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STRUCTURE OF PLECTRIN, AN APHID ANTIFEEDANT DITERPENE FROM PLECTRANTHUS BARBATUS

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The efficient isolation and characterization of plectrin, a highly reactive diterpenoid isolated from Plectranthus barbatus is reported. Plectrin exhibits antifeedant activity against an important pest aphid Schizaphis graminum.

In our continuing search for naturally occurring insect control agents we examined the bitter tasting leaves^1)^ of the East African medicinal plant Plectranthus barbatus (Labiatae)^2)^ on the basis of its known obstinate nature against insect attack. Since preliminary antifeedant assay against several pest insect species indicated that the crude methanol extract of this plant exhibited antifeedant activity to the green bug Schizaphis graminum and the pink bollworm Pectinophora gossypiella, the isolation of the active principle was monitored by the feeding deterrency on these insects.^3)^

Meanwhile, careful observation of the leaves of P. barbatus under the microscope revealed numerous spherical red particles to be present on their surfaces.^4)^ The red particles were collected under the microscope from the surface of a leaf using a fine needle, and were shown to be composed of one major component by TLC (5% CH_3OH in $CHCl_3$). In order to obtain sufficient quantities of the main compound for chemical analysis, the dry leaves (2 kg) were washed with ether and the resulting solution was immediately concentrated. The red particles on the leaf were successfully extracted by this method. However, further purification of the major compound using a silica gel chromatography was unsuccessful because of degradation of the compound under the chromatographic condition (CH_3OH-$CHCl_3$). Preparative reversed-phase (C_{18}) chromatography (45% CH_3OH in H_2O) was therefore applied to give a pure component plectrin 1 (2 g; 0.1% of dry weight), which was confirmed to be the major component of red particles by the direct comparison on TLC. Plectrin exhibits antifeedant activity against S. graminum and P. gossypiella. The protection dose for 50% feeding (PC_{50})^3)^ was 50 ppm and 100 ppm, respectively. The spiro-abietane type diterpenoid, coleon O 2,^5)^ previously isolated from Coleus somaliensis,^8)^ was also obtained as a minor congener.

Plectrin 1, mp 127 °C, $[\alpha]_D^{20}$ + 187° (c 0.35, $CHCl_3$) has the following physical constants: $C_{22}H_{26}O_7$; EI-MS m/z 402 (M^+), 384 ($M-H_2O$), 324 ($M-H_2O$ and CH_3COOH); UV (EtOH) 237 nm (ε 18400); IR ($CHCl_3$) 3380, 1740, 1707, 1663, 1625, and 1380 cm^{-1}; ^{13}C NMR (CD_3OD) 198.8 (s), 198.3 (s), 197.2 (s), 171.7 (s), 154.1 (s), 152.6 (s), 142.2 (s), 134.3 (s), 77.4 (d), 72.8 (t), 22.2 (q), 21.9 (q), 21.0 (q), 17.4 (d), 13.6 (q), and 11.4 (q) ppm. These data are similar to those of coleon O 2[6)] except for the presence of an additional carbonyl function (δ_c 198.3) which is conjugated with a fully substituted double bond (δ_c 134.3 and 154.1). Analysis of the 400 MHz ^1H NMR spectrum of plectrin in CD_3OD (Fig. 1) revealed the following isolated proton systems: (i) $CH_3-\blacksquare$, (ii) $CH_3-\overset{\blacksquare}{C}=\overset{\blacksquare}{C}-CH_3$, (iii) $CH_3-CO-O-$, (iv) $CH_3-\overset{\blacksquare}{C}H-CH_2-\blacksquare$, (v) $CH(OH)-\blacksquare$, (vi) $\blacksquare-CH_{eq}(OH)-CH_{eq}(OAc)-\overset{\blacksquare}{C}H_{ax}-\blacksquare$, (vii) $\blacksquare-CH_2-\blacksquare$. The high field methylene signals (δ 1.19 and 0.98 ppm) of system, iv, suggest the presence of a cyclopropane ring. Systems i, ii, iii, iv, and v are closely similar to those encountered in coleon O, whereas the sequence of the acetoxyl group and the hydroxyl group in vi is reverse of that of 2. The characteristic AB pattern (J=16.4 Hz) signals at 2.95 and 2.36 ppm were assigned to the methylene protons, adjacent to the enone carbonyl. Combination of these spectral and physical data has led to the structure shown in 1. The absolute configuration at C-12 is probably R, since coleon O known to have 12R configuration was isolated from the same plant. The absolute stereochemistry of the cyclopropane moiety were determined as 13S and 15S by the comparison of the CD spectrum in EtOH; $\Delta\varepsilon$ (384 nm) +1.3, (329 nm) -1.5, and (276 nm) +1.6, with that of coleon O for which absolute stereochemistry was recently established.[7)]

Plectrin is highly unstable in aprotic solvents (ether, chloroform) or in basic solvents. For example, even during the measurement of ^{13}C NMR in C_5D_5N it decomposed to give a red colored mixture. The major red pigment obtained by the decomposition of plectrin in a basic condition (0.1 M NaOH/EtOH, 25 °C, 1 min) was identified[9)] as coleon E 3, a unique diterpenoid pigment previously isolated from the same plant Coleus barbatus.[2,8)] In view of this rapid decomposition[10)] it is conceivable that plectrin is a key precursor of coleon E

The authentic samples of coleon E and O were kindly provided by Professor P. Rüedi, Universität Zürich. We thank Dr. J. A. Klocke, Native Plant Institute, for bioassay and Dr. K. Tsujimoto, Tokyo Denki-Tsushin University, for MS measurements.

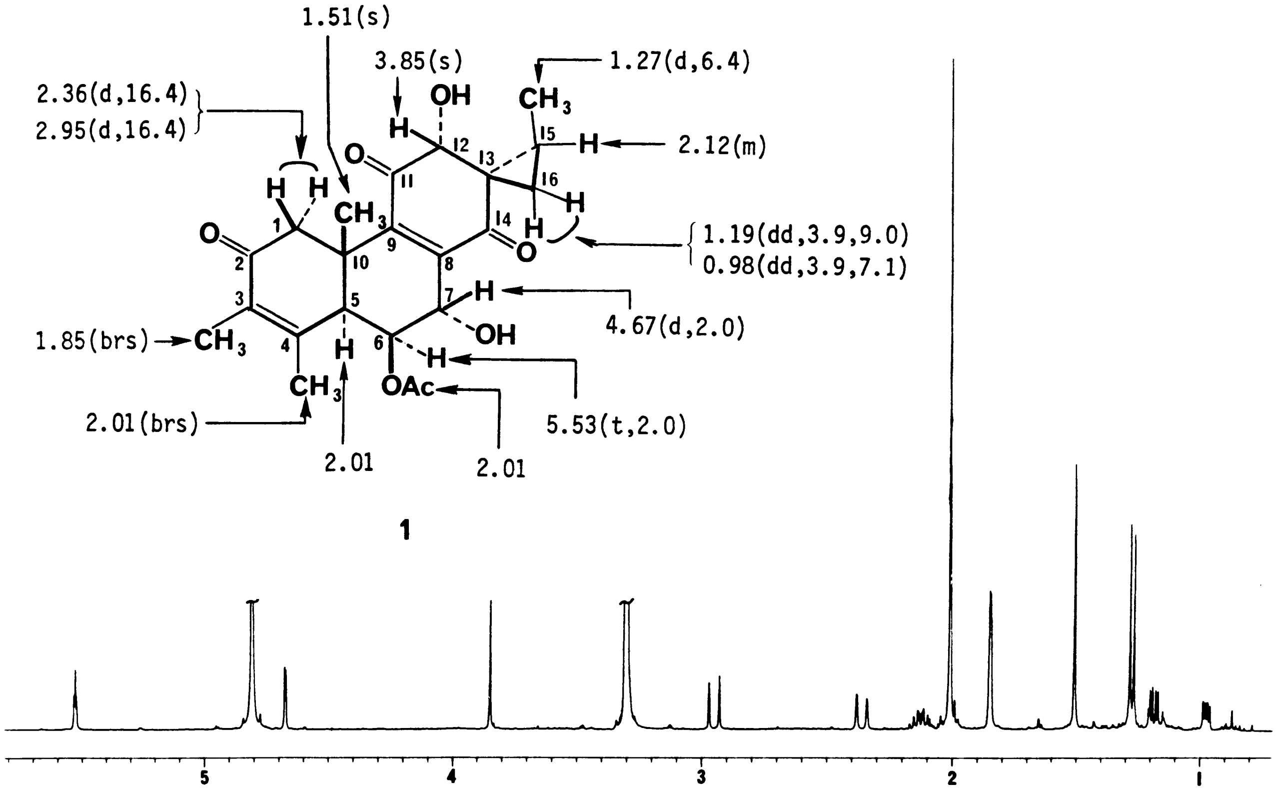
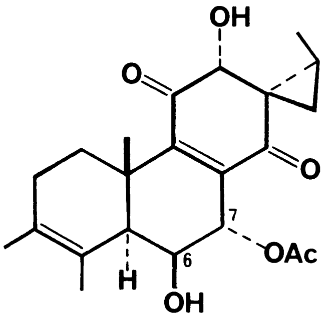


Fig. 1. The 400 MHz ^1H NMR spectrum of plectrin in CD_3OD.



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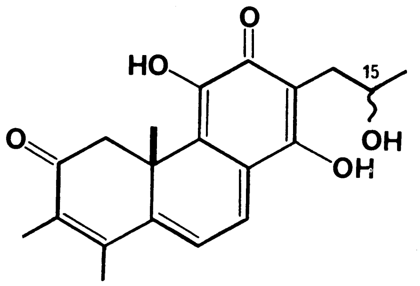
Coleon O



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Coleon E

References

1) The plant was collected near Mt. Kenya, Kenya by one of the authors (I.K.).
2) Used as a remedy for stomach-ache, and as a purgative. Cf. J. O. Kokwaro, "Medicinal Plants of East Africa," East African Literature Bureau, Nairobi (1976), p. 159.
3) I. Kubo and J. A. Klocke, "Plant Resistance to Insects," ed by P. Hedin, ACS Symposium Series 208, American Chemical Society, Washington, D. C. (1983), p. 330.
4) P. Rüedi and C. H. Eugster, Helv. Chim. Acta., 55, 1994 (1972).
5) S. Arihara, P. Rüedi, and C. H. Eugster, Helv. Chim. Acta., 58, 343 (1975).
6) Coleon O: $C_{22}H_{28}O_6$; mp 172 °C; $[\alpha]_D^{20}$ + 194° (c 0.08, $CHCl_3$); CD $\Delta\varepsilon$ (377 nm) +0.47, (316 nm) -0.78, and (236 nm) +3.5; UV (EtOH) 237 (ε 8200) and 208 nm (ε 8400); EI-MS m/z 328, 313, 310, 300, 299, and 295; IR ($CHCl_3$) 3500, 1720, 1705, 1670, and 1615 cm^{-1}; ^{13}C NMR (CD_3OD) 199.3, 197.3, 171.5, 159.5, 139.2, 128.2, 125.3, 77.8, 70.0, 69.4, 46.0, 38.0, 37.3, 34.2, 30.8, 27.3, 21.3, 20.9, 19.2, 14.9, 13.4, and the signal overlapping with those of CD_3OD; ^1H NMR (CD_3OD) 5.71 (1H, d, J=1.7, 7-H), 4.23 (1H, dd, J=1.7, 1.9, 6-H), 3.81 (1H, s, 12-H), 2.43 (1H, brs, 5-H), 2.24 (1H, m, 15-H), 2.01 (3H, s, OAc), 1.77 (3H, brs, 18-CH_3), 1.68 (3H, brs, 19-CH_3), 1.45 (3H, s, 20-CH_3), 1.25 (3H, d, J=6.4, 17-CH_3), 1.10 (1H, dd, J=3.7, 9.1, 16-Ha), and 0.92 (1H, dd, J=3.7, 6.9, 16-Hb).
7) P. Rüedi, J. M. Schmid, R. Prewo, J. H. Bieri, and C. H. Eugster, Helv. Chim. Acta., 66, 429 (1983).
8) The genus Coleus was recombinated as Plectranthus. Cf. H. Hara, Jpn. J. Botany, 42, 193 (1972).
9) By the comparison of ^1H NMR spectrum with that of the authentic sample.
10) J. M. Schmid, P. Rüedi, and C. H. Eugster, Helv. Chim. Acta., 65, 2136 (1982).

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