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BROUSSONINS A AND B, NEW PHYTOALEXINS FROM DISEASED PAPER MULBERRY[1)]

Mitsuo TAKASUGI,* Masaki ANETAI,* Tadashi MASAMUNE,*
Akira SHIRATA,**[2)] and Kokichi TAKAHASHI**

* Department of Chemistry, Faculty of Science, Hokkaido University, Sapporo 060

** The Sericultural Experiment Station, Yatabe-cho, Tsukuba-gun 305

Isolation and structure elucidation of two phytoalexins (1 and 2), produced by diseased paper mulberry and designated as broussonins A and B, are described. These phytoalexins are characterized structurally by a 1,3-diphenylpropane skeleton.

We recently reported isolation and structure determination of 2-phenylbenzofuran- and stilbene-type phytoalexins produced by diseased mulberry (Morus alba Linné).[3)] Continuing studies on phytoalexins of the family Moraceae led to isolation of two new antifungal compounds from another moraceous plant, paper mulberry (Broussonetia papyrifera Vent.), which are designated as broussonins A and B (1 and 2, respectively). We report herein the isolation and structure elucidation of these compounds.

Acetone extracts from cortex and phloem tissues of paper mulberry shoots, infected with Fusarium solani f. sp. mori, were fractionated by repeated chromatography over silica gel to give three antifungal compounds, 1, 2, and marmesin (3) in 0.77, 1.2, and 0.06% yields from the dried tissues, respectively. These compounds were not detected in the corresponding extracts of healthy tissues.

Broussonin A (1), $C_{16}H_{18}O_3$, mp 101-101.5 °C (from CH_2Cl_2); m/e 258.1248 (M^+); λ_{max} (EtOH) 287 nm (sh, ε 4300), 280 (5000), and 225 (17300); ν_{max} (KBr) 3380, 1625, 1515, and 829 cm^{-1}, gave its diacetate (1a) [δ ($CDCl_3$) 2.17 and 2.26 (each 3H, s)], and its dimethyl and diethyl ethers (1b and 1c). The ^1H NMR spectrum (CD_3COCD_3) of 1 revealed the presence of a methylene group flanked by two benzylic methylenes [δ 1.84 (2H, m), 2.56 and 2.59 (each 2H, t, J = 7)], one methoxyl and two phenolic hydroxyl groups [δ 3.68 (3H, s) and 8.10 (2H, br, D_2O exchangeable)] together with seven aromatic protons [δ 6.74 and 7.01 (each 2H, d, J = 8), 6.41 (1H, d, J = 2.5), 6.34 (1H, dd, J = 8 and 2.5), and 6.96 (1H, d, J = 8)]. Location of the three oxygen functions on the benzene rings was deduced as shown in formula 1 from the signal patterns of aromatic protons, MS spectral fragmentation (two tropylium ions at m/e 137 and 107), and a positive Gibbs test for 1. Oxidation of 1c ($KMnO_4$ in aq acetone, room temp) afforded two acids, mps 116.5-117.5 °C and 196-196.5 °C, which were identified as 2-ethoxy-4-methoxy-[4)] and 4-ethoxybenzoic acids, respectively, by direct comparison with authentic samples, confirming structure 1 for broussonin A.

Broussonin B (2), $C_{16}H_{18}O_3$, mp 99.5-100 °C (from $CHCl_3$); m/e 258.1273 (M^+), 137 and 107; λ_{max} (EtOH), 287 nm (sh, ε 4100), 280 (4800), and 225 (16300); ν_{max} (KBr) 3240, 1607, 1515, and 823 cm^{-1}; δ (CD_3COCD_3) 1.78 (2H, m), 2.53 (4H, t, J = 7), 3.75 (3H, s), 8.05 (2H, s, D_2O exchangeable), 6.73 and 7.01 (each 2H, d, J = 8), 6.42 (1H, d, J = 2.5), 6.34 (1H, dd, J = 8 and 2.5), and 6.90 (1H, d, J = 8), also gave its diacetate (2a) [δ ($CDCl_3$) 2.27 (6H, s)] and its dimethyl ether (2b). As suggested by the spectral data, the dimethyl ether (2b) was identical with 1b, while the Gibbs test was negative for 2. These results indicate that broussonin B is represented by structure 2.

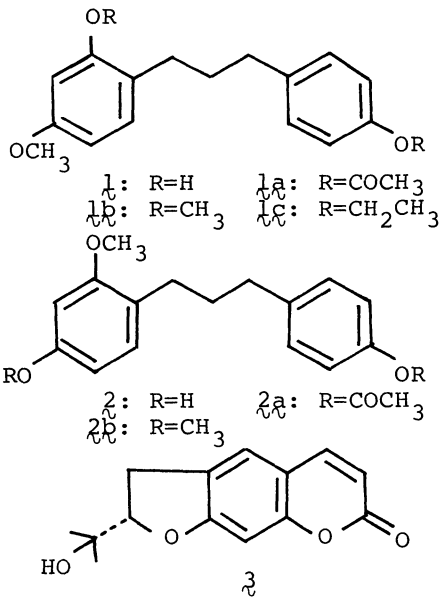
Broussonins A and B (1 and 2, respectively) constitute a new type of phytoalexins which possess a 1,3-diphenylpropane structure and which belong to the simplest flavonoids so far found in nature. Only several 1,3-diphenylpropanes have been isolated from the family Myristicaceae.[5]

The third compound, $C_{14}H_{14}O_4$, mp 186.5-187 °C, was identified as marmesin (3) by direct comparison with an authentic sample.[6] Antifungal activities of 1, 2, and 3 are given in Table 1.

Table 1 Antifungal activities of 1, 2, and 3

Fungus	1[a]	2[a]	3[a]
Fusarium roseum	2×10^{-4}	2×10^{-4}	4×10^{-3}
F. lateritium f. sp. mori	2×10^{-4}	2×10^{-4}	4×10^{-3}
F. solani f. sp. mori	9×10^{-4}	9×10^{-4}	4×10^{-3}
Diaporthe nomurai	2×10^{-4}	2×10^{-4}	4×10^{-3}
Stigmina mori	2×10^{-4}	5×10^{-5}	9×10^{-4}
Sclerotinia sclerotiorum	2×10^{-4}	2×10^{-4}	4×10^{-3}
Bipolaris leersiae	9×10^{-4}	9×10^{-4}	4×10^{-3}
Rosellinia necatrix	2×10^{-4}	2×10^{-4}	4×10^{-3}

a: Minimum concentration (M) required for complete inhibition of fungal growth.



3

References and Notes

1) Part 5 of "Studies on Phytoalexins of the Moraceae;" Part 4, M. Takasugi, S. Nagao, T. Masamune, A. Shirata, and K. Takahashi, Tetrahedron Lett., 4675 (1979).

2) Present address: National Institute of Agricultural Sciences, Yatabe-cho, Tsukuba-gun 305

3) Ref. 1 and refs cited therein.

4) K. N. Gurudutt and T. R. Seshadri, Phytochemistry, 13, 2845 (1974).

5) O. R. Gottlieb, Isr. J. Chem., 16, 45 (1977).

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