[Chem. Pharm. Bull. 34(10)4170—4176(1986)]

Sesquiterpene Lactones from *Ixeris dentata* NAKAI

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(Received April 25, 1986)

Three new sesquiterpene glycosides, ixerin U (III), ixerin V (IV), and ixerin W (XI), in addition to eight known sesquiterpenes, have been isolated from *Ixeris dentata* NAKAI. The structures of the new compounds were determined on the basis of chemical and spectral data.

Keywords——*Ixeris dentata*; Compositae; sesquiterpene glycoside; sesquiterpene lactone; ixerin U; ixerin V; ixerin W

As a part of our studies on sesquiterpene lactones from Compositae plants, we have investigated *Ixeris dentata* NAKAI and isolated three new sesquiterpene glucosides, ixerin U, ixerin V, and ixerin W, together with eight known sesquiterpene lactones. Their structures were elucidated on the basis of some chemical transformations and spectroscopic studies.

10α-Hydroxy-8-desoxy-10,14-dihydrodesacylcinaropicrin (I): From the proton nuclear magnetic resonance (^{1}H-NMR) spectral data, I was assumed to be 10α-hydroxy-8-desoxy-10,14-dihydrodesacylcinaropicrin, previously isolated from *Taeckholmia pinnata*, and its identity was confirmed by comparing the infrared(IR), ^{1}H- and carbon-13 nuclear magnetic resonance (^{1}H- and ^{13}C-NMR) spectra with reported data.[1)]

Ixerin D (II): $C_{21}H_{30}O_9$, mp 230—231 °C. This was the main glycoside of this plant. From the spectral data, II was assumed to be ixerin D, and this was confirmed by direct comparison [IR, ^{1}H-NMR, ^{13}C-NMR] with an authentic sample.[2)]

Ixerin U (III): $C_{30}H_{36}O_{12}$, mp 224—228 °C, $[\alpha]_D$ +49.0 °C. The IR spectrum showed hydroxyl (3500 cm^{-1}), γ-lactone (1740 cm^{-1}) and ester (1695 cm^{-1}) absorptions. The ultraviolet (UV) spectrum showed absorption maxima at 244, 299, 330 nm. The ^{1}H-NMR spectrum showed the presence of a methyl group at δ 1.35 (3H, s) and two exomethylene groups at δ 5.46 (1H, br s), 5.68 (1H, br s) and at δ 5.29 (1H, d, J=3.0 Hz), 6.16 (1H, d, J=3.3 Hz), which are characteristic of an exocyclic α-methylene-γ-lactone. At low field, a pair of doublets (1H, each, J=16 Hz) suggested the presence of a *trans*-cinnamic acid derivative. On saponification of III, caffeic acid and II were obtained, while acid hydrolysis gave glucose as the sugar moiety. In the ^{13}C-NMR spectrum, the signals of the aglycone moiety were very similar to those of II, while C-5 (δ 75.3) of glucose was shifted upfield by 2.7 ppm and C-6 (δ 64.6) of glucose was shifted downfield by 1.7 ppm compared with those of II. These results showed that the caffeic acid is linked with C-6 of glucose. From these data, the structure of ixerin U can be concluded to be III.

Ixerin V (IV): $C_{21}H_{32}O_8 \cdot 3/2H_2O$, $[\alpha]_D$ +11.3°. The ^{1}H-NMR spectrum showed the presence of two methyl groups at δ 1.10 (3H, d, J=7 Hz), 1.36 (3H, s) and an exomethylene group at δ 4.95 (1H, br s), 5.25 (1H, br s). Enzymatic hydrolysis of IV with crude hesperidinase afforded an aglycone IVa, whose mass spectrum (MS) gave the molecular formula $C_{15}H_{22}O_3$, M^+ 250.1553 (Calcd for $C_{15}H_{22}O_3$ 250.1570). Compound IVa afforded IVb by dehydration. In the ^{1}H-NMR spectrum of IVa, a triplet signal at δ 4.26 (1H, t, J=10 Hz) due to the lactonic proton at C-6 suggested *trans*-diaxial dispositions among H-5 (α), H-6 (β) and H-7 (α), a feature common to all the lactones of this genus.[3)] In a nuclear Overhauser

effect (NOE) experiment in dimethyl sulfoxide-d_6 (DMSO-d_6), irradiation of the signal of the methyl group at δ 0.92 (3H, s) increased the intensity of the H-6 carbinol proton signal by 16%, and irradiation of the signal of the methyl group at δ 1.70 (3H, d, J=8 Hz) also increased the H-6 carbinol proton signal by 5%. Thus, the methyl groups of C-13 and C-14 should be β-oriented. Further these results indicate that H-1 is α-oriented; if H-1 was β-oriented, no NOE between the C-14 methyl group and H-6 would be expected. On the basis of Narayanan's rule,[4] we could deduce the stereochemistry to some extent. This rule says that the signal of a pseudo-equatorial methyl group exhibits 0.23 ± 0.06 ppm upfield shift whereas that of a pseudo-axial one shows 0.46 ± 0.06 ppm upfield shift in benzene-d_6 relative to chloroform-d_1 solution. The C-13 methyl groups of IVa and IVb exhibited upfield shifts of

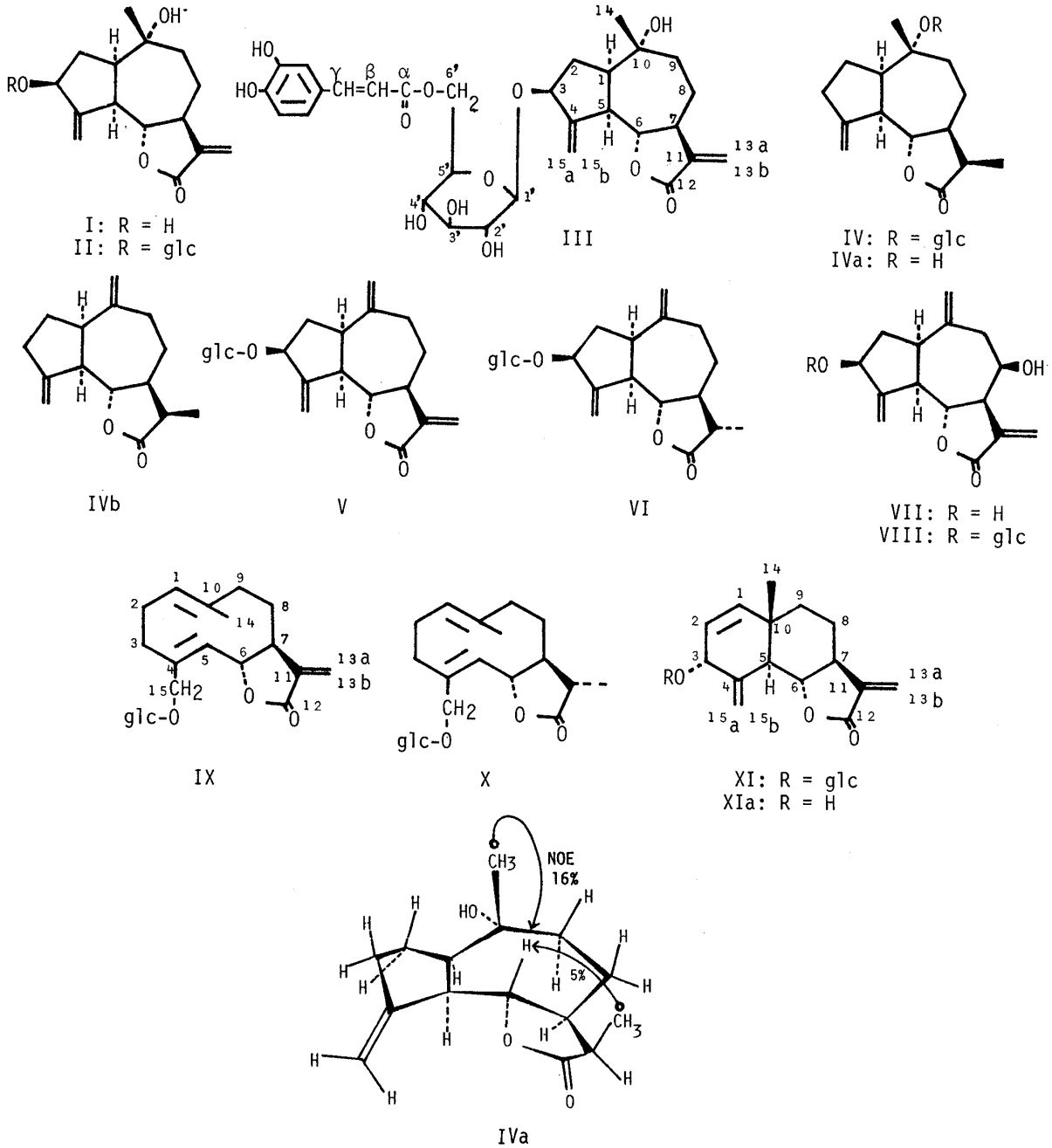

Chart 1

0.40 and 0.42 ppm. This result also suggests that the C-13 methyl group is β-oriented. If the assumption is made that the absolute configuration of the C-7 side chain is as shown (as in all other known sesquiterpene lactones having authenticated stereochemistry), the structure of ixerin V can be concluded to be IV.

Glucozaluzanin C (V): This common sesquiterpene glucoside was identified by direct comparison [IR, ^{1}H-NMR] with an authentic sample.[5]

11, 13α-Dihydroglucozaluzanin C (VI): The ^{1}H-NMR spectrum was similar to that of V. Compound VI was identified by direct comparison [IR, ^{1}H-NMR, ^{13}C-NMR] with an authentic sample.[2]

8-Epidesacylcinaropicrin (VII): Compound VII was identified by direct comparison [IR, ^{1}H-NMR, ^{13}C-NMR] with an authentic sample.[6]

8-Epidesacylcinaropicrin glucoside (VIII): The ^{1}H-NMR spectrum was similar to that of VII. Compound VIII was identified by direct comparison [IR, ^{1}H-NMR, ^{13}C-NMR] with an authentic sample.[7]

Picriside B (IX): Compound XI was identified by direct comparison [IR, ^{1}H-NMR, ^{13}C-

TABLE I. ^{1}H-NMR Chemical Shifts and Coupling Constants

Proton No.	III	IV	IVa	IVa[a]
Aglycone moiety				
3	4.84 (1H, br t, J=8 Hz)			
6	4.41 (1H, t, J=10 Hz)		4.26 (1H, t, J=10 Hz)	4.36 (1H, t, J=9 Hz)
7	3.43 (1H, m)			
13a	5.29 (1H, d, J=3.0 Hz)	1.10 (3H, d, J=7 Hz)	1.19 (3H, d, J=7 Hz)	1.70 (3H, d, J=8 Hz)
13b	6.16 (1H, d, J=3.3 Hz)			
14	1.35 (3H, s)	1.36 (3H, s)	1.09 (3H, s)	0.92 (3H, s)
15a	5.68 (1H, br s)	5.25 (1H, br s)	4.96 (1H, dd, J=3, 1.5 Hz)	4.85 (1H, m)
15b	5.46 (1H, br s)	4.95 (1H, br s)	5.12 (1H, dd, J=3, 1.5 Hz)	4.96 (1H, m)
Anomeric		4.98 (1H, d, J=7 Hz)		
Caffeic acid moiety				
β	6.65 (1H, d, J=16 Hz)			
γ	7.97 (1H, d, J=16 Hz)			

Proton No.	IVb	XI	XIa
Aglycone moiety			
1		5.46 (1H, dd, J=10, 2 Hz)	5.62 (1H, s)
2		5.86 (1H, dd, J=10, 3 Hz)	5.62 (1H, s)
3		6.36 (1H, br s)	4.74 (1H, br s)
5		2.55 (1H, br d, J=11 Hz)	2.60 (1H, br d, J=11 Hz)
6	4.05 (1H, t, J=9 Hz)	4.22 (overlapped)	4.08 (1H, t, J=11 Hz)
7		2.5 (1H, m)	2.6 (overlapped)
13a	1.16 (3H, d, J=7 Hz)	5.36 (1H, d, J=3.1 Hz)	5.43 (1H, d, J=2.9 Hz)
13b		6.15 (1H, d, J=3.2 Hz)	6.10 (1H, d, J=3.2 Hz)
14	4.78 (1H, br s)	0.92 (3H, s)	0.94 (3H, s)
	4.87 (1H, br s)		
15a	5.21 (1H, br s)	5.18 (1H, br s)	5.43 (overlapped)
15b	5.05 (1H, br s)	5.13 (1H, br s)	5.08 (1H, br s)
Anomeric		5.06 (1H, d, J=7 Hz)	

Run at 89.55 Hz; III, IV, XI in pyridine-d_5 and IVa, IVb, XIa in $CDCl_3$ solution. *a*) In DMSO-d_6 solution.

TABLE II. ^{13}C-NMR Chemical Shifts

Carbon No.	III	IV	IVa	XI
Aglycone moiety				
1	50.9[a]	52.4[e]	52.2[g]	127.1
2	34.5[b]	21.4	22.5	138.3[h]
3	80.5	30.6	31.1	76.2
4	150.5[c]	152.9	152.2	141.1
5	50.6[a]	51.9[e]	51.3[g]	49.0
6	81.7	82.8	84.2	77.3
7	44.5	39.8	41.5	51.7
8	24.8	26.4	26.1	20.4
9	35.8[b]	35.3	39.5	39.5
10	73.4	81.3	74.4	35.7
11	142.9	42.6	43.1	139.1[h]
12	170.1	179.8	179.7	169.4
13	118.1	11.2	10.9	115.1
14	30.9	25.4	25.8	19.6
15	113.5	105.1	107.4	107.5
Sugar moiety				
1	103.9	98.3		104.2
2	75.1[d]	75.3		74.4
3	78.2	78.9[f]		77.5
4	71.8	72.0		70.8
5	75.3[d]	77.8[f]		77.5
6	64.6	63.1		61.8
Caffeic acid moiety				
α	167.4			
β	115.8			
γ	145.9			
1	126.9			
2	115.0			
3	150.2[c]			
4	147.5			
5	116.5			
6	121.9			

Run at 22.5 MHz. III, IV, XI in pyridine-d_5 and IVa in $CDCl_3$. *a—h*) Assignments may be interchanged in each column.

NMR] with an authentic sample.[8]

Ixerin H (X): The ^{1}H-NMR spectrum was similar to that of IX. Compound X was identified by direct comparison [IR, ^{1}H-NMR, ^{13}C-NMR] with an authentic sample.[9]

Ixerin W (XI): The fast atom bombardment mass spectrum (FAB-MS) exhibited an ion peak at m/z 431 $(M+Na)^+$. The ^{1}H-NMR spectrum showed a methyl signal at δ 0.92 (3H, s), and two exomethylene signals at δ 5.13 (1H, br s), 5.18 (1H, br s) and at δ 5.36 (1H, d, $J=3.1$ Hz), 6.15 (1H, d, $J=3.2$ Hz), which are characteristic of exocyclic methylene protons of an α-methylene-*trans*-γ-lactone. The stereochemistry of the C-7 side chain was decided on the basis of a negative Cotton effect $[\theta]_{243}$ -2734 in the circular dichroism (CD) spectrum. Meanwhile a methyl signal at δ 0.92 (3H, s) was somewhat upfield. This indicates that ixerin W has a eudesmane-type skeleton. The structure of XI could be deduced from the ^{1}H-NMR data (Table I). The position of the hydroxyl group followed from the splitting of the olefinic signals and from the result of decoupling experiments. Irradiation of the H-3 signal at δ 6.36 (1H, br s) collapsed the olefinic signals and sharpened the signals of the exomethylene protons. As these signals were also coupled with a doublet signal at δ 2.55, which was further coupled with

the lactonic proton, the assignments of H-1, H-2, H-3, H-5, H-6 and H-15 were possible. The remaining signals could be assigned by further decouplings. In relation to the orientation of H-3, the coupling constants J_{1-3} and J_{2-3} were 2 and 3 Hz, respectively. Therefore, the dihedral angle between H-2 and H-3 must be nearly 100° and so H-3 is β-oriented from inspection of a Dreiding stereo model. Acid hydrolysis gave glucose as the sugar moiety. Enzymatic hydrolysis with crude hesperidinase afforded an aglycone XIa, $C_{15}H_{18}O_3$, M^+ 246.1228 (Calcd for $C_{15}H_{18}O_3$: 246.1257). Therefore XIa was assumed to be bracyraenolide[10] which had been isolated from *Bracylaena transvaolensis* and identified by comparison with spectral data. The structure of ixerin W was concluded to be XI.

Experimental

Melting points were determined on a Yanaco MP-500 micromelting point apparatus and are uncorrected. Optical rotations were determined with a JASCO DIP-140 digital polarimeter. IR spectra were run on a JASCO A-202 IR spectrometer and UV spectra on a Shimadzu UV-360 recording spectrophotometer. MS were measured on JEOL JMS D-100 and HS-100 mass spectrometers. CD spectrum was recorded on a JASCO J-20A spectropolarimeter. ^{1}H-NMR and ^{13}C-NMR spectra were recorded on a JEOL FX-90Q NMR (89.55 and 22.5 MHz, respectively) spectrometer. Chemical shifts are given on the δ scale with tetramethylsilane as an internal standard (s, singlet; d, doublet; m, multiplet; br, broad). Gas chromatography (GC) was done on a Hitachi K 53 gas chromatograph. High-performance liquid chromatography (HPLC) was run on a Kyowa Seimitsu model K 880 instrument.

Isolation——Air-dried whole plants (450 g) of *Ixeris dentata* NAKAI collected in Shizuoka, April, 1985, were extracted with hot water. The crude extract was passed through an Amberlite XAD-2 column, the eluate with MeOH was concentrated under reduced pressure, and then the residue was purified by silica gel column chromatography $CHCl_3$–MeOH (95 : 5)—(85 : 15) and HPLC (column, Develosil ODS-10 20 mm × 25 cm; solvent, H_2O–CH_3CN (9 : 1)—(6 : 4) to afford the following sesquiterpene lactones.

10α-Hydroxy-8-desoxy-10,14-dihydrodesacylcinaropicrin (I)——Colorless gum (10 mg). IR ν_{max}^{KBr} cm^{-1}: 3430, 1760, 1665, 1635 1460, 1105. ^{1}H-NMR (pyridine-d_5) δ: 1.34 (3H, s, H_3-14), 4.45 (1H, dd, J=10, 9 Hz, H-6), 4.83 (1H, brt, J=6 Hz, H-3), 5.39 (1H, d, J=3.2 Hz, H-13a), 5.49, 5.60 (1H each, m, H_2-15), 6.23 (1H, d, J=3.5 Hz, H-13b). ^{13}C-NMR (pyridine-d_5) δ: 25.2 (C-8), 28.8 (C-14), 36.9 (C-9), 37.8 (C-2), 44.8 (C-7), 49.5, 49.6 (C-1/C-5), 72.7 (C-3), 73.6 (C-10), 82.9 (C-6), 108.8 (C-15), 118.5 (C-13), 142.2 (C-11), 155.3 (C-4), 170.1 (C-12).

Ixerin D (II)——Colorless needles (45 mg). mp 230—231 °C (MeOH). *Anal.* Calcd for $C_{21}H_{30}O_9$; C, 59.14; H, 7.09. Found: C, 58.92: H, 6.92. ^{1}H-NMR (pyridine-d_5) δ: 1.29 (3H, s, H_3-14), 3.34 (1H, m, H-7), 4.86 (1H, brt, J=7 Hz, H-3), 5.05 (1H, d, J=7 Hz, H-1 of glucose), 5.35 (1H, d, J=3.1 Hz, H-13a), 5.42, 5.69 (1H each, brs, H_2-15), 6.19 (1H, d, J=3.2 Hz, H-13b). ^{13}C-NMR (pyridine-d_5) δ: 24.9 (C-8), 30.1 (C-14), 35.3, 35.4 (C-2/C-9), 44.5 (C-7), 50.2, 50.6 (C-1/C-5), 62.9 (C-6′), 71.8 (C-4′), 73.4 (C-10), 75.1 (C-2′), 78.0 (C-5′), 78.3 (C-3′), 79.7 (C-3), 81.8 (C-6), 103.5 (C-1′), 112.9 (C-15), 118.2 (C-13), 142.6 (C-11), 150.5 (C-4), 170.0 (C-12).

Ixerin U (III)——Colorless needles (30 mg). mp 224—228°C (MeOH). $[\alpha]_D^{25}$ + 49.0° (c=0.49, pyridine). *Anal.* Calcd for $C_{30}H_{36}O_{12}$: C, 61.22; H, 6.16. Found: C, 61.01; H,6.21. IR ν_{max}^{KBr} cm^{-1}: 3500, 1740, 1695, 1635, 1615, 1605, 1520, 1290, 1180, 1155, 1120, 1055, 1045. UV λ_{max}^{MeOH} nm (log ε): 244 (4.07), 299 sh (4.15), 330 (4.27). ^{1}H-NMR and ^{13}C-NMR: Tables I and II.

Ixerin V (IV)——Amorphous powder (40 mg). $[\alpha]_D^{25}$ +11.3° (c=0.40, MeOH). *Anal.* Calcd for $C_{21}H_{32}O_8 \cdot 3/2H_2O$: C, 57.39; H, 8.03. Found: C, 57.66; H, 7.73. IR ν_{max}^{KBr} cm^{-1}: 3450, 1760, 1660, 1640, 1455, 1075, 1030, 985. ^{1}H-NMR and ^{13}C-NMR: Tables I and II.

Glucozaluzanin C (V)——Amorphous powder (3 mg). IR ν_{max}^{KBr} cm^{-1}: 3450, 1770, 1660, 1645, 1265, 1160, 1080, 1035. ^{1}H-NMR (pyridine-d_5) δ: 5.39 (1H, d, J=3.1 Hz, H-13a), 5.54, 5.86 (1H each, brs, H_2-15), 6.23 (1H, d, J=3.5 Hz, H-13b).

11, 13α-Dihydroglucozaluzanin C (VI)——Amorphous powder (5 mg). IR ν_{max}^{KBr} cm^{-1}: 3400, 1770, 1660, 1640, 1450, 1350, 1160, 1070, 1020, 980, 895. ^{1}H-NMR (pyridine-d_5) δ: 1.18 (3H, d, J=7 Hz, H_3-13), 4.86, 5.02 (1H each, brs, H_2-14), 5.06 (1H, d, J=7 Hz, H-1 of glucose), 5.51, 5.89 (1H each, brs, H_2-15). ^{13}C-NMR (pyridine-d_5) δ: 13.4 (C-13), 32.5 (C-8), 36.1 (C-9), 37.9 (C-2), 42.3, 44.2 (C-7/C-1), 50.0 (C-11), 50.3 (C-5), 63.1 (C-6′), 72.0 (C-4′), 75.4 (C-2′), 78.4 (C-5′), 78.7 (C-3′), 80.6 (C-3), 83.6 (C-6), 104.4 (C-1′), 111.9 (C-15), 113.3 (C-14), 149.5 (C-10), 150.4 (C-4), 178.4 (C-12).

8-Epidesacylcinaropicrin (VII)——Colorless gum (45 mg). IR ν_{max}^{KBr} cm^{-1}: 3450, 1770, 1610, 1520, 1460. ^{1}H-NMR (pyridine-d_5) δ: 5.70 (2H, s, H_2-14), 5.25, (1H, brs, H-15), 5.68 (overlapped, H-13a), 5.68 (overlapped, H-15), 6.49 (1H, d, J=3.5 Hz, H-13b). ^{13}C-NMR (pyridine-d_5) δ: 39.9 (C-2), 44.2 (C-9), 44.7 (C-1), 50.1 (C-7), 50.5 (C-5), 66.0 (C-8), 73.1 (C-3), 78.8 (C-6), 109.0 (C-15), 115.9 (C-14), 120.9 (C-13), 137.7 (C-11), 145.1 (C-10), 155.2 (C-4), 170.1 (C-12).

8-Epidesacylcinaropicrin Glucoside (VIII)——Amorphous powder (30 mg). IR ν_{max}^{KBr} cm^{-1}: 3430, 1760, 1665,

1645, 1155, 1080, 1040, 915. ^{1}H-NMR (pyridine-d_5) δ: 4.84 (1H, brt, J=8 Hz, H-3), 5.00, 5.18 (1H each, s, H_2-14), 5.60 (1H, brs, H-13a), 5.70, 5.89 (1H each, brs, H_2-15), 6.50 (1H, brs, H-13b). ^{13}C-NMR (pyridine-d_5) δ: 38.5 (C-2), 43.7 (C-9), 45.2 (C-1), 50.0, 50.7 (C-7/C-5), 63.0 (C-6′), 66.1 (C-8), 71.9 (C-4′), 75.3, 75.5 (C-2′/C-6), 78.2, 78.5 (C-5′/C-3′), 80.8 (C-3), 104.6 (C-1′), 111.9 (C-15), 116.1 (C-14), 121.0 (C-13), 137.7 (C-11), 145.0 (C-10), 150.8 (C-4), 170.2 (C-12).

Picriside B (IX)——Amorphous powder (5 mg). IR ν_{max}^{KBr} cm^{-1}: 3450, 1765, 1665, 1635, 1620, 1450, 1445, 1070, 1010, 965. ^{1}H-NMR (pyridine-d_5) δ: 1.37 (3H, brs, H_3-14), 4.96 (1H, d, J=7.5 Hz, H-1 of glucose), 5.51 (1H, d, J=3.2 Hz, H-13a), 6.35 (3H, d, J=3.6 Hz, H-13b). ^{13}C-NMR (pyridine-d_5): 16.3 (C-14), 27.1, 27.7 (C-8/C-2), 36.0 (C-3), 41.1 (C-9), 50.8 (C-7), 62.9 (C-6′), 67.8 (C-15), 71.8 (C-4′), 75.2 (C-2′), 78.6 (C-3′), 78.6 (C-5′), 80.3 (C-6), 105.3(C-1′), 119.1 (C-13), 126.9 (C-1), 130.1 (C-5), 137.6 (C-10), 141.0, 141.2 (C-4/C-11), 170.3 (C-12).

Ixerin H (X)——Amorphous powder (6 mg). IR ν_{max}^{KBr} cm^{-1}: 3400, 1765, 1660, 1635, 1450, 1440, 1380, 1310, 1205, 1180, 1155, 1070, 1040, 1020, 960, 890. ^{1}H-NMR (pyridine-d_5) δ: 1.23 (1H, d, J=7 Hz, H_3-13), 1.36 (3H, br s, H_3-14), 4.96 (1H, d, J=7 Hz, H-1 of glucose). ^{13}C-NMR (pyridine-d_5) δ: 13.4 (C-13), 16.3 (C-14), 27.0, 28.2 (C-8/C-2), 36.0 (C-3), 41.3 (C-9), 42.2 (C-11), 54.9 (C-7), 62.9 (C-6′), 67.7 (C-15), 71.8 (C-4′), 75.3 (C-2′), 78.6 (C-3′), 78.6 (C-5′), 79.8 (C-6), 105.3 (C-1′), 126.9 (C-1), 130.5 (C-5), 137.5 (C-10), 140.1 (C-4), 178.4 (C-12).

Ixerin W (XI)——Amorphous powder (5 mg). $[\alpha]_D^{25}$: + 101.0° (c=0.47, MeOH). IR ν_{max}^{KBr} cm^{-1}: 3450, 2950, 1770, 1630, 1075, 1015. MS m/z: 431 $(M+Na)^+$. CD (c=0.47, MeOH) [θ] (nm): −2734 (243). ^{1}H-NMR and ^{13}C-NMR: Tables I and II.

Saponification of Ixerin U (III)——A solution of III (0.1 mg) in aqueous 2% NaOH was stirred for 50 min at room temperature under a nitrogen atmosphere. The solution was acidified with diluted HCl and extracted with *n*-butanol 3 times. The butanol extract was concentrated to give ixerin D (II) and caffeic acid (this was methylated with AcCl–MeOH (1 : 20) under reflux for 20 min), which were identified by HPLC. Conditions: column, YMC Pack AM-212 C_8, 6 mm × 15 cm; eluent, H_2O–CH_3CN (82 : 18); flow rate 1.3 ml/min; UV detector at 205 nm. t_R 4.8 min (ixerin D). column, TSK GEL LS-410 AK 4 mm × 30 cm; eluent, H_2O–MeOH (50 : 50); flow rate 1.3 ml/min; UV detector at 245 nm. t_R 6.2 min (methyl caffeate).

Enzymatic Hydrolysis of Ixerin V (IV)——IV (25 mg) was dissolved in water (2 ml) and the solution was treated with crude hesperidinase (20 mg) for 3 h at 38 °C with stirring. The solution was passed through an Amberlite XAD-2 column, and the eluate with methanol was purified on a silica gel column to give IVa (6 mg). $C_{15}H_{22}O_3$, 250.1553 (M^+, Calcd for $C_{15}H_{22}O_3$: 250.1570); $C_{14}H_{19}O_2$, 235.1311, (Calcd for $C_{14}H_{17}O_2$: 235.1335); $C_{15}H_{20}O_2$, 232.1451 (Calcd for $C_{15}H_{20}O_2$: 232.1464); $C_{14}H_{22}O_2$, 222.1596 (Calcd for $C_{14}H_{22}O_2$, 222.1621, $C_{14}H_{17}O_2$ (Calcd for $C_{14}H_{17}O_2$: 217.1231). IR ν_{max}^{KBr} cm^{-1}: 3350, 2940, 1780, 1650, 1450, 1205, 985, 890. MS m/z: 250 (M^+, 6), 232 ($M^+ - H_2O$, 27), 158 (77), 121 (96), 107 (96), 81 (100).

Dehydration of IVa——IVa (6 mg) was dissolved in pyridine (0.5 ml) and 3 drops of $POCl_3$ were added to the mixture. The mixture was left to stand for 2 h at room temperature, then excess H_2O was added in order to destroy the reagent. The aqueous solution was extracted with ethyl acetate 4 times. The residue from the extract was purified by HPLC to afford a colorless oil, IVb (1 mg). ^{1}H-NMR: Table I. HPLC conditions: column, Develosil ODS-7 column 4.6 mm × 25 cm; eluent, H_2O–CH_3CN (40 : 60).

Enzymatic Hydrolysis of Ixerin W (XI)——XI (1 mg) was dissolved in water (0.5 ml) and the solution was treated with crude hesperidinase (5 mg) for 1 h at 38 °C with stirring, then the reaction mixture was extracted with ethyl acetate 4 times. The ethyl acetate extract was purified by HPLC to give XIa (0.2 mg) as an amorphous powder. ^{1}H-NMR: Table I. $C_{15}H_{18}O_3$, 246.1228 (Calcd for $C_{15}H_{18}O_3$: 246.1257); $C_{15}H_{16}O_3$, 246.1105 (Calcd for $C_{15}H_{16}O_3$: 246.1101); $C_{12}H_{13}O$, 173.0965 (Calcd for $C_{12}H_{13}O$: 173.0967); $C_8H_5O_3$, 149.0272 (Calcd for $C_8H_5O_3$: 149.0240); $C_{10}H_{12}O$, 148.0877 (Calcd for $C_{10}H_{12}O$: 148.0889); $C_{10}H_{11}O$, 147.0804 (Calcd for $C_{10}H_{11}O$: 147.0810); $C_9H_{11}O$, 135.0781 (Calcd for $C_9H_{11}O$: 135.0910); $C_9H_{10}O$, 134.0729 (Calcd for $C_9H_{10}O$; 134.0731). MS m/z: 246 (M^+, 31), 231 (12), 217 (16), 203 (9), 173 (11), 91 (57), 55 (47), 42 (100). It was shown to be identical with bracyraenolide[10] by comparison of spectral data.

Acid Hydrolysis of Ixerin U (III), V (IV), W (XI)——A solution of a glycoside (*ca.* 0.1 mg) in 10% H_2SO_4 (2 drops) was heated in a boiling water bath for 30 min. The solution was passed through an Amberlite IR-45 column and concentrated to give a residue, which was reduced with $NaBH_4$ (*ca.* 2 mg) for 30 min at room temperature. The reaction mixture was passed through an Amberlite IR-120 column and concentrated to dryness. Boric acid was removed by co-distillation with methanol. The residue was acetylated by acetic anhydride and pyridine (each 1 drop) at 100 °C for 1 h. The reagents were evaporated off *in vacuo*. Glucitol acetate was detected by GC. GC conditions: column, 1.5% OV-17, 3 mm × 1 m; column temperature, 215 °C; carrier gas, N_2; t_R, 6.0 min.

Acknowledgement We thank the staff of the Central Analytical Laboratory of this college for elemental analyses and measurement of MS.

References and Notes

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