6.88 dt(J=10 and 3 cps) and δ 5.80d(J=10) $(\text{-CH}_2\text{-C}\underline{\text{H}}\text{=C}\underline{\text{H}}\text{-}\overset{|}{\text{C}}\text{=O})$, δ 6.26s (tert-OH), δ 5.62m $(\text{-CH=}\overset{|}{\text{C}}\text{-})$, δ 4.57m $(\text{H}\overset{|}{\underset{|}{\text{C}}}\text{-O-})$, δ 4.28dd (J=13 and 4) and δ 3.60d(J=13) $(\text{-}\overset{|}{\text{C}}\text{H-C}\underline{\text{H}}_2\text{-O-})$, δ 1.81(3H)s (tert-$CH_3$), δ 1.19(3H)s (tert-$CH_3$), δ 1.12 (3H)s (tert-$CH_3$). On catalytic hydrogenation physalin B (II) yielded dihydrophysalin B ($C_{28}H_{32}O_9$; mp. > 300°) (III) and tetrahydrophysalin B ($C_{28}H_{34}O_9$; mp. > 300°) (IV). The NMR-spectrum of III showed no peak corresponding to α- and β-protons of conjugated enone but only one olefinic proton (δ 5.56m), and no olefinic proton was observed in the NMR-spectrum of IV.

On the other hand, physalin A ($C_{28}H_{30}O_{10}$) (I) was treated with acid affording two yellow amorphous substances [V ($C_{28}H_{28}O_9$) R_f= 0.4 and VI ($C_{28}H_{28}O_9$) R_f= 0.6 on SiO_2-TLC ($CHCl_3$: CH_3COCH_3 = 9:1)]. The NMR-spectrum of V showed peaks corresponding to seven olefinic protons [δ 6.04d(J=6), δ 7.03dd(J=10 and 6) and δ 5.83d(J=10) $(\text{-}\overset{|}{\text{C}}\text{=CH-CH=CH-}\overset{|}{\text{C}}\text{=O})$; δ 6.43 and δ 5.60 $(\text{H}_2\text{C=}\overset{|}{\text{C}}\text{-C=O})$: δ 6.30(2H)]. The UV-absorption of V (λ_{max}= 320 mμ; ε = 6,500) suggested that I had been dehydrated on acid treatment resulting in the formation of a conjugated trienone system. Compound V was hydrogenated to give an octahydro-derivative, deoxyhexahydrophysalin A ($C_{28}H_{36}O_9$; mp.> 300°) (VII), which could be obtained directly by the hydrogenation of I.

The UV-spectrum of VI (λ_{max}= 328 mμ; ε = 5,000) indicated the presence of a conjugated system similar to that of V. In the NMR-spectrum of VI peaks assigned to five olefinic protons of the conjugated trienone system [δ 6.08d(J=6), δ 7.03dd(J=9 and 6) and δ 5.87d(J=9) $(\text{-}\overset{|}{\text{C}}\text{=CH-CH=CH-}\overset{|}{\text{C}}\text{=O})$ and δ 6.30(2H)m (-CH=CH-)] were observed but no peaks corresponding to terminal methylene group. The absence of terminal methylene in VI suggested that addition of the C_{14}-OH to the C_{25}-C_{27} double bond had occurred making an ether bridge, the presence of which was supported by the NMR-spectrum of VI [δ 4.38dd(J=13 and 4) and δ 3.67d(J=13) $(\text{-}\overset{|}{\text{C}}\text{H-C}\underline{\text{H}}_2\text{-O-})$]. Inspection of the stereomodel of I indicated that the addition is sterically favorable. Catalytic hydrogenation of VI yielded a hexahydro-derivative, which was identical with tetrahydrophysalin B (IV). Thus the structure of IV has been established.

In order to complete the structure of physalin B (II) the positions of two double bonds must be determined. One of them is obviously located at C_2-C_3. The position of the other double bond, which is trisubstituted and not conjugated, must be C_5-C_6, C_7-C_8 or C_9-C_{11}. On acid treatment II was isomerized to a diene compound (VIII), the UV-absorption of which showed a maximum at $\lambda = 228$ mμ ($\varepsilon = 11{,}500$). The chemical shifts of three olefinic protons (δ 6.02(1H)m and δ 5.72(2H)m) of VIII indicated that the α,β-unsaturated carbonyl system of II was no more retained in VIII. It may be reasonable to assume that the trisubstituted double bond in II is located at C_5-C_6 and that on acid treatment the C_2-C_3 double bond is migrated to C_3-C_4 position constituting a conjugated diene system in VIII. The assumption is supported by the formation of dihydrophysalin B (III), the double bond of which must be located at the same position as in physalin B (II), on the catalytic hydrogenation of VIII.



REFERENCES

1) T. Matsuura, M. Kawai, R. Nakashima and Y. Butsugan; Tetrahedron Letters, No. 14 (1969).

2) All the NMR-spectra in this communication were mesured in DMSO-d_6.