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TWO NEW VETISPIRANE DERIVATIVES: STRESS METABOLITES FROM POTATO (SOLANUM TUBEROSUM) TUBERS

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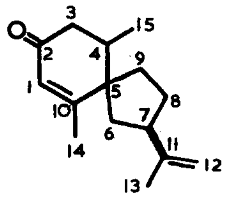
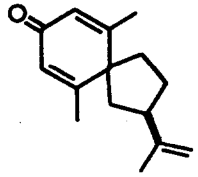
We recently reported the structure of phytuberin[1], a unique sesquiterpenoid produced by potato tubers inoculated with certain races of the late blight fungus Phytophthora infestans[2] or with the soft-rot bacterium Erwinia carotovora var atroseptica[3]. In continuing these studies of stress metabolites produced by infected potato tubers, the above laboratories simultaneously and independently isolated two new sesquiterpenes unlike either phytuberin or rishitin and we present here evidence that they are vetispirane derivatives with the formulae (I) and (II).



(I)



(II)

Spirovetiva-1(10),11-dien-2-one (I) was obtained as a major stress metabolite both from E. carotovora and P. infestans infected potato tissue. Purification was effected by preparative liquid, gas and thin layer chromatography which provided a colorless mobile oil $[\alpha]_D$ - 119° (EtOH), $C_{15}H_{22}O$ (high resolution mass spectrometry). (I) gave two isomeric (syn- and anti-) 2,4-dinitrophenylhydrazones ($M^{+\bullet}$398) with m.p.s. of 126° and 137° respectively, and a semicarbazone derivative ($M^{+\bullet}$275) m.p. 168°. Spirovetiva-1(10),3,11 -trien-2-one (II) was obtained from P. infestans infected potato tissue extracts and was purified by liquid chromatography and crystallization from pentane. (II) which had m.p. 44-44.5° and $[\alpha]_D$ + 57° (EtOH) analyzed for $C_{15}H_{20}O$ ($M^{+\cdot}$216) and gave a 2,4-dinitrophenylhydrazone ($M^{+\cdot}$396), m.p. 181°.

Spectral data indicated that (I) contained the following structural units: an $\alpha\beta$-unsaturated carbonyl function with a β-methyl substituent [λ_{max}(EtOH) 243nm, ϵ 12,900, ν_{max} (Film) 1669 and 1616cm^{-1}, δ 1.89 (3H, doublet J=1.2Hz) and 5.72 (1H, quartet J=1.2Hz)] ; an isopropenyl group [ν_{max} 3070, 1650 and 893 cm^{-1}, δ 1.71 (3H, broad singlet) and 4.71 (2H,broad)]; a secondary methyl group [δ 0.96 (3H, doublet J=6Hz)] and a methylene group adjacent to a carbonyl system [observed as the AB part of an ABX system (J_{AB} = 17Hz; J_{AX} = J_{BX} = 4.5 Hz) in the pmr spectrum of (I) measured in the presence of Eu $(fod)_3$]. The ^{13}C natural abundance nmr spectrum of (I) showed 15 distinct peaks (Table), which were provisionally assigned from an analysis of the single-frequency off-resonance decoupled spectrum and by comparison with published terpenoid spectra. In particular, the singlet signal observed at δ 50.2 could be unambiguously assigned to the spirocarbon at C-5.

Catalytic reduction of (I) produced a completely saturated (by ir and pmr) alcohol $C_{15}H_{28}O$ (HRMS), thus confirming the bicyclic structure. Oxidation of the alcohol to the corresponding ketone and subsequent deuterium exchange of four hydrogens (MeOD/Na) confirmed that there was no methyl substitution α to the carbonyl.

Spectral data on (II) indicated the presence of a cross-conjugated cyclo-hexadienone system [λ_{max} (EtOH) 247, ϵ 20,800, ν_{max} (KBr) 1666, 1620 and 1606 cm^{-1}]; an isopropenyl group [ν_{max} 3060 and 892 cm^{-1}, δ 1.80 (3H, broad singlet) and 4.79 (2H, broad)] ; two vinylic methyl groups [δ 2.05 (3H,s) and 2.09 (3H,s)] and two vinylic protons [(δ 6.04 (2H,s)] . The ^{13}C nmr assignment for (II) is given in the Table. The structure assigned to (II) corresponds to that of anhydro-β-rotunol[4] and to a recently described photoconversion product of dehydronootkatone[5]. A sample of this was found to be identical (tlc, gc, uv, ir, ms, pmr and $[\alpha]_D$) with our sample of (+)-spirovetiva-1(10), 3, 11-trien-2-one (II). Compound (II) was also prepared from (I) by dehydrogenation with 2,3-dichloro-5,6-dicyano quinone in refluxing dioxan, thereby confirming its structure as (I) and establishing its absolute configuration at C-7. Further work is in progress to determine the absolute configuration at C-4 and C-5 in (I) and this will be reported in our full publication.

TABLE

^{13}C NMR SHIFTS* OF (I) AND (II)

Carbon	I	II
1	125.4	126.0
2	198.4	186.3
3	43.1	126.0
4	39.3	164.2 or 164.4
5	50.2	52.8
6	40.9	41.4
7	46.6	49.3
8	32.7	33.5
9	34.3	36.5
10	166.1	164.4 or 164.2
11	146.8	146.1
12	108.9	109.6
13	20.8	20.7
14	21.2	21.4
15	15.9	21.4

* Measured in $CDCl_3$ solutions and expressed in p.p.m. from TMS

These vetispirane derivatives are produced in potato tuber tissue in response to both compatible and incompatible races of P. infestans. The fungitoxicity of these compounds has not been clearly defined. The evidence indicates that they are produced in naturally blighted potatoes and it will be desirable to examine them for possible toxicological and sensory properties.

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