

MALKANGUNIOL, ONE OF THE POLYALCOHOLS FROM CELASTRUS PANICULATUS WILLD.

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In connection with pharmacological properties ascribed to the seeds of Celastrus paniculatus Willd. (Hindi: Malkanguni), a plant mentioned in old Indian medicinal literature, the composition of the components of these seeds has been studied.

In 1938, Gunde and Hilditch¹⁾ investigated the fat of the aril-free seeds of Celastrus paniculatus and, by extraction with 80% MeOH aq., segregated it into glyceride and non glyceride fractions. From the latter fraction, these authors isolated, after saponification and acetylation of the neutral part, a resinous product which on the basis of element analysis, was considered to be the tetra-acetate of a tetrahydroxylic alcohol with an approximate composition $C_{15}H_{26}O_5$. The nature of this compound(s), however, could not be defined.

Some years ago, a more detailed investigation of this polyalcohol mixture was undertaken, independently, by two different groups, in India²⁾ and in the Netherlands³⁾. We find that several polyhydric alcohols are present and now report on the structure of one of the major constituents.

This compound, now called malkanguniol (I) is a crystalline solid, m.p. 171-172° $[\alpha]_D^{20}$ (-) 32.94° (c:2.99)⁴⁾ and analyses for $C_{15}H_{26}O_5$ (M^+ , m/e 286). The compound has no C=O (IR) or C=C bond (IR, NMR, negative tetranitromethane test) and is, thus, clearly a tricyclic polyalcohol. By D_2O exchange and total acetylation (Ac_2O , pyridine, reflux) to a tetraacetate (III), m.p. 134-135°, $[\alpha]_D^{20}$ (-) 25.0° (c:3.08); $C_{23}H_{34}O_9$, (M^+ , m/e 454; NMR, see table), it could be established that malkanguniol is a tetrol and hence the fifth oxygen must be located as cyclic ether and the carbon skeleton must be bicyclic.

On dehydrogenation with Se at 300° or dehydration with $KHSO_4$ at 180°, the compound gives β -eudalene (1-methyl-7-isopropyl-naphthalene) as the principal reaction product. Cu-dehydrogenation at 300° gives formaldehyde (detected with chromotropic acid)⁵⁾ and acetone (2,4-dinitrophenylhydrazone).

Acetylation with Ac_2O -pyridine at room temperature ($\sim 25^\circ$) for 4 hr gives a mono-hydroxytriacetate (II), m.p. 168-169°, $[\alpha]_D^{20}$ (-) 43.51° (c:3.30); $C_{21}H_{32}O_8$ (M^+ , m/e

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412); NMR, fig.1 and table. By oxidation with Jones' reagent, II can be converted into a keto-triacetate (IV), m.p. 121-122°, $[\alpha]_D^{25} (-)31.46^\circ$ (c:3.48), $C_{21}H_{30}O_8$, (M^+ m/e 410); NMR, fig.2 and table. This indicates that the remaining hydroxyl in II is secondary and must be sterically, relatively shielded.

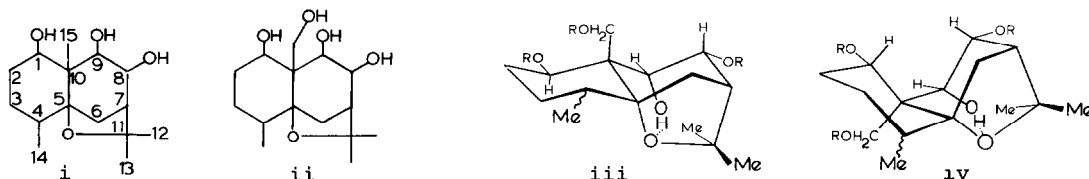
TABLE - NMR Spectral data (δ in p.p.m.)

proton	I		II		III		IV	
	δ	J(c.p.s.)	δ	J(c.p.s.)	δ	J(c.p.s.)	δ	J(c.p.s.)
C ₁ -H			5.37	J _{1,2} = 4.5 J _{1,2} = 12.0			5.46	J _{1,2} = 4.7 J _{1,2} = 12.0
C ₆ -H	1.79	J _{6,6'} = 13.0					2.33	J _{6,7} = 0 J _{6',7} = 5.0
C ₆ -H'	2.15						2.63	J _{6,6'} = 13.0
C ₇ -H			2.27	J _{7,8} = 3.3			2.38	J _{7,8} = 3.3
C ₈ -H			5.23	J _{8,9} = 5.2			5.32	
C ₉ -H			3.91	J _{9OH} = 11.8			-	-
C ₉ -OH			2.86		-	-	-	-
C ₁₂ -H ₃	1.50	s	1.60	s	1.56	s	1.60	s
C ₁₃ -H ₃	1.05	s	1.20	s	1.21	s	1.16	s
C ₁₄ -H ₃	0.94	J _{4,14} = 7.5	1.03	J _{4,14} = 7.5	1.07	J _{4,14} = 7.5	1.03	J _{4,14} = 7.5
C ₁₅ -H	3.49	J _{15,15'} = 13.0	4.22	J _{15,15'} = 12.0	4.39	J _{15,15'} = 12.5	4.36	J _{15,15'} = 12.0
C ₁₅ -H'	3.89		4.63		4.53		4.56	
C ₁₅ -OH	4.72	d,d	-	-	-	-	-	-

All spectra were taken on a Varian H-100 N.M.R. spectrometer, using T.M.S. as the internal standard and CDCl₃ as the solvent. Compound I was measured in DMSO-d₆.

From an examination of the NMR spectrum of malkanguniol (in DMSO-d₆ and pyridine-d₅, with and without D₂O) and its comparison with the NMR spectrum of its tetra-acetate, it is clear that of the four hydroxyls, one is primary and three are secondary (table). Decoupling experiments and proton exchange with compounds II and IV (see fig.1 and 2) show presence in them of the groupings A, B, C and A, B and C' respectively.

These results, taken in conjunction with the dehydrogenation data, the presence of a cyclic ether and the NMR spectral data, lead to the possible structure i, in which the primary OH may be present at either C₁₂, C₁₃, or C₁₅, as NMR evidence is not decisive in this connection. Examination of the mass spectral data, however,



provides clear support for the placement of primary OH at C₁₅ (ii) and for the agarofuran-type framework.

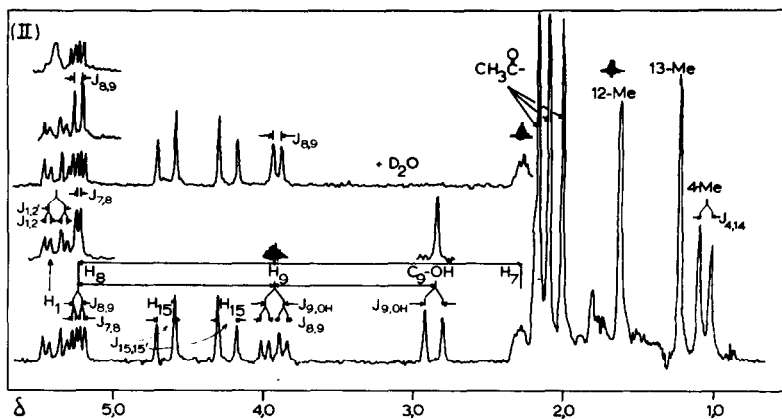
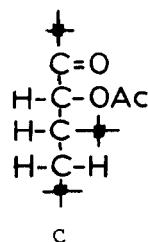
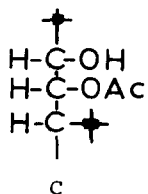
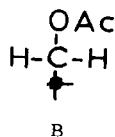
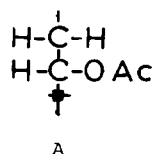


fig.1

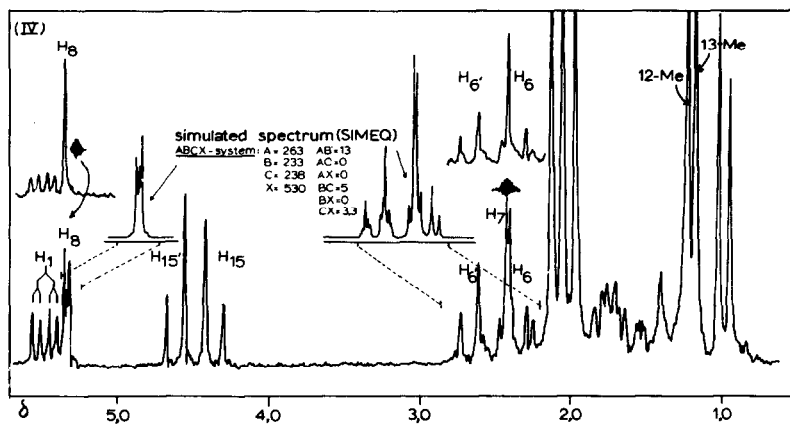
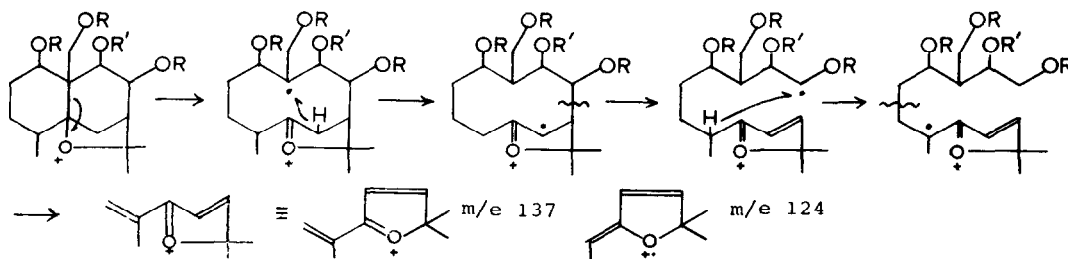


fig.2

The mass spectra of compounds I, II, III and IV, all display the same two important ions on the lower mass side, viz. m/e 137 and m/e 124 or 125 (depending on the mass spectrometer used). This means that the functionality must be located in such a way that these fragments do not carry any hydroxy or its derived function. This is readily understood in terms of structure ii, when genesis of ion m/e 137 can be readily explained as follows:



Similarly the genesis of the other ion m/e 125/124 can be explained.

From the available evidence it is not possible yet to decide in which way the rings are fused in the decalin system, as with either trans-fusion (iii) or cis-fusion (iv), the hydroxyls can be so arranged (iii, iv) as to be consistent with the observed coupling constants (table). Similarly, the configuration of C₄-methyl also remains to be elucidated.

Recently, structures of maytol, C₁₅H₂₆O₈ and deoxymaytol, C₁₅H₂₆O₇ from Maytenus ovatus⁶⁾ and, of evoninol, C₁₅H₂₄O₁₀, euonyminol and iso-euonyminol, C₁₅H₂₆O₁₀ from Euonymus sieboldiana Blume⁷⁾, alcohol components of ester alkaloids from these Celastraceae species, have been elucidated, which have been shown to be agarofuran derivatives with the two six-membered rings trans-locked.

There are a few NMR spectral features of malkanguniol which deserve a brief comment. In solvents like CCl₄ and CDCl₃ it is often difficult to observe a J_{CH-OH} coupling in alcohols, but intramolecular H-bonding is one of the reasons that enables us to observe this coupling⁸⁾ in the case of malkanguniol. It is expected that a Karplus type relationship exists in a similar way as for HC-CH-systems⁹⁾. From Dreiding models of compound II (iii or iv) it can be seen that the intramolecular hydrogen bonding between C₉-OH and the ring oxygen is possible and, this makes in the molecule a dihedral angle of nearly 180°. This is in agreement with J_{HC-OH} = 11,8 c.p.s. in compound II.

To explain the apparently anomalous absorption pattern for H₆ in compound IV the computer program SIMEQ (developed by Dr. C.F. Kort, Lab. for Org. Chemistry, the University, Amsterdam) was used. When only the frequencies of H₆, H'₆ and H₇ are very close and these nuclei are part of an ABCX-system with H₈, a very good matching is obtained with the experimental absorption patterns of the corresponding protons.

The rather high δ-value of ~1.60, for one of the Me-groups on C₁₁ in compounds I, II, and III might be explained through the deshielding effect of the C₉-OH group. This δ-value returns to a "normal" value upon oxidation of this hydroxyl group to a keto group in compound IV. A similar shift back to the "normal" value is observed for the δ of one of the Me-groups of the C₁₁-isopropoxy group upon oxidation of the C₉-OH group in linguloxidiol¹⁰⁾.

Acknowledgement:

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