Experientia-24-1968-2009 24

Separatum EXPERIENTIA *24*, 109 (1968)
Birkhäuser Verlag, Basel (Schweiz)

The Chemistry of Thespesin[1]

Thespesin[2], a yellow crystalline compound, m.p. 196 to 197 °C, $[\alpha]_D$ + 457 ° (benzene), isolated from the fruit of *Thespesia populens* Soland, has now been assigned the molecular formula $C_{30}H_{30}O_8$ on the basis of its mass spectrum (M^+ 518).

Three interesting features of the chemistry of thespesin are the presence of potential aldehyde functions in the molecule, the apparent symmetry of the molecule, and its strong dextrorotation. The IR-spectrum of thespesin is devoid of any C=O absorption between 1625 and 1800 cm^{-1}, but thespesin readily forms a dioxime m.p. 320 °C, a dianilino derivative m.p. 305 °C and a di-2,4-dinitrophenyl hydrazone m.p. 215–220 °C. On methylation in acetone with dimethyl sulphate in the presence of potassium carbonate, a colourless hexamethyl ether $C_{36}H_{42}O_8$ (M^+ 602), m.p. 242–244 °C, $[\alpha]_D$ + 177 ° (chloroform) is formed. This compound has a discernible aldehyde carbonyl function (ν_{max}^{KBr} 1690 cm^{-1}) and forms the expected dioxime m.p. 200–204 °C and a diphenyl hydrazone m.p. 266–268 °C. These observations can be explained if the thespesin molecule has 2 hemiacetyl functions.

The apparent symmetry of the thespesin molecule is indicated by the uniqueness of the NMR-spectrum of

---

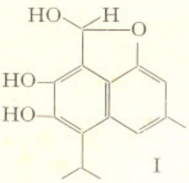
[1] Communication No. 1225 from the Central Drug Research Institute.

[2] S. N. SRIVASTAVA, D. S. BHAKUNI and V. N. SHARMA, Indian J. Chem. *1*, 451 (1963).

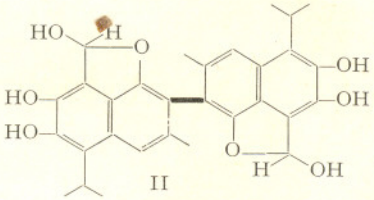
thespesin and more particularly those of its derivatives. These spectra are sharply defined and the proton count of any peak can be halved. The NMR-spectrum of thespesin, determined in carbon tetrachloride, has a doublet at 8.60 τ (12H) and a singlet at 7.92 τ (6H) indicating the presence of 2 isopropyl groups (supported by $\nu_{max}^{CHCl_3}$ 1375, 1360, 1170 and 1128 cm^{-1}) and 2 aromatic methyl groups respectively. Other features are 3 singlets for hydroxylic protons at 4.10 τ (2H), 2.8 τ (2H) and -4.4 τ (2H), an aromatic proton singlet at 2.42 τ (2H) and a benzylic proton multiplet centred at 6.25 τ (2H). Its IR-spectrum indicates the presence of bonded and non-bonded phenolic hydroxyls in the molecule ($\nu_{max}^{CHCl_3}$ 3350, 3300, 3500 and 1195 cm^{-1}) and its aromatic nature ($\nu_{max}^{CHCl_3}$ 3040, 1621, 1600 and 1575 cm^{-1}). The NMR-spectrum of thespesin hexamethyl ether in carbon tetrachloride has a doublet for 2 isopropyl groups (8.52 τ), a singlet for 2 aromatic methyl groups (7.88 τ), a singlet for 2 aromatic protons (2.30 τ) and a multiplet for 2 benzylic protons centred at 6.25 τ. The protons of the 6 methoxyl groups appear as 3 singlets at 6.12 τ (6H), 6.20 τ (6H) and a highly shielded 6.88 τ (6H). Hexaacetyl thespesin, $C_{42}H_{42}O_{14}$ (M^+ 770), m.p. 186–188 °C, $[\alpha]_D$ + 328° (benzene), prepared by treatment of thespesin with acetic anhydride-sodium acetate, had a similar NMR-spectrum but its IR-spectrum had no aldehyde C=O absorption.

The molecular ion peak (M^+ 518) in the mass spectrum of thespesin is weak. The cracking pattern is characterized by the loss of 2 molecules of water, $-H_2O$ (m/e 500) and $-2H_2O$ (m/e 482, base peak) and the subsequent loss of other functional groups: $-CH_3$ (m/e 467), $-C=O$ (m/e 454), $-CHO$ (m/e 453), $-(CH_3 + C=O)$ (m/e [illegible]), $-CH(CH_3)_2$ (m/e 439) and $-CH_3-\overset{+}{C}H=CH_2$ (m/e 441). The other feature of this spectrum is the abundance of doubly charged ions m/e 241 downwards, and is good evidence for the aromatic nature of thespesin and the dimeric nature of the molecule. The mass spectrum of hexaacetyl thespesin shows similar fragmentation but the base peak in the mass spectrum of hexamethyl thespesin is the molecular ion peak (M^+ 602).

On the basis of the above data, thespesin is a 1,1′ or a 2,2′ dimer of the sesquiterpenoid naphthalene I. Gossypol[3], the well-known pigment from cotton seed, has the structure II but is optically inactive and so far has only been isolated from Gossypium species. The UV-spectrum of thespesin and gossypol (λ_{max}^{EtOH} 236 nm (77,300), 280 nm (shoulder), 289 nm (30,740) and 373 nm (16,800)) were determined under identical conditions and found to be superimposable as were also their IR-spectra. The UV-spectra of 1,1′ and 2,2′ binaphthalenes are distinguishable[4] (extension of transverse and longitudinal polarized bands respectively). Thespesin must therefore be an optically active (+)-isomer of gossypol, now encountered for the first time.



I



II

Treatment of thespesin with acid does not alter its optical rotation. It would therefore appear that the asymmetric hemiacetyl carbon atoms make no contribution and that the optical activity of thespesin is due to restricted rotation of the 2 naphthalene units about the interlinking C–C bond (atropisomerism). Atropisomerism has recently been observed in (−)-isodiospyrin[5], a binaphthaquinone isolated from *Diospyros chloroxylon*[6].

Zusammenfassung. Thespesin, der optisch aktive gelbe Farbstoff aus den Früchten der *Thespesia populens* Soland hat eine dimere sesquiterpene-naphthalene Struktur, die mit dem optischen inaktiven Baumwollsamen-Farbstoff Gossypol identisch ist. Die optische Aktivität des Thespesin ist bedingt durch Atropisomerie.

D. S. BHAKUNI, M. M. DHAR
and V. N. SHARMA

Central Drug Research Institute and National Botanical Gardens, Lucknow (India), 26 October 1967.

---

[3] R. ADAMS, T. A. GEISSMAN and J. D. EDWARDS, Chem. Rev. *60*, 555 (1960).

[4] H. H. JAFFE and M. ORCHIN, *Theory and Application of Ultra-Violet Spectroscopy* (John Wiley & Sons, New York 1962), p. 302.

[5] G. S. SIDHU and K. K. PRASAD, Tetrahedron Lett. 2905 (1967).

[6] We thank Dr. R. S. KAPIL for mass and NMR-spectra and valuable suggestions.