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ALBAFURANS A AND B, GERANYL 2-PHENYLBENZOFURANS FROM MULBERRY[1)]

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The structure elucidation of two minor antifungal compounds, isolated from "intact" epidermis of mulberry shoots and designated as albafurans A and B, is described.

In connection with our continuing studies on mulberry phytoalexins, we already reported the structure of several substituted flavones[2)] named albanins A ∿ G as antifungal principles pre-existing in shoot epidermis of mulberry (Morus alba Linné). Further extensive search for antifungal compounds of the epidermis led to isolation of two minor components, named albafurans A (1) and B (2), in 0.006% and 0.0003% yields. We report herein the structure elucidation of these compounds.

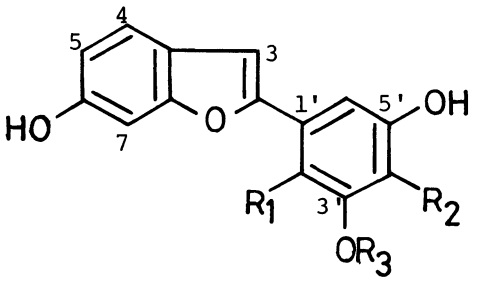
Albafuran A (1), mp 150-150.5 °C, had a molecular formula of $C_{24}H_{26}O_4$ (HR-EIMS, m/e 378.1826). The UV spectrum (EtOH) [UV_{max} 312 nm (ε 27300), 282 (sh 14200), and 214 (40300)] closely resembled that [UV_{max} 311 nm (ε 27200), 283 (sh 14600), and 217 (39300)] of moracin I[3)] (3), suggesting the presence of a 6-hydroxy-2-phenylbenzofuran skeleton. This was substantiated by the ^1H NMR spectrum (CD_3COCD_3): δ 6.78 (1H, d, J = 1 Hz, 3-H), 6.81 (1H, dd, J = 2 and 8, 5-H), 6.99 (1H, dd, J = 2 and 1, 7-H), 7.40 (1H, d, J = 8, 4-H), 6.50 and 6.75 (each 1H, d, J = 2, 4'- and 6'-H). The spectrum also revealed the presence of three hydroxyl [δ 8.35 (3H, br s)] and one alkenyl ($C_{10}H_{17}$) group. The latter was assigned a geranyl structure by comparison of the ^1H NMR spectrum with those of 2-geranyl (4) and 2-nerylresorcinols[4)] (5) (Table 1) and also by comparison of the ^{13}C NMR spectrum (CD_3SOCD_3) [δ 15.9 (q, C-4"), 17.4 (q, C-9"), 25.0 (t, C-1"), 25.4 (q, C-10"), 26.0 (t, C-6"), 39.1 (t, C-5"), 124.1 (d, C-2"), 124.2 (d, C-7"), 130.5 (s, C-8"), and 133.3 (s, C-3")] with those[5)] of geraniol and nerol derivatives. Disposition of three substituents, geranyl and two hydroxyl groups, on the phenyl ring was deduced from the following reason: (i) two aromatic protons on the phenyl ring was located meta each other, (ii) all carbon atoms adjacent to four oxygen atoms showed signals at lower field than δ 153 [δ 153.9, 154.9, 155.4, 155.6, and 156.4 (each s)], and (iii) a large peak (91%) appeared at m/e 255 attributed to a fragment ($M^+ - C_9H_{15}$).[6)] All these data indicate that albafuran A is represented favorably by formula 1.

Albafuran B (2), mp 158-158.5 °C, had the same molecular formula $C_{24}H_{26}O_4$ (HR-EIMS, m/e 378.1817) as 1, and exhibited the UV spectrum (EtOH) [UV_{max} 335 nm (ε 29000), 320 (34000), 311 (sh 24000), 298 (sh 15400), 286 (sh 13100), and 219 (27000)] superimposable over that of moracin C[7)] (6) and the mass spectrum with the

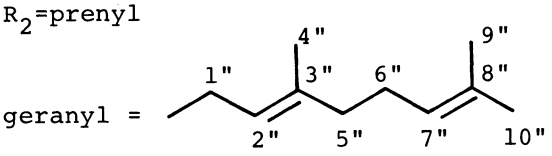
relevant characteristic peak at m/e 255 (100%). These spectra suggested that 2 would be 6-hydroxy-2-(4'-geranyl-3',5'-dihydroxyphenyl)benzofuran. The ^{1}H NMR spectrum (CD_3COCD_3) was completely consistent with this structure: Table 1 and δ 6.89 (3H, br s, 3-, 2'-, and 6'-H), 6.93 (1H, br d, J = 2 Hz, 7-H), 6.79 (1H, dd, J = 2 and 8, 5-H), 7.35 (1H, d, J = 8, 4-H), and 8.30 (3H, br s, 3-OH). Hence albafuran B is assigned correctly by formula 2.

Table 1 ^{1}H NMR spectra of alkenyl substituents of the resorcinols and albafurans

Compound	Chemical shift (δ in CD_3COCD_3)				
	1(1")	2(2")	5(5"),6(6")	7(7")	4(4"),9(9"),10(10")
2-geranylresorcinol (4)	3.35	5.29	1.98	5.07	1.54, 1.60, 1.76
2-nerylresorcinol (5)	3.36	5.28	2.19	5.20	1.61, 1.64, 1.64
albafuran A (1)	3.53	5.21	2.00	5.08	1.54, 1.60, 1.68
albafuran B (2)	3.39	5.33	2.05	5.09	1.55, 1.61, 1.79



1 R_1=geranyl, R_2=R_3=H
2 R_1=R_3=H, R_2=geranyl
3 R_1=prenyl, R_2=H, R_3=CH_3
6 R_1=R_3=H, R_2=prenyl



Albafurans A and B completely inhibit spore germination of Bipolaris leersiae at $10^{-4} \sim 10^{-5}$ M. As already mentioned, only flavanoids have been isolated from "intact" epidermis of mulberry shoots as antifungal compounds,[2] while many 2-phenylbenzofurans from infected mulberry tissues as stress compounds.[3] Since the epidermis tissues are always exposed to various stimuli in nature, the "intact" ones may contain injured tissues to some extent, which would produce the 2-phenylbenzofurans. However such stress compounds with a geranyl substituent have never been isolated yet. Hence it is noteworthy that albafurans formulated as 1 and 2 have been isolated from "intact" mulberry epidermis.

References

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