The Stereochemistry of the Furanoditerpenoids α-, β-, and δ-Caesalpin

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Summary Under the conditions of the Serini reaction the benzofuran (4) derived from α-caesalpin rearranges to the diketone (5) with a *cis*-A,B ring-junction, while on mild base treatment the benzofuran mesylate (11) from δ-caesalpin undergoes a pinacol-type rearrangement to the hemiacetal (12); consideration of the steric course of these reactions, in conjunction with other evidence, allows the assignment of the relative stereochemistry of α-, β-, and δ-caesalpins as in (1), (2), and (3), respectively.

The constitutions of α-, β-, and δ-caesalpins have already been established.[1] The following evidence supports the relative stereochemistry as shown in (1), (2), and (3), respectively, for these compounds.

Mild acid treatment of α-caesalpin afforded the benzofuran (4)[2] in which the 6-acetate is equatorial [6-H, δ 5·67 ($J_{AX} + J_{BX} = 16$ Hz)]. On sublimation from zinc dust under vacuum (Serini reaction)[3] (4) was smoothly converted into the diketone (5) [ν_{max} 1723 cm^{-1} (CCl_4)], whose n.m.r.

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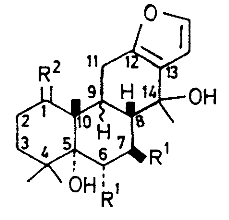
spectrum showed a singlet (2H) at δ 3·64 due to the C-7 methylene protons. The mass spectrum of (5) has a base peak at m/e 213 (6) which could arise by a McLafferty rearrangement followed by C-1, C-10 cleavage. The diketone (5) underwent spontaneous oxidation to the yellow triketone (7) [ν_{max} 1739, 1729, and 1695 cm^{-1} (CCl$_4$)] which has lost the n.m.r. singlet for the 7-methylene protons and which, like xanthoperol,[4,5] does not enolise. Reduction of (5) with LiAlH$_4$ yielded the ketol (8) whose n.m.r. spectrum showed a singlet (3H) at δ 0·34 due to the 4α-CH$_3$ which has penetrated the diamagnetic shielding zone of the aromatic ring. This is only possible if the AB ring junction in (5) and its derivatives is *cis*.[5,6] The corresponding keto-acetate (9) was obtained directly from the benzofuran (10) by sublimation from zinc dust.

The benzofuran (10) was converted by alkaline hydrolysis, or LiAlH$_4$ reduction followed by mesylation, into the monomesylate (11) [6-H, δ 5·36, q ($J_{AX} + J_{BX}$ = 17 Hz)] which underwent a ready pinacol-type rearrangement in mild base to a ketone which was isolated as the hemiacetal (12). Reduction with LiAlH$_4$, followed by acetylation, transformed (12) into the diacetate (13) [1-H, δ 5·30, q (J 7·3 Hz); 5-H, δ 5·00, d (J 3 Hz)].

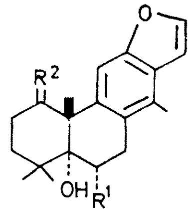
The rationalisation of these results in terms of the relative configurations at C-5, C-6, and C-10 shown in (1), (2), and (3) is unexceptionable. In addition, these results required us to reconsider the epoxide structure (14) previously assigned[1] to a product of the Serini reaction on 14-dehydro-δ-caesalpin 6,7-diacetate. This is best represented by (15) and must arise by a rearrangement analoguous to the formation of the acetal (12) from mesylate (11). Support for the structure (15) follows from LiAlH$_4$ reduction to a tri-secondary alcohol which does not consume sodium periodate and from the isolation, in low yield, of the rearranged ketone (16) from the Serini reaction on the benzofuran (10) (*vide supra*).

The configuration at C-1 in δ-caesalpin (3) has already been established[1] by the formation of a cyclic phosphate with the tertiary alcohol at C-5. The large coupling constants (10 Hz) between 6-H and 7-H and between 7-H and 8-H of the 6-acetate of β- (2) and δ-caesalpin (3) are in agreement with the assigned configuration for C-7 and C-8.

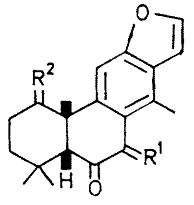
The remaining problems are the relative configurations at C-9 and C-14 in α-, β-, and δ-caesalpin and the absolute configuration. In order to resolve the latter, attempts have been made to correlate them with the ϵ-caesalpin (17) whose complete stereochemistry has been resolved by X-ray analysis.[2] These attempts have so far resulted in failure. While the deoxy-derivative (18) was obtained from ϵ-caesalpin, all efforts to remove the C-6 oxygen substituent from (4) or (10) were unsuccessful.



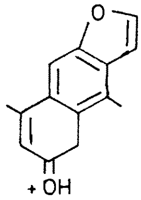
(1) R^1=OAc; R^2=O
(2) R^1=OH ; R^2=O
(3) R^1=OH ; R^2=H,α-OH



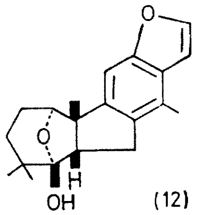
(4) R^1=OAc; R^2=O
(10) R^1=OAc; R^2=H,α-OAc
(11) R^1=OMs; R^2=H,α-OH
(18) R^1=H ; R^2=O



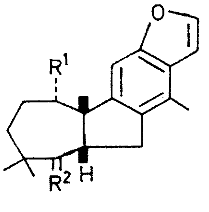
(5) R^1=H$_2$; R^2 = O
(7) R^1=R^2=O
(8) R^1=H$_2$; R^2=H,α-OH
(9) R^1=H$_2$; R^2=H,α-OAc



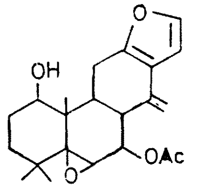
(6)



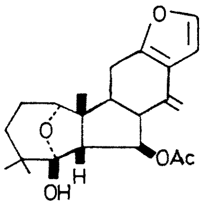
(12)



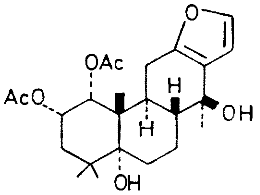
(13) R^1=H,α-OAc; R^2=H,OAc
(16) R^1=H,α-OAc; R^2=O



(14)



(15)



(17)

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