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STRUCTURES OF LASIOCARPANIN, RABDOLASIONAL, AND CARPALASIONIN: NEW DITERPENOIDS FROM *RABDOSIA LASIOCARPA*

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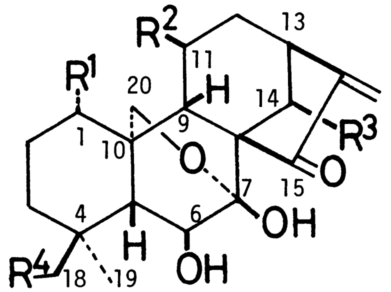
Three new diterpenoids, lasiocarpanin, rabdolasional, and carpalasionin were isolated from the stem and leaves of *Rabdosia lasiocarpa* and their structures were elucidated from spectral and chemical findings.

During the investigation on biologically active substances of *Rabdosia* plants (Labiatae), we examined the constituents of the stem and leaves of *Rabdosia lasiocarpa* (Hayata) Hara[1] and isolated three new diterpenoids, lasiocarpanin (1)(0.34 %), rabdolasional (2)(0.34 %), and carpalasionin (3)(0.03 %) along with known lasiokaurin (4), lasiodonin (5), nodosin (7), epinodosin (8), enmein (9), and oridonin (6).[2] Among the diterpenoids from *Rabdosia* plants, (1) is the first example oxidized at C-18 of *ent*-kaurane skeleton and (3) is also the first example oxidized at C-19 of enmein (9) skeleton. This paper describes the structure elucidation of these new compounds.

Lasiocarpanin (1), $C_{20}H_{28}O_6$, an amorphous powder, $[\alpha]_D^{27}$ -59.4° (c=0.40, MeOH) has a five membered ketone conjugated with an α-methylene group as a partial structure from the following spectral data: λ_{max} (MeOH) 234.5 nm (ε 6605); ν_{max}(KBr) 1710 and 1640 cm^{-1}; ^1H nmr (C_5D_5N) δ 5.51 and 6.26 (each 1H, br.s); ^{13}C nmr (C_5D_5N) δ 119.9 (t), 152.7 (s), and 208.7 (s). The ^1H nmr spectrum of (1) showed the presence of a tertiary Me group (δ 1.18), two oxygenated methyl groups[δ 3.68 (2H, br.s), 3.93 (1H, ABdd, 10 and 1 Hz), and 4.17 (1H, ABd, 10 Hz)],and two methine protons attached to a hydroxyl group bearing carbon [δ 4.27 (1H, dd, 11 and 7 Hz, changed to d, 7 Hz, on adding D_2O), and 5.11 (1H, br.s)]. The ^{13}C nmr spectrum exhibited the signal due to an acetalic carbon (δ 98.0) besides the signals due to two primary carbinyl carbons (δ 66.8 and 73.6), and two secondary carbinyl carbons (δ 73.3 and 73.9). These spectral data, together with the consideration of the structure of diterpenoids isolated so far from the genus *Rabdosia*,suggested that this substance has a structure of *ent*-7α-hydroxyl-7β,20-epoxy-kaur-16-en-15-one (10) as a basic skeleton.

This suggestion was supported by the fact that the dihydro-compound (11) obtained by catalytic hydrogenation showed a negative Cotton effect [λ (MeOH) nm (ϕ): 330 (-1627), 316 (-3327), 300 (0), 280 (+ 2810), and 270 (+ 2440)] in the ord. The positions having oxygen functional groups were determined as follows. One of the two oxygenated methyl groups (δ 3.93 and 4.17) was easily assigned to be at C-20 bearing two hydrogens by comparison with other similar type diterpenoids. In the ^{1}H nmr spectrum of (1), a signal due to only one tertiary Me group was observed. This fact suggests that one of the two methyl groups at C-4 was oxidized into an alcoholic group. An NOE (13 %) was observed for the signal (δ 4.17, 20-H_1) on irradiation of the methyl signal at δ 1.18. It indicates that the position of this oxygenated methyl group should be at C-4β. The positions of two secondary hydroxyl groups were further determined as follows. The signal at δ 5.11 changed into a sharp singlet on irradiation at δ 3.16 (1H, br.d, 9 Hz, 13-H) and shifted to δ 6.22 in the diacetate (13) which was obtained by acetylation (Ac_2O-C_5H_5N). This fact enabled us to assign this signal as 14α-H. Treatment of (1) with 2,2-dimethoxypropane in DMF in the presence of *p*-TsOH gave an acetonide (12) [^{1}H nmr (C_5D_5N) δ 1.42 and 1.79 (each 3H, s, acetonide Me_2), and 4.86 (1H, d, 1.5 Hz, 14α-H)], indicating that the tertiary hydroxyl group at C-7 has β-orientation as expected. The proton (δ 4.27) could be presumed to be located between a methine group and a quarternary carbon, i.e. C-6α, judged from its splitting pattern (d, 7 Hz, after D_2O treatment). This presumption was further supported from the fact that the hydroxyl group was not acetylated in the diacetate (13) owing to a hydrogen bonding to the ketone at C-15. Oxidation of (1) with periodic acid followed by Jones oxidation gave a dilactone (14) [ν_{max} ($CHCl_3$) 1780, 1740, and 1705 cm^{-1}], which confirmed the presence of a hydroxyl group at C-6β. On the basis of these data lasiocarpanin has structure (1).

Rabdolasional (2), $C_{22}H_{30}O_7$, an amorphous powder, $[\alpha]_D^{27}$ + 7.5° (c=0.27, MeOH) showed bands at ν_{max} (KBr) 3750-3100, 1740, 1715, and 1635 cm^{-1} in the ir. The ^{1}H nmr ($CDCl_3$) spectrum showed the presence of three secondary carbinyl protons [δ 3.68-4.00, 4.44 (t, 3 Hz), and 5.01-5.24] together with two tertiary Me groups (δ 1.13, 6H, s), an acetoxymethyl group [δ 2.01 (3H, s) and 4.90 (2H, s)], an exo-methylene [δ 5.18 (2H, br.s)], and an aldehyde group [δ 9.94 (1H, d, 3 Hz)]. The ^{13}C nmr ($CDCl_3$) signals were summarized in the structure (2).[3] These data, coupled with the fact that this compound does not exhibit absorption maximum above 210 nm, suggested that rabdolasional has a structure (2) in which the carbonyl group at C-15 in isodonal (15)[2] is reduced to a hydroxyl group. This presumption was further supported by the fact that INDOR signal was observed for the signal at δ 5.18 (exo-methylene) on monitoring the signal at δ 4.44 (15-H) which was observed in the ^{1}H nmr spectrum of (2) and was not observed in that of (15). Compound (2) was then subjected to a Garryfoline-Cuauchichicine rearrangement[4,5] yielding dihydroepinodosin (16). Accordingly,



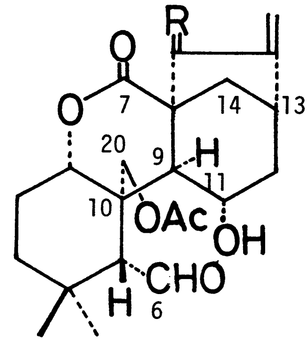
(1): R^1=R^2=H; R^3=R^4=OH

(4): R^1=OAc; R^2=R^4=H; R^3=OH

(5): R^1=R^2=OH; R^3=R^4=H

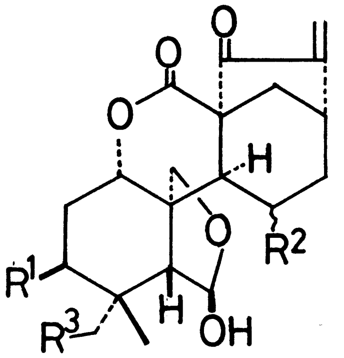
(6): R^1=R^3=OH; R^2=R^4=H

(13): R^1=R^2=H; R^3=R^4=OAc



(2): R= α-OH; β-H

(15): R=O

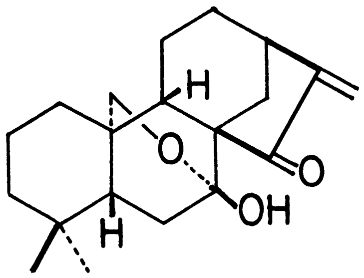


(3): R^1=H; R^2= β-OH; R^3=OAc

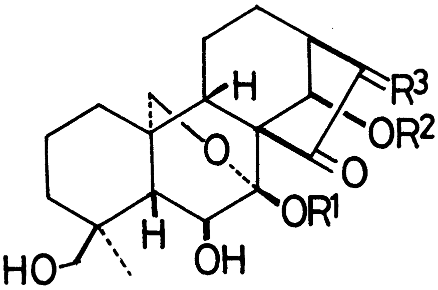
(7): R^1=R^3=H; R^2= β-OH

(8): R^1=R^3=H; R^2= α-OH

(9): R^1=OH; R^2=R^3=H

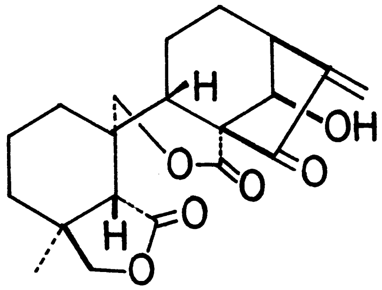


(10)

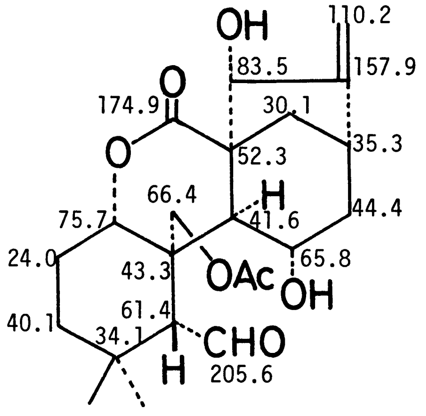


(11): R^1=R^2=H; R^3= β-Me; α-H

(12) $\begin{matrix}R^1\\R^2\end{matrix} = \mathrm{{>}C{<}}\begin{matrix}\mathrm{Me}\\\mathrm{Me}\end{matrix}$; R^3= CH_2

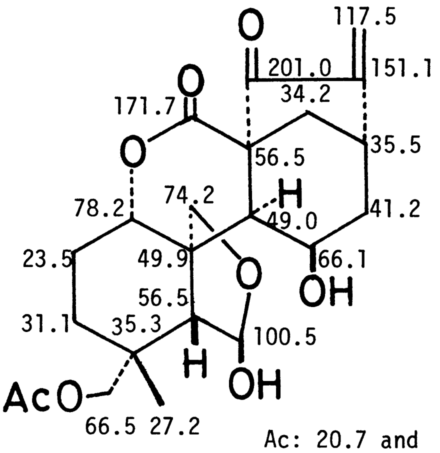


(14)



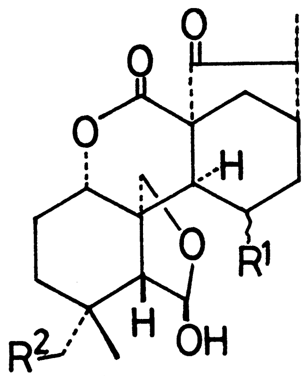
Ac: 21.4 and 170.5

(2)



Ac: 20.7 and 170.6

(3)



(16): R^1= α-OH; R^2=H

(17): R^1= β-OH; R^2=OAc

the configuration of the hydroxyl group at C-15 was determined as α and the structure of rabdolasional should be represented as (2).

Carpalasionin (3), $C_{22}H_{28}O_8$, mp 287-288° C, $[\alpha]_D^{27}$ -122.3° (c=0.19, MeOH) showed the following spectral data: λ_{max} (MeOH) 231 nm (ε 6857); ν_{max} (KBr) 3650-3100, 1740, 1700, and 1640 cm^{-1}; ^1H nmr (C_5D_5N) δ 1.14 (3H, s), 2.01 (3H, s), 2.91 (1H, s), 3.10 (1H, d, 4 Hz), 3.70 (1H, d, 12 Hz, 14β-H), 4.26 and 4.58 (each 1H, ABd, 12 Hz), 4.38 and 4.57 (each 1H, ABd, 9 Hz), 5.29 and 5.94 (each 1H, br.s), and 5.98 (1H, s). The ^{13}C nmr (C_5D_5N) data of carpalasionin (3) were summarized in the structure (3).[6] The ^1H nmr spectrum of (3) is very similar to that of nodosin (7) except for the signals due to a tertiary Me group (δ 1.14) and an acetoxymethyl group (δ 2.01, 4.26, and 4.58). In the ^{13}C nmr spectrum, the signal due to C-4 was observed at δ 35.3 which was observed at δ 31.6 in that of (7). Above mentioned data suggest that this compound has a structure in which one of the two methyl groups at C-4 in nodosin (7) was oxidized into an acetoxymethyl group. The location of the acetoxy group was deduced to be located at C-19 from the fact that an NOE (7.8 %) was observed for 5β-H (δ 2.91) on irradiation of the signal at δ 1.14. The dihydro-compound (17) further showed a negative Cotton effect [λ (MeOH) nm (φ): 350 (-2315), 322 (-3719), 310 (-3202), 295 (-2413), and 280 (-3350)] in the ord. On the basis of these data carpalasionin has a structure (3).

References

1. H. Hara, Japan J. Bot., 47, 193 (1972).
2. E. Fujita, Y. Nagao, and M. Node, Heterocycles, 5, 793 (1976) and references cited therein.
3. The assignements are based on a combination of PND, off-resonance decoupling,and comparison with the spectrum of isodonal (15).
4. C. Djerassi, C.R. Smith, A.E. Lippman, S.E. Figdor, and H. Herran, J. Am. Chem. Soc., 77, 4801 (1955).
5. M.F. Barnes and J. MacMillan, J. Chem. Soc. (C), 1967, 361.
6. The assignements are based on a combination of PND, off-resonance decoupling,and comparisons with the spectra of nodosin (7), epinodosin (8), isodocarpin, and the oxidation product of effusanin C.[7] The detailed study will be published elsewhere.
7. T. Fujita, Y. Takeda, T. Shingu, and A. Ueno, Chemistry Letters, 1980, 1635.

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