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ISOFLAVONES FROM *VIROLA CADUCIFOLIA**

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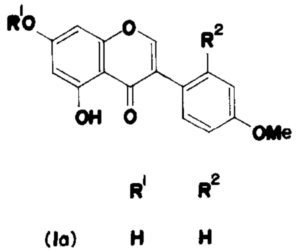
Key Word Index—*Virola caducifolia*; Myristicaceae; biochanin A; 5,7,2′-trihydroxy-4′-methoxyisoflavone; 5,7-dihydroxy-2′,4′-dimethoxyisoflavone.

Abstract—The Myristicaceae must be added to the small number of families which contain isoflavonoids; the previously unknown 5,7,2′-trihydroxy-4′-methoxyisoflavone and 5,7-dihydroxy-2′,4′-dimethoxyisoflavone having been found to co-occur with biochanin A in *Virola caducifolia* W. Rodr.

In contrast to the near ubiquitous occurrence in higher plants of other flavonoids, isoflavonoids are confined very largely to the Leguminosae. To the small list of other families in which they occasionally occur [2], the Myristicaceae must now be added. We have located isoflavones and even pterocarpans in several species [3] and are of the opinion that isoflavonoids constitute a general, rather than a sporadic, characteristic of this family.

The present report is concerned with *Virola caducifolia* W. Rodr. *n.sp.* [4], an arboreous species akin to *Virola multinervia* Ducke [5] called "ucuúba" near Manaus, Amazonas State. The benzene extract of a trunk wood sample was found to contain besides sitosterol, the typical *Virola* constituents 1-(2-hydroxy-4-methoxyphenyl)-3-(3,4-methylenedioxyphenyl)-propane (virolane) and 2-hydroxy-1-(2-hydroxy-4-methoxyphenyl)-3-(3,4-methylenedioxyphenyl)-propane (virolanol) [5–7], as well as biochanin A (**1a**) [2] and two hitherto unreported compounds $C_{15}H_6O_2(OH)_3OMe$ (**1b**) and $C_{15}H_6O_2(OH)_2(OMe)_2$(**1c**).



	R¹	R²
(1a)	H	H
(1b)	H	OH
(1c)	H	OMe
(1d)	Me	OMe

Their practically identical UV spectra suggested that both are 5,7-dihydroxy ($AlCl_3$ and NaOAc shifts) isoflavones with identical oxygenation pattern. Indeed CH_2N_2 methylation of **1b** and of **1c** gave the same partially etherified derivative, **1d**.

The presence of OH-5 (τ −2.7 ± 0.1, *s*) and of H-2 in **1b–d** (τ 2.0 ± 0.2, *s*) was evidenced by the PMR spectra. Additional features concerned the *meta* split doublets due to H-6 and H-8, partially superimposed on the signals due to H-3′ and H-5′. The substitution of ring B can, nevertheless, be diagnosed, since a one proton *ortho* split doublet (*J* 9.0 Hz) at relatively low field (τ 2.78 ± 0.02) clearly indicates the existence of H-6′ and its relation to other protons at C-3′ and 5′.

Position 2′ must, consequently, be substituted, and by an OH in **1b** [MS: M − 17 (23%), M − 31 (0%)] and an OMe in **1c** [MS: M − 17 (2%), M − 31 (24%)]. The structures of 5,7,2′-trihydroxy-4′-methoxyisoflavone (**1b**) and 5,7-dihydroxy-2′,4′-dimethoxyisoflavone (**1c**), which are indicated by these data, are further supported by appropriate retro-Diels–Alder MS peaks.

According to a recent survey [2], the oxygenation pattern of **1b** and **1c** has so far been observed only in the case of two complex isoflavones: parvisoflavones A and B [8]. No simple 5,7,2′,4′-tetraoxy-isoflavone derivative has been isolated previously. This is surprising due to the reasonable frequency of occurrence of biochanin A [2], its putative precursor.

EXPERIMENTAL

Isolation of the constituents. A specimen of *Virola caducifolia* was collected at the Ducke Forest Reserve, near Manaus, by the botanist W. A. Rodrigues. Voucher: Herbarium INPA, Manaus, 42232, compared with 27822. A sample of trunk wood (10 kg) was extd with C_6H_6. The ext (60 g) was chromatographed on a SiO_2 column, giving, in order, the following fractions with the indicated eluants: A (petrol), B (petrol–C_6H_6, 1:1), C and D (C_6H_6), E ($CHCl_3$), F (MeOH). A was composed of fatty oil. B was cryst from C_6H_6–MeOH giving virolane (1.7 g). C was sitosterol (2 g). D was recryst from $CHCl_3$ giving virolanol (63 mg). E was cryst from $CHCl_3$. The crystals were washed with MeOH to pure **1c** (1.5 g). The washings were separated by repeated SiO_2 chromatography into **1a** (120 mg) and **1b** (130 mg). The identification of virolane [5],

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virolanol [5], biochanin A [9] and sitosterol relied on direct comparison with authentic samples.

5,7,2′-*Trihydroxy*-4′-*methoxyisoflavone* (**1b**). Crystals, mp 201–203° [M^+ found: 300.0629; $C_{16}H_{12}O_6$ requires: 300.0634]. λ_{max}^{EtOH} (nm): 221, 263, 290 (log ϵ 4.26, 4.37, 4.06); $\lambda_{max}^{EtOH+NaOH}$ (nm): 235, 273, 327 (log ϵ 4.27, 4.30, 4.01); $\lambda_{max}^{EtOH+NaOAc}$ (nm): 225, 275, 336 (log ϵ 4.26, 4.35, 3.76); $\lambda_{max}^{EtOH+AlCl_3}$ (nm): 221, 275, 378 (log ϵ 4.30, 4.38, 3.08); ν_{max}^{KBr} (cm^{-1}): 3260, 1665, 1618, 1585, 1570, 1509, 1330, 1280, 1265, 1191. PMR [$(CD_3)_2CO$, τ]: −2.74 (*s*, OH-5), 1.80 (*s*, H-2), 2.77 (*d*, *J* 9.0 Hz, H-6′), ~3.44 (*d*, *J* 2.4 Hz, H-3′), ~3.42 (*dd*, *J* 9.0, 2.5 Hz, H-5′), 3.52 (*d*, *J* 2.4 Hz, H-8), 3.65 (*d*, *J* 2.4 Hz, H-6), 6.20 (*s*, OMe). MS (%): 300 (100) M^+, 299 (14), 285 (3), 283 (23), 153 (10), 152 (4), 148 (88), 133 (14). Methylation with CH_2N_2 gave **1d**.

5,7-*Dihydroxy*-2′,4′-*dimethoxyisoflavone* (**1c**), crystals, mp 222–223° [M found: 314.0792; $C_{17}H_{14}O_6$ requires: 314.0790]. λ_{max}^{EtOH} (nm): 218, 262, 322 (log ϵ 4.28, 4.36, 3.40); $\lambda_{max}^{EtOH+NaOH}$ (nm): 235, 275, 335 (log ϵ 4.28, 4.42, 4.02); $\lambda_{max}^{EtOH+NaOAc}$ (nm): 225, 265, 333 (log ϵ 4.24, 4.33, 3.67); $\lambda_{max}^{EtOH+AlCl_3}$ (nm): 219, 275, 378 (log ϵ 4.31, 4.37, 2.97). ν_{max}^{KBr} (cm^{-1}): 3274, 1650, 1620, 1582, 1505, 1308, 1262, 1165, 1050. PMR [$(CD_3)_2CO$, τ]: −2.6 (*s*, OH-5), 2.00 (*s*, H-2), 2.78 (*d*, *J* 8.0 Hz, H-6′), 3.39 (*d*, *J* 2.4 Hz, H–3′), 3.43 (*dd*, *J* 8.0, 2.4 Hz, H–5′), 3.62 (*d*, *J* 2.4 Hz, H-8), 3.75 (*d*, *J* 2.4 Hz, H-6), 6.19 (*s*, OMe), 6.22 (*s*, OMe). MS (*m*/*e*): 314 (100%) M^+, 283 (30), 162 (15), 161 (22), 153 (5), 152 (2). Methylation with CH_2N_2 gave **1d**. *Diacetate*, crystals, mp 199–201° (C_6H_6). ν_{max}^{KBr} (cm^{-1}): 1768, 1652, 1620, 1588, 1571, 1512, 1219, 1198. PMR ($CDCl_3$, τ): 2.18 (*s*, H–2), 2.75 (*d*, *J* 2.0 Hz, H–6), 2.80 (*d*, *J* 8.0 Hz, H–6′), 3.18 (*d*, *J* 2.0 Hz, H-8), 3.30–3.55 (*m*, H-3′, H-5′), 6.20 (*s*, OMe, 6.23 (*s*, OMe), 7.60 (*s*, OCOMe), 7.63 (*s*, OCOMe). MS (%): 398 (80) M^+, 356 (100), 314 (66), 313 (10), 297 (5), 283 (24), 162 (12), 161 (17), 153 (21).

5-*Hydroxy*-7,2′,4′-*trimethoxyisoflavone* (**1d**). Crystals, mp 160–162° [M found 328; $C_{18}H_{16}O_6$ requires 328]. λ_{max}^{EtOH} (nm): 217, 261, 277 inf., 319 (log ϵ 4.12, 4.24, 3.91, 3.27); $\lambda_{max}^{EtOH+NaOH}$ (nm): 235, 270, 358 (log ϵ 4.09, 4.18, 3.13); no NaOAc shift; ν_{max}^{KBr} (cm^{-1}): 1660, 1615, 1576, 1512, 1508, 1498, 1270, 1210, 1200. PMR ($CDCl_3$, τ): −2.80 (*s*, OH-5), 2.20 (*s*, H-2, 2.80 (*d*, *J* 9.0 Hz, H–6′), 3.40 (*d*, *J* 2.4 Hz, H–3′), 3.45 (*dd*, *J* 9.0, 2.4 Hz, H–5′), 3.62 (*s*, H–6, H–8), 6.20 (*s*, OMe), 6.22 (*s*, OMe), 6.25 (*s*, OMe).

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