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THE CONSTITUTION OF ARCHANGELIN, A NEW COUMARIN ISOLATED FROM THE ROOT OF *ANGELICA ARCHANGELICA* LINN. (UMBELLIFERAE)

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Under the research programme on Indian Medicinal Plants the chemical investigation of the root of *Angelica archangelica* L. has been undertaken. The chemical constituents of this botanical species vary with the climate and the soil (1,2).

From the root of this species collected from Kashmir, five crystalline compounds have been isolated. Three of these are furocoumarins : angelicin, $C_{11}H_6O_3$, m.p. 139° (0.2%), prangolarine (3), $C_{16}H_{14}O_5$, m.p. 104-5° (0.1%) and archangelin, $C_{21}H_{22}O_4$, m.p. 132° (0.2%). Other two are phenolic compounds designated as angelicain, $C_{17}H_{18}O_7$ (Mass number, 334), m.p. 194° (0.25%) and archangelicain, m.p. 129-30° (0.04%), the latter being a flavonoid derivative.

The present communication concerns the structure elucidation of archangelin.

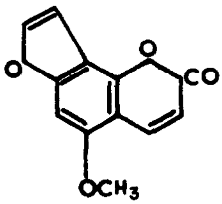
The petrol (b.p. 60-80°) extract of powdered air-dried roots of *A. archangelica* upon chromatography over deactivated alumina followed by elution with the same solvent furnished

archangelin. The Tswett column upon elution with a mixture of petrol and benzene (1:1) yielded prangolarine. Further washings of the column with benzene gave angelicin.

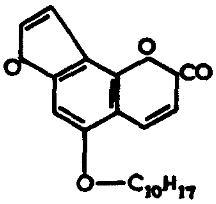
The chloroform extract of the marc on keeping in the frigidaire for two weeks deposited angelicain which crystallises from acetone in pale yellow shining plates. The alkali washings of the mother liquor followed by acidification gave crude archangelicain. It was purified by chromatography over deactivated alumina from which pure archangelicain migrated out on elution with benzene-chloroform mixture (1:1).

Archangelin, $C_{21}H_{22}O_4$, m.p. 132° (Mass number, 338), is freely soluble in ether, benzene, ethylacetate and chloroform, sparingly soluble in petrol (b.p. 60-80°), methanol, ethanol and insoluble in water. It crystallises from methanol in thick rods and is free from methoxyl, methylenedioxy and active hydrogen atoms but contains at least one $-\overset{|}{\underset{|}{C}}.CH_3$ group. Archangelin is neutral in character and a coumarin derivative as indicated from its behaviour towards 5% aqueous and alcoholic alkali. The compound shows light absorption in the ultraviolet region, $\lambda^{EtOH}_{max.}$ 222 ($\log \epsilon$, 4.38), 251 ($\log \epsilon$, 4.19) and 310 mμ ($\log \epsilon$, 4.08). The infrared spectrum of the compound reveals the presence of a conjugated lactone (5.8 μ), an ether (8.9 μ) and a benzofuran (9.3 μ). The N.M.R. spectrum of the coumarin shows pair of doublets at 2.18 and 2.75 τ which are exactly at the right positions for the α and β protons of furan. Thus, U.V., I.R., and N.M.R. spectra of archangelin suggest its benzofuran structure which has been subsequently confirmed from various chemical evidences discussed in the sequel.

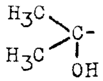
Archangelin contains an ethylenic double bond catalytic hydrogenation of which results in hydrogenolysis of the molecule giving rise to isobergaptol and another substance (having terpenaceous odour) not yet characterised. It undergoes pyrolysis when heated in high vacuum (180°/ 0.05 mm) giving rise to a volatile terpenoid compound having a -C_{10} unit and isobergaptol, $C_{11}H_6O_4$, m.p. 274-78° which also arises from the coumarin during its cleavage with acids. Isobergaptol thus obtained upon methylation with diazomethane gave isobergapten I.

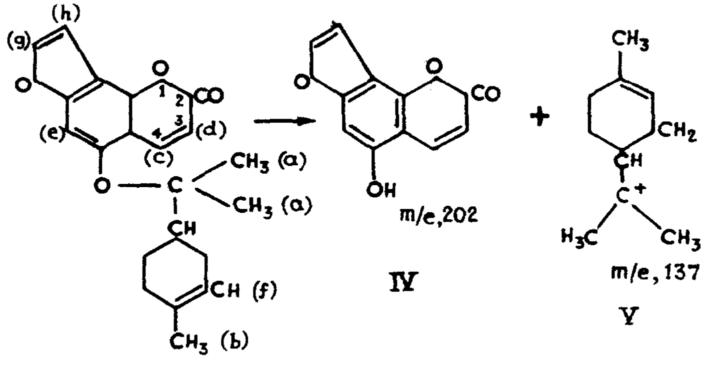


I



II

The fact that -$C_{10}H_{17}$ fragment is eliminated from the neutral archangelin during pyrolysis, hydrogenolysis as also during acid hydrolysis with the generation of the phenol, isobergaptol (which reactions are typical of prenoxycoumarins) affirms that archangelin is isobergaptol ether of a terpene alcohol II. Now, archangelin undergoes oxidation with chromic acid forming acetone (identified as its D.N.P.H., m.p. 126-27°). Taking into consideration the absence of an epoxide linkage like that in prangolarine (3) and the absence of an isopropylidene or  $(H_3C)_2C(OH)-$ groupings in the compound (as indicated from the N.M.R. spectrum), the latter must have a potential isopropyloxy group (involved in the ether linkage) III. This isopropyloxy group during chromic acid oxidation in glacial acetic acid would give rise to acetone. As regards the nature of the C_{10} fragment the possibility of its occurrence as geranyl or its isomer has been considered but ruled out from a comparison of their N.M.R. spectra and that of archangelin. The mass number of the coumarin also excludes the possibility of $-C_{10}H_{17}$ fragment as dihydro and tetrahydrogeranyl rather suggests the cyclic structure of this terpenoid fragment. These observations coupled with the mass fragmentation pattern of the coumarin and the N.M.R. spectra elaborate the structure of archangelin as III.



III

IV

V

The mass fragmentation pattern (the major peaks of which are shown above) is in accord with the structure III which fits excellently with the N.M.R. data discussed below.

The chemical shift for gem dimethyl group (a) appears as a singlet at 9.08 τ (6 protons) while methyl group (b) attached to the olefinic carbon atom gives sharp signal at 8.32 τ. The pair of doublets centred at 1.85 τ and 3.7 τ are the expected positions for the protons at C_3(d) and C_4(c) of the coumarin nucleus. The protons at (g) and (h) of furan form doublets at 2.38 τ and 2.75 τ respectively. Sharp signals for the aromatic proton (e) are discernible at 2.99 τ and at 4.35 τ for the olefinic proton (f). The multiplets in the region of 8.9 - 7.58 τ may be assigned to the pair of protons in the alicyclic portion of archangelin.

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