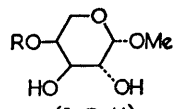
A New Synthesis of Methyl 3,4-*O*-Ethylidene-β-L-Arabinopyranoside by Reduction of an Acetoxonium Ion Salt

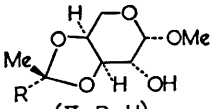
By J. G. BUCHANAN and A. R. EDGAR

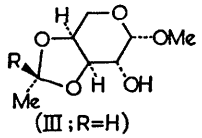
(*Department of Organic Chemistry, University of Newcastle upon Tyne*)

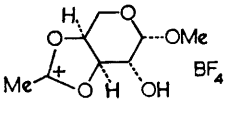
THE acid-catalysed reaction between methyl β-L-arabinopyranoside (I) and paraldehyde yields two isomeric 3,4-*O*-ethylidene compounds.[1] We have re-examined this reaction using toluene-*p*-sulphonic acid as catalyst and separated the two components by chromatography on alumina. The major component (*ca.* 90% of the mixture) was crystalline, m.p. 73—75°, and was clearly the crystalline isomer, m.p. 76°, previously isolated.[1] The minor, syrupy, component had the higher chromatographic mobility. The n.m.r. spectrum of the crystalline isomer showed a methyl doublet centred on τ 8·55, while that of the syrupy isomer had a doublet at τ 8·65, showing that the crystalline isomer has the *endo*-methyl structure (II).[2] When the syrupy isomer (III) was treated with toluene-*p*-sulphonic acid in chloroform at room temperature the isomer (II) could be isolated in 70% yield. The strong preference for the *endo*-methyl isomer at equilibrium is interesting in view of the behaviour of substituted 2-phenyl-1,3-dioxolans where comparable amounts of the *endo*- and *exo*-phenyl isomers are present at equilibrium.[3]

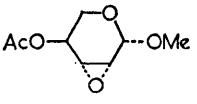
Acetoxonium ion intermediates have been proposed in the acid-catalysed ring opening of vicinal epoxides bearing a neighbouring *trans*-acetoxy-group.[4–7] We were interested in the possibility of converting salts of these acetoxonium ions into ethylidene acetals, a conversion already accomplished in the steroid series.[6]

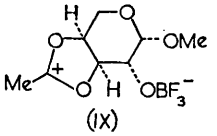

(I; R=H)
(VI; R=Ac)


(II; R=H)
(IV; R=OEt)


(III; R=H)
(V; R=OEt)


(VII)


(VIII)


(IX)

Meerwein and his colleagues[8] have obtained acetoxonium ion salts from ortho-esters by treatment with boron trifluoride or antimony pentachloride. We therefore prepared methyl 3,4-*O*-ethoxyethylidene-β-L-arabinopyranoside by ortho-ester exchange[9,10] from (I) and triethyl orthoacetate in the presence of toluene-*p*-sulphonic acid. The product was purified by chromatography on alumina and by distillation (120°/0·01 mm.) to give an analytically pure syrupy, $[\alpha]_D$ + 100·3° (pyridine). The n.m.r. spectrum showed two methyl singlets at τ 8·43 [corresponding to the *endo*-methyl group in compound (IV)] and τ 8·53 [*exo*-methyl, compound (V)].[11] The relative amounts of the two, calculated from the integrated areas was *ca.* 5 : 1. Hydrolysis with aqueous acid yielded two monoacetates,[9,10] mainly methyl 4-*O*-acetyl-β-L-arabinopyranoside (VI) identified as the ditoluene-*p*-sulphonate.[7] When the isomeric mixture of orthoesters in benzene solution was treated with boron trifluoride etherate[8,12] a gummy fluoroborate salt, presumably (VII), was precipitated immediately. Treatment of this gum with an excess of lithium borohydride in ether[6] yielded the ethylidene acetal (II), m.p. 70—73°, in 38% yield. The relative amounts of the two acetals (II) and (III) were 9 : 1 as determined by n.m.r. It is not known whether equilibration of the acetals occurred during the reaction.

When methyl 4-*O*-acetyl-2,3-anhydro-β-L-lyxopyranoside (VIII)[7] was treated in benzene solution with boron trifluoride etherate a gummy precipitate, presumably (IX), separated. Reduction of this product with lithium borohydride in ether[6] yielded the ethylidene acetal (II), m.p. 70—73°, in 37% yield, thereby confirming the participation of the acetoxy-group in the original ring opening. None of the other isomer (III) was detected by thin-layer chromatography, showing that the borohydride ion had attacked only from the less hindered *exo*-side.[11]

N.m.r. spectra were measured for carbon tetrachloride solutions on a Perkin-Elmer R.10 spectrometer operating at 60 Mc./sec.

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