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Chemical Study on the Root of *Ulmus macrocarpa*

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왕느릅나무의 성분 연구

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Abstract

From the root of *Ulmus macrocarpa* Hance, Caffeic acid, (+)-catechin and (+)-catechin-5-0-β-D-apiofuranoside were isolated.

Key Words : *Ulmus macrocarpa*, Ulmaceae, Caffieic acid, catechin, catechinglycoside.

緖 言

The roots of *Ulmus macrocarpa* Hance are used in Korea as a folk medicine "You Pi(楡皮)" for treatment of gastric cancer, gastroenteric disorder, granulating, eruption, hemorrhoid and mastitis[1,2].

Chemical constituients of Fig. Ulmus davidiana Planch Fig. var. japonica Nakai have been studied by authors[1]. However, until now no work has been done on the constituents of *Ulmus macrocarpa*. *In the course of our chemical studies on biologopcally active constituents of Korean folk medicines, we investigated the constituents of the root of Ulmus macrocarpa* and isolated caffeic acid (1), (+)-catechin (2) and catechinapioside (3). Up to now, a number of catechin type glycoside[3,4] and many glycosides having an apiosyl moiety have been reported[5-8].

Column chromatography of the methanol extract of the root of *Ulmus macrocarpa* have 1, 2 and 3. 1, caffeic acid was identified with authentic sample[9]. 2, $[\alpha]_D$+11.9° (MeOH), was shown by its IR spectrum to have hydroxyl and aryl groups.

The mass, ^1H and ^{13}C NMR(Table 1) spectra of 2 showed fragments and signals assignable to (+)-catechin[10-12]. Acetylation of 2 liberated pentaacetate 2a, whereas methylation of 2 afforded tetramethylate 2b and pentamethylate 2c. The isolated 2 and its derivative(2a, 2b) had mp, $[\alpha]_D$, $_1H$ and ^{13}C NMR spetra identical to published data[10-12]. Based on the above evidence, 2 was determined as (+)-catechin.

The IR spectrum of 3, $[\alpha]_D$-43.7(MeOH), shows the presence of hydroxyl and aryl groups. From the ^1H (experimetal) and ^{13}C NMR(Table 1) spectra of 3, 3 was suggested to catechin monoglycoside. Acid hydrolysis of 3 furnished (+)-catechin(2)[10-12] and methyl apiofuranoside[8] on the basis of the spectral evidence. An optical rotation($[\alpha]_D^{22}$+8.9° (H_2O, 10hr) : lit.[8]:$[\alpha]_D^{22}$+9.1°) of apiose, which was obtained from acid hydrolysis of methyl apiofuranoside with 10% aq. H_2SO_4, indicated the presence of D-apiose in 3. The anomeric configura-

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tion at the D-apiofuranoside linkage in 3 was assigned as β on the bases of the difference in molecular optical rotation($\Delta[M]_D$-219° ; lit[13]: methyl-α-D-apiofuranoside, $\Delta[M]_D$+221° ; methyl-β-D-apiofuranoside obtained by acid hydrolysis of 3[8]).

Acethylation of 3 gave heptaacetate 3a, whereas methylation of 3 by prolanged CH_2N_2 treatment affored tetramethylate 3b and pentamethylate 3c. The ^1H NMR spectra of 3a, 3b and 3c suggested that sugar moiety is substituted in the phenolic hydroxyl, since there are three aromatic acetyl and methoxyl groups, and four aliphatic acetyl, and one and two methoxyl groups, respectively(experimental). The location of the sugar moiety in 3 was confirmed by mass fragment patterns of 3b and 3c; RDA fragments of B-ring were observed at m/z 180, respectively, by comparison of the ^{13}C NMR spetra of 2 & 3 and 2b & 3b; the carbon resonance of C-10 was shifted downfield by 2.6ppm and 3.3ppm, respectively, while the carbon resonances of C-3′ and C-4′ nearly remained unchanged(Table 1), and by application of a positive Gibbs' test (for phenol with no substituent in the para position)[4] on 7,3′,4′-tri-O-methyl-(+)-cate-chin[14] which was obtained by acid hydrolysis of 3c. Accordingly, from these observations, the structure of compound 3 was determined as (+)-catechin-5-0-β-D-apiofuranoside.

Experimental and Method

Extraction and Isolation

The air-dried root(1kg) of *Ulmus macrocarpa*, collected at Cheon Ri Po Herbal Garden, Chung Cheong Buk Do, in August, 1989, were pulverized and extracted with methanol for 5hr(3times). All the filtrates were concentrated under reduced pressure to affored the extract(67.7g). The extract(6g) was subjected to silica gel column chromatography (SiO_2, 70-230mesh, Merck) developing with $CHCl_3$-MeOH(10:1→3:1) to furnish caffeic acid fraction (100mg), (+)-catechin fraction(250mg) and uldavioside A fraction(550mg). The fraction containing caffeic acid(100mg) was recrystalized from MeOH(1, 90mg). The (+)-catechin (250mg) fraction was purified with Sephadex LH-20(MeOH) to afford (+)-catechin (2) (180mg). The uldavioside A fraction (550mg) was successively purified by Si gel ($CHCl_3$-MeOH=5:1), Sephadex LH-20 (MeOH), and HPLC(Semi Prep Zorbax ODS, MeOH-H_2O=5:1) to furnish ulidavioside A(3) (287mg).

1. Pale brown needles(from MeOH), mp 196-197 ℃. ^1H NMR(methanol-d_4) δ:6.23(1H, d, J=15.9Hz, α-H), 6.78(1H, d, J=8.2Hz, 5-H), 6.93(1H, dd, J-8.2, 2.0Hz, 6-H), 7.04(1H, d, J=2.0Hz, 2-H), 7.53(1H, d, J=15.9Hz, β-H). ^{13}C NMR(methanol-d_4) δ:115.9(d, C-5), 116.4(d, C-2), 117.3(d, C-α), 171.9(s, COOH), 123.6(d, C-6), 128.6(s, C-1), 147.5(s, C-3), 147.8(d, C-β), 150.2(s, C-4). The ^1H and ^{13}C NMR data were identical with those of an authentic sample.

2. yellowish amorphous solid, mp 175-176°, $[\alpha]_D$ +11.9°(MeOH, c 1.0). UV λ_{MaX}^{MeOH} nm(logε) : 284 (3.29). IR $\nu_{MaX}^{KBr}cm^{-1}$: 3254, 1610. EIMS(probe), m/z(rel. int.) : 290[M^+](48), 272[M^+-H_2O](3), 152(46), 139(100). ^1H NMR(500MHz, pyridine-d_5) : δ 5.19(1H, d, J=7.5Hz, H-2), 4.59(1H, ddd, J=8.5, 7.5, 5.5Hz, H-3), 3.31(1H, dd, J=16.0, 8.5Hz, H-4), 3.67(1H, dd, J=16.0, 5.5Hz, H-4), 6.73, 6.64(both 1H, d, J=2.0Hz, H-6 and H-8), 7.64 (1H, d, J=1.8Hz, H-2′), 7.24(1H, d, J=8.0Hz, H-5′), 7.20(1H, dd, J=8.0, 1.8Hz, H-6′). ^{13}C NMR : as shown in Table I.

3. anorphous solid, $[\alpha]_D$ -43.7°(MeOH, c 0.52). IR $\nu_{MaX}^{KBr}cm^{-1}$: 3380(br), 1615, 1600, 1040. ^1H NMR(500MHz, pyridine-d_5) : δ 5.17(1H, d, J=7.5Hz, H-2), 4.53(1H, ddd, J=8.0, 7.5, 5.5Hz, H-3), 3.57(1H, dd, J=16.0, 5.5Hz, H-4), 3.25(1H, dd, J=16.0, 8.0Hz, H-4), 6.80, 6.75(both 1H, s, H-6 and H-8), 7.25(1H, s, H-2′), 7.22(1H, d, J=8.0Hz, H-5′), 7.17(1H, d, J=8.0Hz, H-6′), 6.21

(1H, d, J=2.5Hz, H-1″), 4.97(1H, d, J=2.5Hz, H-2″), 4.67, 4.39(Abq, J=9.5Hz, H_2-4″), 4.17, 4.15 (both 1H, s, H_2-5″). ^{13}C NMR : as shown in Table 1.

Acid Hydrolysis of 3

A soln of 3(80mg) in 9% dry methanolic HCl(1.5ml) was stirred at r.t. for 3hr(N_2 atomosphere). The reaction mixture was neutraliized with Ag_2CO_3 and filtrated. The residue, obtained by removal of the solvent, was purified by Si gel($CHCl_3$-MeOH=7:1) and then with Sephadex LH-20(MeOH) to furnish an aglycone(30mg) and methyl apiofuranoside(15 mg). The agylcone was identical([α]$_D$, ^1H NMR (500MHz, pyridine-d_5) : δ5.36(1H, d, J=2.5Hz, H-1), 4.63(1H, d, J=2.5Hz, H-2), 4.47, 4.30(ABq, J=9.5Hz, Hz-4), 4.10, 4.07(ABq, J=11.0Hz, H_2-5), 3.40(3H, s, H-methoxyl). ^{13}C NMR(125MHz, pyridine-d_5) : δ111.4(C-1), 77.6(C-2), 80.3(C-3), 74.9(C-4), 65.2(C-5), 55.2(C-methoxyl).

Heptaacetate(3a) of Compound 3

3a, [α]$_D$-40° ($CHCl_3$, c 1.2), IR $\nu_{MaX}^{CHCl_3}cm^{-1}$: 1760(*sh*), 1745(*br*), 1217. EIMS(probe), m/z(rel. int.) : 457[M^+-apiose moiety](2), 398[458-AcOH](14), 356[398-$COCH_2$](10), 314[356-$COCH_2$](9), 272 [314-$COCH_2$](8), 259(98), 139[259-2AcOH] (100), 97(16), 43(44). ^1H NMR(500MHz, $CDCl_3$) : δ5.15(1H, d, J=6.0Hz, H-2), 5.24(1H, ddd, J=6.0, 6.0, 5.0Hz, H-3), 2.78(1H, dd, J=16.5, 5.0Hz, H-4), 2.61(1H, dd, J=16.5, 6.0Hz, H-4), 6.58, 6.45(both 1H, d, J=2.5Hz, H-6 and H-8), 7.16(1H, s, H-2′), 7.18(1H, d, J=8.5Hz, H-5′), 7.23(1H, dd, J=8.5, 1.8Hz, H-6′), 5.61(1H, s, H-1″), 5.59 (1H, s, H-2″), 4.82, 4.63(ABq, J=12.5Hz, H_2-4″), 4.38, 4.23(ABq, J=10.5Hz, H_2-5″), 2.27, 2.26, 2.25(each 3H, s, aromatic acetyls), 2.12, 2.11, 2.05, 1.98(each 3H, s, aliphatic acetyls). ^{13}C NMR : as shown in Table 1.

Tetrametyhlate(3b) and Pentamethylate(3c) of Compound 3

3b, [α]$_D$-77.8° (MeOH, c 1.0), IR $\nu_{MaX}^{CHCl_3}cm^{-1}$: 3380 (*br*), 1614, 1595, 1024. EIMS(probe), *m/z*(rel. int.) : 478[M^+](15), 332[M^+-apiose moiety](94), 180 (100), 165(16), 153(90), ^1H NMR(500MHz, $CDCl_3$) : δ4.64(1H, d, J=8.5Hz, H-2), 4.03(1H, ddd, J=9.0, 8.5, 5.5Hz, H-3), 3.04(1H, dd, J=16.5, 5.5Hz, H-4), 2.58(1H, dd, J=16.5, 9.0Hz, H-4), 6.30, 6.19(both 1H, d, J=2.5Hz, H-6 and H-8), 6.95 (1H, s, H-2′), 6.88, 6.97(both 1H, d, J=8.0Hz, H-5′ and H-6′), 5.63(1H, d, J=1.5Hz, H-1″), 3.83 (1H, d, J=1.5Hz, H-2″), 3.94, 3.89(ABq, J=10.0Hz, H_2-4″), 3.79, 3.51(ABq, J=7.5Hz, H_2-5″), 3.88, 3.88, 3.80(each 3H, s, aromatic methoxyls). 3.56(3H, alipatic methoxyl). ^{13}C NMR : as shown in Table I. 3c, [α]$_{DD}$-68.0° ($CHCl_3$, c 0.5), IR $\nu_{MaX}^{CHCl_3}cm^{-1}$: 3580, 1618, 1597, 1060, 1027. EIMS(probe), *m/z* : (rel. int.) : 492[M^+](32), 332[M^+-api-ose moiety](77), 313(16), 180(100), 165[180-CH_3](17), 153(76). ^1H NMR(500MHz, $CDCl_3$) : δ 4.64(1H, d, J=8.5Hz, H-2), 4.04(1H, ddd, J=9.0, 8.5, 6.0Hz, H-3), 3.05(1H, dd, J=16.5, 6.0Hz, H-4), 2.59(1H, dd, J=16.5, 9.0Hz, H-4), 6.32, .22(both 1H, d, J=2.5Hz, H-6 and H-8), 6.95(1H, d, J=1.8Hz, H-2′), 6.88(1H, d, J=8.2Hz, H-5′), 6.97(1H, dd, J=8.2, 1.8Hz, H-6′), 5.63(1H, d, J=2.5Hz, H-1″), 3.44, 3.42(ABq, J=11.0Hz, H_2-5″), 3.89, 3.89, 3.81 (each 3H, s, aromatic methoxyls), 3.55, 3.50(both 3H, s, aliphatic methoxyls). ^{13}C NMR : as shown in Table 1.

Acid Hydrolysis of 3c

A soln of 3c(10mg) in 9% dry methanolic HCl (1ml) was stirred at r.t. for 3hr(N_2 atmosphere). The reaction mixture was treated as descibed in the case of 3 and the residue thus obtained was purified by Si gel(*n*-hexane-AcOEt-MeOH=3:3:0.1) to give 7.3′,4′-tri-O-methyl-(+)-catechin(5mg) identical to published date[14].

Acknolwledgement

Table 1. ^{13}C NMR data for compounds 2, 2a, 2b, 2c, 3, 3a, 3b and 3c[a]

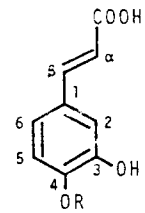
carbon	2	2a[b]	2b	2c	3	3a[c]	3b	3c
2	82.9	77.6	81.4	79.8	82.9	77.4	81.7	81.8
3	68.1	68.2	67.5	76.8	67.8	68.3	68.0	68.2
4	29.3	23.9	27.4	24.8	29.2	23.4	27.6	27.8
5	157.1[d]	149.4[d]	159.3[d]	158.7[d]	157.9[d]	155.5[d]	158.7[d]	158.8[d]
6	96.5[e]	108.7[e]	92.8[e]	93.0[e]	97.1[e]	104.0[e]	96.8[e]	97.1[e]
7	158.1[d]	154.3[d]	158.3[d]	158.7[d]	156.8[d]	154.5[d]	156.3[d]	156.7[d]
8	95.4[e]	107.6[e]	91.4[e]	91.8[e]	96.1[e]	103.8[e]	93.1[e]	93.1[e]
9	158.5[d]	149.8[d]	155.0	155.3	157.8[d]	149.8	155.2	155.3
10	100.8	110.1	101.5	101.4	103.4	106.7	104.8	103.4
1′	132.0	136.1	130.5	131.7	131.8	136.2	130.4	130.4
2′	115.8[f]	123.6[f]	109.9[f]	110.1[f]	115.7[f]	123.5[f]	110.1[f]	110.0[f]
3′	146.9	142.1[g]	148.8	149.0[g]	146.9	142.0[g]	149.3	149.4
4′	146.9	142.0[g]	148.8	148.9[g]	146.9	141.9[g]	149.3	149.4
5′	116.2[f]	124.3[f]	110.8[f]	111.1[f]	116.1[f]	124.2[f]	111.2[f]	111.3[f]
6′	119.5	121.7	119.6	119.5	119.4	121.5	119.9	119.9
1″					108.8	102.1	103.4	105.5
2″					77.8	76.1	86.1	86.5
3″					80.0	83.5	79.4	78.6
4″					75.4	73.0	75.0	75.0[g]
5″					64.5	62.7	65.5	74.8[g]
$-OCH_3$			55.5	57.3			59.1	59.6
			55.5	55.9			55.9	59.2
			55.0	55.9			55.9	56.0
			54.9	55.5			55.6	56.0
				55.4				55.6

[a]2 was measured at 22.5MHz and 3 was at 125MHz in pyridine-d_5(135.5ppm) as the internal standard, and 2a, 2b, 2c, 3a, 3b and 3c were at 125MHz in $CDCl_3$(77.1ppm) as the int. stnadard.

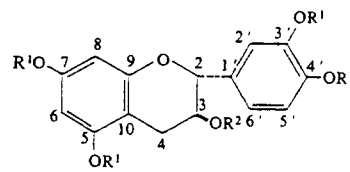
[b]Acetyle unit : 170.0, 168.8, 168.2, 167.9, 167.9, 21.0, 20.8, 20.6, 20.5, 20.5.

[c]Acetyl unit : 170.3, 170.0, 169.5, 168.9, 168.4, 167.8, 167.8, 23.4, 20.6, 20.5, 20.5, 20.4, 20.3, 20.2.

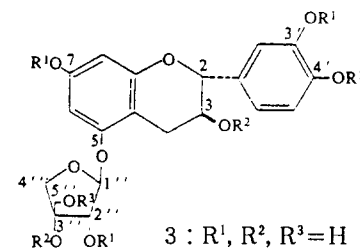
[d-g]Assignments may be interchangeable within the same vertical column.



1 : R=H



2 : R^1, R^2=H
2a : R^1, R^2=Ac
2b : R^1=Me, R^2=H
2c : R^1, R^2=Me



3 : R^1, R^2, R^3=H
3a : R^1, R^2, R^3=Ac
3b : R^1=ME, R^2, R^3=H
3c : R^1, R^3=Me, R^2=H

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