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STRUCTURES OF ALBANOLS A AND B, TWO NOVEL PHENOLS FROM MORUS ALBA BARK

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Abstract : Structures for albanol A and B, isolated from Morus alba bark, have been proposed on the basis of X-ray analysis of albanol A methyl ether.

Artocarpus and Morus species, belonging to the family Moraceae, possessing a variety of novel phenolic compounds as evidenced by the chemotaxonomic studies on these two genera[1]. Recent findings that some of the phenolic constituents from the root bark of Morus species showed marked hypotensive effect in rabbit[2] prompted us to reopen our earlier investigations[3], specially on two of the complex compounds, albanol A and albanol B which were isolated a few years ago from Morus alba bark[4].

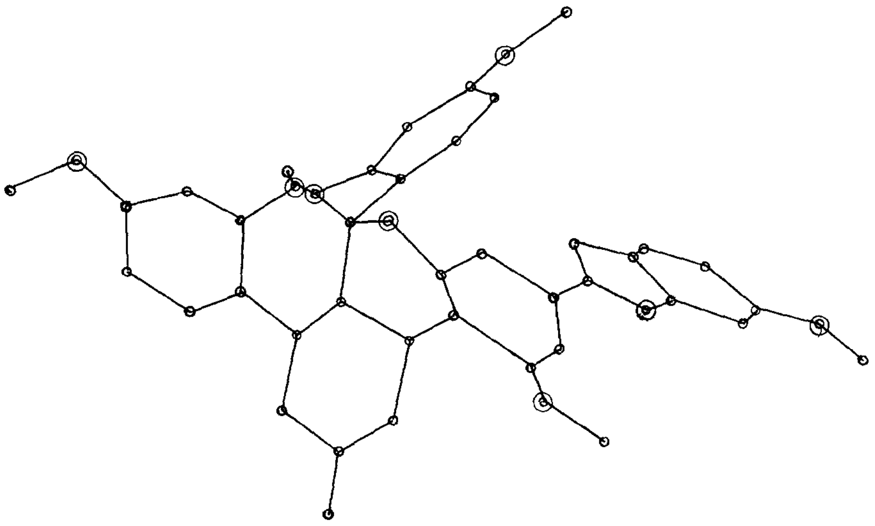
The total acetone extract of M. alba bark was successively extracted with hexane, benzene, ether and finally with acetone. The ether soluble portion was chromatographed over silica gel column and eluted with benzene-acetone mixture. The initial fractions gave mulberrochromene (morusin)[5], mulberrin (kuwanon C)[5] and mulberranol,[3d] followed by latter fractions containing two new complex phenolic compounds, albanol A and albanol B.

Albanol A was obtained as pale yellow amorphous powder, $(\alpha)_D^{25}$ + 137.17° (c=0.203 in MeOH) gave deep red colour on warming with methanolic HCl and no colouration with alcoholic $FeCl_3$. Its mass spectral molecular weight could not be obtained as the product decomposed. The UV spectrum in ethanol showed maxima : 277 and 314 nm (log ϵ 3.1 and 4.5 respectively) and the IR spectrum in nujol mull showed a strong band at 3300 cm^{-1} for phenolic OH groups and absence of carbonyl group in the molecule. ^1H NMR spectrum (acetone-d_6) suggested the presence of one vinylic Me group, five aliphatic protons (CH_2 and 3 CH-) and a number of aromatic protons in the region 6.17 to 7.37. However, methylation with dimethyl sulfate in boiling acetone in presence of anhydrous potassium carbonate gave its pentamethyl ether in colourless needles (m.p. 177-78°). High resolution mass spectral results suggested its molecular ion peak at m/e 632.243 corresponding to the molecular formula $C_{39}H_{36}O_8$. The molecular ion is the base peak and showed loss of Me and OMe groups. The loss of 137 mass units from the molecular ion (peak at m/e 495) corresponded to the loss of a dimethoxyphenyl radical.

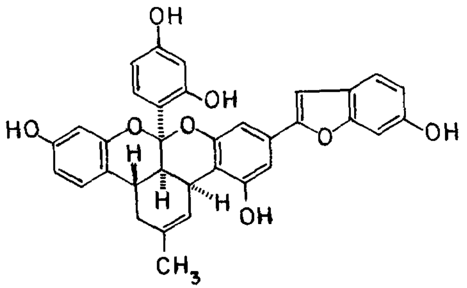
A detailed 'H NMR spectrum (220 MHz, $CDCl_3$) of albanol A methyl ether showed the following signals : 1.77 (3H, s, <u>Me</u>-C=), 2.06 to 2.64 (2H, m, CH_2-), 3.0 to 3.3 (3H, m, 3 <u>CH</u>-), 3.75, 3.76, 3.86 (correspond to 1 + 2 + 2 OMe groups respectively). In the region 6.25 to 7.42, there were absorptions corresponding to 13 protons and the splitting pattern of the aromatic protons were characteristic of all <u>Morus</u> pigments,[1a,b] which invariably showed ABX pattern of substituted resorcinol units. ^{13}C NMR spectrum of the methyl ether suggested the presence of 39 carbon atoms, corresponding to 5 OMe groups, 24 aromatic carbons (11 x H-$\overset{|}{C}$=, 8 x O-$\overset{|}{C}$= and 5 x -$\overset{|}{C}$=) and other 10 carbons of various nature (1 x CH_3, 1 x CH_2, 1 x C=CH, 3 x CH, 1 x CH=C-O, 1 x O-C-O). These data indicated that albanol A was derived from C_{15} + C_{14} + C_5 units. C_{15} could be a flavone or its precursor and C_{14} has to be a stilbene or a 2-phenylbenzofuran and one of them having a C-prenyl group, an inference based on the knowledge of other <u>Morus</u> pigments. Further, the spectral evidence showed clearly the C_5 unit in the form of an alicyclic unit.

Albanol B, yellow plates, m.p. 248° (decomp.) showed similar colour reactions as albanol A and gave the following results : The UV spectrum in ethanol showed, nm (log ϵ) 284 (4.36), 318 (4.53), 332 (4.7), 347 (4.82), 365 (4.77) indicating a higher degree of unsaturated and extended conjugation compared to albanol A. Its 'H NMR spectrum indicated the absence of OMe and aliphatic protons and the presence of one Me group on an aromatic skeleton besides a number of aromatic protons. On methylation, it formed a pentamethyl ether (colourless needles, m.p. 232-234°, M^+ 628) corresponding to the molecular formula $C_{39}H_{32}O_8$. Its 'H NMR spectrum (220 MHz, $CDCl_3$) showed the presence of 5 OMe group (singlets at 3.57, 3.73, 3.84, 3.97 and 4.00), an aromatic Me group (s, 2.50). The other 14 protons were in the region 6.98 to 8.23 and resembled that of the 'H NMR spectrum of albanol A. It was therefore concluded that albanols A and B have similar carbon skeletons with the exception that the alicyclic ring in the former has been oxidized to an aromatic ring in the latter compound.

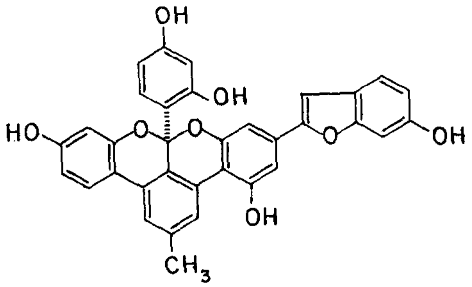
In order to determine the structures of these compounds unambiguously, an X-ray study of methyl ether of albanol A was undertaken. The crystals were orthorhombic, space group $P2_12_12_1$, a=28.337(5), b=15.961(3), c=8.188(4)Å, V=3703.3 $Å^3$, D_x=1.134 g.cm^{-3} , D_m=1.149 g. cm^{-3}, Z=4. Intensity data were collected by θ-2θ scan method on an Enraf-Nonius CAD4F-11M automatic diffractometer upto $\theta=24°$, using Mo$K_\alpha$radiation (λ = 0.7107 Å). Out of 2926 possible unique reflections, 742 were observed. The structure was solved by direct methods and refined by the isotropic full matrix least squares method[6]. The final R was 0.156. The high R is due to insufficient data as well as disorder in the structure. The appreciable differences in observed intensities for some low angle reflections



X-ray structure of 1



2



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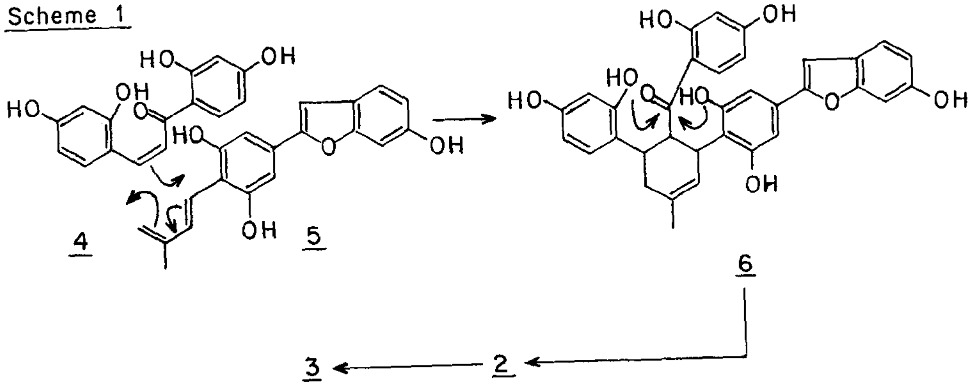
Scheme 1



for different crystals indicated disorder. The details of the X-ray crystal structure will be published elsewhere.

The structure (1) for albanol A methyl ether obtained by X-ray analysis corresponds to (2) for albanol A. All the spectral data are in perfect agreement with structure 2. The structure of albanol B can be easily derived as 3 based on the fact that the alicyclic ring in albanol A is oxidized to an aromatic ring in albanol B.

Albanols A and B are unique in many respects compared to other natural plant phenolics so far isolated. Their structures are unusual and therefore intriguing. Biogenetically albanol A is derived by a 2 + 4 cycloaddition reaction between a chalcone (4) and a C-isoprenyl-2-phenylbenzofuran (5),[7] as shown in Scheme 1, to give 6 (mulberrofuran C)[2a] which on intramolecular ketalization of the carbonyl group with the two adjoining phenolic hydroxyl groups resulted in the formation of albanol A.

References and Notes

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