Natural Product Sciences
16(1) : 15-19 (2010)

Lignans from Lonicerae caulis

Min Hye Yean[1], Ju Sun Kim[1], Je-Hyun Lee[2], and Sam Sik Kang[1,*]

[1]*Natural Products Research Institute and College of Pharmacy, Seoul National University, Seoul 151-742, Korea*
[2]*Department of Korean Medicine, College of Oriental Medicine, Dongguk University, Gyeongju 780-714, Korea.*

Abstract – A new 2,7'-cyclolignan named lonicerinol (**1**) along with eight known lignans, (−)-epipinoresinol (**2**), (−)-pinoresinol (**3**), 9α-hydroxypinoresinol (**4**), 7*R*,8*S*-dihydrodehydrodiconiferyl alcohol (**5**), (±)-neo-olivil (**6**), (+)-isolariciresinol (**7**), 3-methoxy-8,4'-oxyneoligna-3',4,7,9,9'-pentol (**8**), and (−)-pinoresinol 4-*O*-glucoside (**9**), were isolated from the caulis of *Lonicera japonica* THUNB. (Caprifoliaceae). All of these constituents except for (−)-pinoresinol (**3**) and 9α-hydroxypinoresinol (**4**) are reported for the first time from the genus *Lonicera*. The structures and absolute configurations of these compounds were determined on the basis of spectroscopic analysis, including CD and 1D- and 2D-NMR techniques and chemical methods.
Keywords - *Lonicera japonica*; Caprifoliaceae; caulis; lignan

Introduction

Lonicera (Caprifoliaceae) is a genus of about 200 species of erect climbing or scrambling shrub distributed chiefly in the sub-tropical and temperate regions of the Northern Hemisphere (Evans, 2002). The caulis of *Lonicera japonica* Thunb., Japanese honeysuckle, has been used to treat urinary disorders, fever and headache. It has been well known as an anti-inflammatory and antiviral agent in Korea from ancient times and is used widely for upper respiratory tract infections, diabetes mellitus and rheumatoid arthritis (Kwak *et al*., 2003; Lee *et al*., 1998; Son *et al*., 1992). Previous investigations of *L. japonica* have yielded flavonoids, iridoids, triterpenoid saponins and other compounds (Kawai *et al*., 1988; Kawai *et al*., 1998; Kumar *et al*., 2005; Kwak *et al*., 2003; Lee *et al*., 1998; Machida *et al*., 2002; Shoji *et al*., 1990; Son *et al*., 1992; Son *et al*., 1994a,b). However, no chemical investigation on lignans from *L. japonica* has been reported so far.

As part of our efforts to isolate the chemical constituents of Lonicerae caulis to evaluate *L. japonica* qualitatively, we isolated a number of major and minor constituents from the caulis of *L. japonica* (Kim *et al*., 2009a,b,c). This paper describes the structural elucidation of a new aryltetraline lignan, lonicerinol (**1**), together with the isolation of eight known lignans.

*Author for correspondence
Tel: +82-2-8802481; E-mail: sskang@snu.ac.kr

Experimental

Analytical methods – The following instruments were used to obtain physical data: Optical rotation, Jasco P-1020 polarimeter (l = 1 cm); CD spectra, Jasco J-715 spectrometer; UV spectra, Hitachi U-3010 spectrometer; IR spectra, Jasco FT/IR 300E spectrometer; EI-MS, Jeol JMS-700 mass spectrometer; ^{1}H-NMR spectra, Bruker/Avance-500 (500 MHz) spectrometer; ^{13}C-NMR spectra, Bruker/Avance-500 (125 MHz) spectrometer (The chemical shifts (δ) are reported in part per million (ppm) and J values in Hz, using CD_3OD). TLC were performed using Kiesel gel 60 F_{254} (precoated, Merck, art. 5715) and RP-18_{254s} (Merck, art. 5685) plates, and detection was achieved by spraying with 10% H_2SO_4 followed by heating. Column chromatography was carried out on Kiesel gel 60 (70 – 230 mesh, Merck, art. 7734), Kiesel gel 60 (230 – 400 mesh, Merck, art. 9385), Kiesel gel 60 (finer than 230 mesh, Merck, art. 7729), Lichroprep RP-18 (particle size 40 – 63 μm, Merck) and Sephadex LH-20 (Pharmacia Biotech AB).

Plant material – The caulis of *Lonicera japonica* was collected in Bonghwa mountain, Gyeongsangbuk-do province, South Korea, in March 2007, and authenticated by Dr. J.-H. Lee (College of Oriental Medicine, Dongguk University). A voucher specimen was deposited in the herbarium of the College of Oriental Medicine, Dongguk University.

Extraction and Isolation – The caulis of *L. japonica* (15.6 kg) were chopped into small pieces and refluxed

with 70% EtOH for 3 h at 70 – 80 °C. The 70% EtOH extract was evaporated to dryness under reduced pressure and then partitioned successively between H_2O and hexane (81.3 g), CH_2Cl_2 (97.8 g), EtOAc (127.2 g), and then BuOH (491.5 g). The CH_2Cl_2 fraction (97.8 g) was fractionated by column chromatography (CC) over silica gel (7734) with hexane, hexane/CH_2Cl_2 (1 : 1), CH_2Cl_2/MeOH (gradient) to yield 35 subfractions (Fr. C-01 – Fr. C-35). Fraction C-11 (6.0 g) was purified on a CC (silica gel; 7729, hexane/EtOAc; gradient). Subfraction C-11-7577 (150 mg) was further purified by CC (silica gel; 7729, CH_2Cl_2, CH_2Cl_2/MeOH; 100 : 0.5), among which subfraction C-11-7577-69 (25 mg) was rechromatographed on an RP-18 column with 60% MeOH to afford **2** {(–)-epipinoresinol, 7 mg}. Subfraction C-11-7980 (150 mg) was further purified by CC (silica gel; 7729, CH_2Cl_2/MeOH/H_2O; 7 : 0.1 : 0.5) to yield subfraction C-11-7980-208 (100 mg) and rechromatographed on an RP-18 column with 50% MeOH afforded **3** {(–)-pinoresinol, 30 mg}. EtOAc fraction (126.2 g) was fractionated by CC over silica gel (7734) with CH_2Cl_2/MeOH (gradient) to yield 20 subfractions (Fr. E-01 – Fr. E-20). Fr. E-7 (6.05 g) was purified on a CC (silica gel; 7734, hexane/EtOAc; gradient). Subfraction E-7-49 (1.3 mg) was fractionated by CC (silica gel; 9385, CH_2Cl_2/MeOH/H_2O; 7 : 0.1 : 0.5 → 7 : 2 : 0.5) to give Fr. E-7-49-13 (58 mg) and rechromatographed on a Sephadex LH-20 column with CH_2Cl_2/MeOH (5 : 5) afforded Fr. E-7-49-13-1116 (50 mg). Fr. E-7-49-13-1116 (50 mg) was further purified by silica gel (7729) with CH_2Cl_2/MeOH/H_2O (7 : 0.5 : 0.5) to afford **5** (7*R*,8*S*-dihydrodehydrodiconiferyl alcohol, 13 mg), **6** {(±)-neo-olivil, 3 mg}, **7** {(+)-isolariciresinol, 1.5 mg}. **4** (9α-hydroxypinoresinol, 5mg) was obtained from Fr. E-7-50 by recrystallization. Fr. E-12 (7.0 g) was further purified on a silica gel column (hexane/EtOAc; gradient). Subfraction E-12-911 (800 mg) was fractionated by CC (silica gel; 7734, CH_2Cl_2/MeOH/H_2O; 7 : 0.1 : 0.5 → 7 : 2 : 0.5). Fr. E-12-911-1526 (48 mg) was purified by silica gel (7729) with EtOAc saturated with H_2O/MeOH (gradient) to afford **8** (3-methoxy-8,4'-oxyneoligna-3',4,7,9,9'-pentol, 2 mg). Subfraction E-12-911-2740 (34 mg) was rechromatographed on an RP-18 column with 60% MeOH to afforded **1** (2 mg). Subfraction E-12-1731 (1.59 g) was fractionated by CC (silica gel; 7734, CH_2Cl_2/MeOH/H_2O; 7 : 1 : 0.5 → 7 : 3 : 1). Subfraction Fr. E-12-1731-711 (124 mg) was purified by silica gel (9385) with CH_2Cl_2/MeOH/H_2O (7 : 0.5 : 0.5 → 7 : 3 : 1) to afforded **9** {(–)-pinoresinol 4-*O*-glucoside, 105 mg}. The

Table 1. ^{1}H- and ^{13}C-NMR data and key HMBC correlations of **1**

Position	δ_H	δ_C	HMBC
1	–	130.5 (C)	
2	–	124.8 (C)	
3	–	148.2 (C)	
4	–	145.9 (C)	
5	–	137.8 (C)	
6	6.44 (br s)	111.3 (CH)	C-2, 4, 5, 7
7	2.46 (dd, 11.7, 14.8)	33.3 (CH_2)	C-1, 2, 6, 8, 9, 8'
	2.59 (dd, 4.8, 14.8)		
8	1.58 (m, $W_{1/2} \geq 26$ Hz)	41.1 (CH)	C-7, 9, 8', 9'
9	3.42 (dd, 6.9, 10.8)	67.0 (CH_2)	C-7, 8, 8'
	3.54 (dd, 5.2, 10.8)		
3-OCH_3	3.36 (s)	60.3 (CH_3)	C-3
1'	–	140.1 (C)	
2'	6.68 (d, 1.8)	113.3 (CH)	C-1', 3', 4', 6', 7'
3'	–	148.7 (C)	
4'	–	145.3 (C)	
5'	6.64 (d, 8.2)	115.7 (CH)	C-1', 3', 4', 6'
6'	6.48 (dd, 1.8, 8.2)	121.7 (CH)	C-2', 4', 5', 7'
7'	4.28 (d, 5.2)	41.7 (CH)	C-1, 2, 3, 8, 1', 2', 6', 8', 9'
8'	1.94 (m, $W_{1/2} \geq 15$ Hz)	49.1 (CH)	C-2, 7, 8, 9, 1', 9'
9'	3.46 (2H, d, 5.5)	64.5 (CH_2)	C-8, 7', 8'
3'-OCH_3	3.74 (s)	56.4 (CH_3)	C-3'

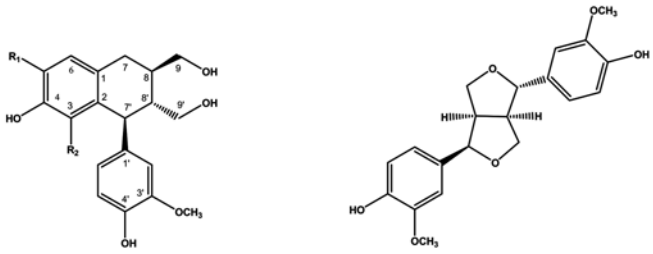
known lignans were identified as (−)-epipinoresinol (**2**), (−)-pinoresinol (**3**), 9α-hydroxypinoresinol (**4**), 7*R*,8*S*-dihydrodehydrodiconiferyl alcohol (**5**), (±)-neo-olivil (**6**), (+)-isolariciresinol (**7**), (7*R*,8*R*)-*threo*-4,7,9,3',9'-pentahydroxy-3-methoxy-8-*O*-4'-neolignan (= 3-methoxy-8,4'-oxyneoligna-3',4,7,9,9'-pentol) (**8**), and (−)-pinoresinol 4-*O*-glucoside (**9**), based on detailed NMR, CD, and MS analyses and comparison with the literature data.

Physical properties of lonicerinol (1): Lonicerinol (**1**), amorphous powder. $[\alpha]_D^{25}$ +20.5° (*c* = 0.04, MeOH). IR (KBr) cm^{-1}: 3370 (OH), 1609, 1514, 1462 (aromatic C = C), 1275, 1228, 1048, 938. UV λ_{max} (MeOH) nm (log ε): 282 (3.92). HREIMS *m/z*: 376.1513. Calcd for $C_{20}H_{24}O_7$: 376.1522. EIMS *m/z*: 376 $[M]^+$, 358 $[M - H_2O]^+$, 327, 313, 295, 281, 263, 234, 203, 191, 159, 153 $[CH_3O(OH)_2C_6H_2CH_2]^+$, 137. ^{1}H- and ^{13}C-NMR data (CD_3OD): Table 1. CD (MeOH, $c = 1.0 \times 10^{-4}$ M) Δε (nm): −1.80 (293), 8.19 (277), 19.04 (241).

Results and Discussion

The dried caulis of *L. japonica* was chopped, extracted with 70% EtOH and partitioned successively with H_2O and hexane, CH_2Cl_2, EtOAc and then *n*-BuOH. The CH_2Cl_2 and EtOAc soluble fractions were subjected to sequential column chromatography over silica gel, Sephadex LH-20 and RP-18 gel to yield a new minor lignan, lonicerinol (**1**), along with eight known lignans (**2** – **9**). The known lignans were identified as (−)-epipinoresinol (**2**) (Casabuono and Pomilio, 1994; Schöttner *et al*., 1997), (−)-pinoresinol (**3**) (Casabuono and Pomilio, 1994; Schöttner *et al*., 1997), 9α-hydroxypinoresinol (**4**) (Abe and Yamauchi, 1988; Khan and Shoeb, 1985), 7*R*,8*S*-dihydrodehydrodiconiferyl alcohol (**5**) (Matsuda *et al*., 1996; Takeda *et al*., 1998), (±)-neo-olivil (**6**) (Hanawa *et al*., 1997; Kikuchi and Kikuchi, 2005; Schöttner *et al*., 1997), (+)-isolariciresinol (**7**) (Jutiviboonsuk *et al*., 2005; Okuyama *et al*., 1995; Wang *et al*., 2008), (7*R*,8*R*)-*threo*-4,7,9,3',9'-pentahydroxy-3-methoxy-8-*O*-4'-neolignan (= 3-methoxy-8,4'-oxyneoligna-3',4,7,9,9'-pentol) (**8**) (Hou *et al*., 2008; Matsuda and Kikuchi, 1996a), and (−)-pinoresinol 4-*O*-glucoside (**9**) (Casabuono and Pomilio, 1994; Kudo *et al*., 1980), based on detailed NMR, circular dichroism (CD), and MS analyses and comparison with the literature data.

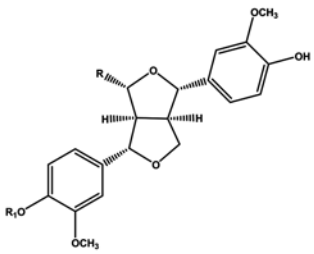
Lonicerinol (**1**) was obtained from EtOAc soluble fraction as an amorphous white powder. High-resolution (HR)-EI-MS exhibited an ion peak for $[M]^+$ at *m/z* 376.1513, which is compatible with molecular formula $C_{20}H_{24}O_7$ (Calcd 376.1522). The IR and UV spectra of **1** showed similar absorption patterns to those of isolariciresinol (Okuyama *et al*., 1995). The ^{1}H- and ^{13}C-NMR spectra of **1** exhibited signals characteristic of an aryltetralin type lignan (Agrawal and Thakur, 1985; Eklund *et al*., 2002; Ward *et al*., 1979; Yang *et al*., 2005). The ^{13}C-NMR and Distorsionless Enhancement by Polarization Transfer (DEPT) spectroscopic data showed signals for eight aromatic quaternary carbons, five of which are oxygenated quaternary, seven methines including four aromatic methines, one methylene, two oxygenated methylenes, and two methoxy carbons. In the ^{1}H-NMR spectrum, signals were at δ 3.36 (3H, s) and 3.74 (3H, s), one aromatic proton signal at δ 6.44 (1H, s) and a set of ABX-system of the aromatic ring at δ 6.48 (1H, dd, *J* = 1.8, 8.2 Hz), 6.64 (1H, d, *J* = 8.2 Hz), and 6.68 (1H, d, *J* = 1.8 Hz). The proton signal of methoxy at δ 3.36 (3H, s) was shielded by the aromatic ring (Ouyang *et al*., 2007; Raju and Pillai, 1989). ^{1}H-^{1}H Correlation Spectroscopy (COSY) spectrum showed the presence of a structural fragment -CH_2-CH(CH_2OH)-CH(CH_2OH)-CH-. The Heteronuclear Multiple-Bond Correlation (HMBC) experiment showed the linkages between H-6 and C-2, 4, and 7, between H-7' and C-3, 8, 1' and 9', and between H-7 and C-2, 6, 9 and 8', respectively. The methoxyl groups at δ 3.36 and 3.74 were linked to C-3 and C-3', as determined by their correlations with C-3 and C-3', respectively. The relative configurations at C-8, 8' and 7' were determined by Nuclear Overhauser Enhancement and Exchange Spectroscopy (NOESY) experiments, and corroborated by inspection of coupling constant (^3J) and the width of the multiplet at half height ($W_{1/2}$). The Nuclear Overhauser Enhancement (NOE) correlations between H-8 and H-7', H-8 and H-7α, H-7' and CH_2-9', H-8' and CH_2-9, and H-8' and H-7β revealed that H-7β, CH_2-9, H-8' and aryl group at C-7' were co-facial and arbitrarily defined as β-oriented. The vicinal two protons (H-7', 8') gave the coupling constant (*J* = 5.2 Hz), and the vicinal two protons (H-8, 8') showed the $W_{1/2} \geq 15$ Hz, indicating both were axial position. Thus, the three protons (H-7', 8', 8) were trans form each (Ouyang *et al*., 2007). Therefore, the relative configurations at C-7', C-8' and C-8 were decided as *rel*-(7'*S*,8'*R*,8*R*). Compound **1** exhibited the positive optical rotatory activity ($[\alpha]_D$ +20.5°) compared with (+)-isolariciresinol ($[\alpha]_D$ +65°) (Eklund *et al*., 2002), it is suggested (+)-isolariciresinol derivative. The absolute configuration of **1** was determined by examination of the CD spectrum of **1**, which showed the negative B-absorption. The sign of its CD spectrum indicated that the absolute configuration of the aryl substituent at C-7' is 7'*S* for **1**, since the sign of



1 R_1= OH R_2= OCH_3

7 R_1= OCH_3 R_2= H

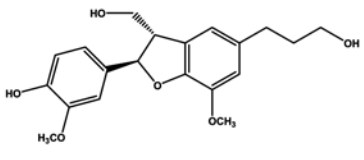
2



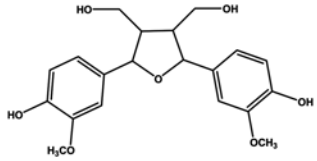
3 R= R_1= H

4 R= OH R_1= H

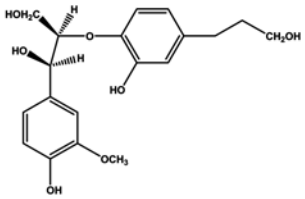
9 R= H R_1= Glc



5



6



8

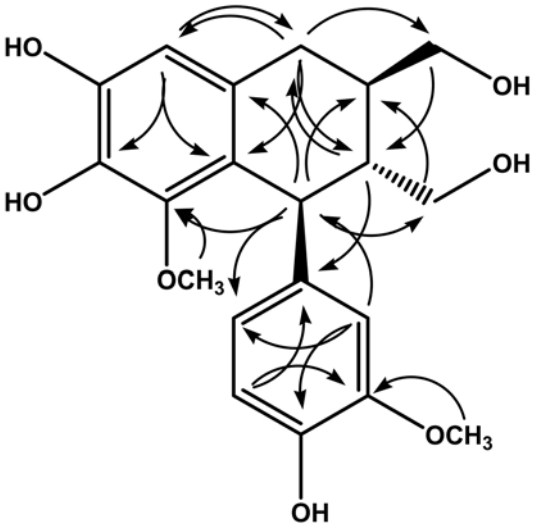


Fig. 1. Key HMBC correlations of **1**.

the first couplet reflects the aryl substituent at C-7', namely negative for 7'*S* and positive for 7'*R* (Ohashi *et al*., 1994; Sakakibara *et al*., 1974). Based on the above evidence, the structure of **1** was definitely determined to be (7'*S*,8'*R*,8*R*)-4,4',5,9,9'-pentahydroxy-3,3'-dimethoxy-2,7'-cyclolignan and designated by the name lonicerinol.

The other isolated lignans **2** – **9** were structurally elucidated by spectroscopic analysis and comparison with literature data. In previous studies, only three furofuran lignans (Khan and Shoeb, 1985; Lee *et al*., 2001; Matsuda and Kikuchi, 1996b) and six 8-*O*-4'-neolignans (Matsuda and Kikuchi, 1996a) have been reported from *Lonicera* species. In the present study, three different lignan skeletons were identified: the 2,7'-cyclolignans **1** and **7**, 7,7'-epoxylignan **6**, 7,9':7',9-diepoxylignans **2**, **3**, **4** and **9**, 8,3'-neolignan **5**, and 8-*O*-4'-neolignan **8**, all of which were isolated for the first time from *L. japonica*.

Acknowledgements

This research was supported by a grant (08182 KFDA252) from the Korea Food & Drug Administration in 2008.

References

Abe, F. and Yamauchi, T., 9α-Hydroxypinoresinol, 9α-hydroxymedioresinol and related lignans from *Allamanda neriifolia*. *Phytochemistry*, **27**, 575-577 (1988).

Agrawal, P.K. and Thakur, R.S., ^{13}C NMR spectroscopy of lignan and neolignan dirivatives. *Magn. Reson. Chem*., **23**, 389-418 (1985).

Casabuono, A.C. and Pomilio, A.B., Lignans and a stilbene from *Festuca argentina*. *Phytochemistry*, **35**, 479-483 (1994).

Eklund, P., Sillanpää, R., and Sjöholm, R., Synthetic transformation of hydroxymatairesinol from Norway spruce (*Picea abies*) to 7-hydroxysecoisolariciresinol, (+)-lariciresinol and (+)-cyclolariciresinol. *J. Chem. Soc. Perkin Trans*., I, 1906-1910 (2002).

Evans, W.C., Trease and Evans Pharmacognosy, 15th edition, Elsevier Science Ltd., London, P 35 (2002).

Hanawa, F., Shiro, M., and Hayashi, Y., Heartwood constituents of *Betula maximowiczana*. *Phytochemistry*, **45**, 589-595 (1997).

Hou, C., Liang, H., Zhao, Y., Wang, B., and Zhang, Q., Neolignan glycosides from *Symplocos caudate*. *Phytochemistry*, **69**, 788-795 (2008).

Jutiviboonsuk, A., Zhang, H., Tan, G.T., Ma, C., Hung, N.V., Cuong, N.M., Bunyapraphatsara, N., Soejarto, D.D., and Fong, H.H.S., Bioactive constituents from root of *Bursera tonkinensis*. *Phytochemistry*, **66**, 2745-2751 (2005).

Kawai, H., Kuroyanagi, M., Umehara, K., Ueno, A., and Satake, M., Studies on the saponins of *Lonicera japonica* THUNB. *Chem. Pharm. Bull*., **36**, 4769-4775 (1988).

Kawai, H., Kuroyanagi, M., and Ueno, A., Iridoid glucosides from *Lonicera japonica* THUNB. *Chem. Pharm. Bull*., **36**, 3664-3666 (1998).

Khan, K.A. and Shoeb, A., A lignan from *Lonicera hypoleuca*. *Phytochemistry*, **24**, 628-630 (1985).

Kikuchi, M. and Kikuchi, M., Studies on the constituents of *Swertia japonica* MAKINO II. On the structures of new glycosides. *Chem. Pharm. Bull*., **53**, 48-51 (2005).

Kim, J.S., Yean, M.H., Lee, S.Y., Lee, J.-H., and Kang, S.S., Phytochemical studies on Lonicera caulis (1) - Sterols and triterpenoids. *Kor. J. Pharmacogn*., **40**, 319-325 (2009a).

Kim, J.S., Yean, M.H., Seo, H.K., Lee, J.-H., and Kang, S.S., Phytochemical studies on Lonicera caulis (2) - Aliphatic and phenolic compounds. *Kor. J. Pharmacogn*., **40**, 326-333 (2009b).

Kim, J.S., Yean, M.H., Lee, S.Y., Lee, J.-H., and Kang, S.S., Phytochemical studies on Lonicera caulis (3) - Iridoids. *Kor. J. Pharmacogn*., **40**, 334-338 (2009c).

Kudo, K., Nohara, T., Komori, T., Kawasaki, T., and Schulten, H.R., Lignan glycosides from the bark of *Ligustrum japonicum*. *Planta Med*., **40**, 250-261 (1980).

Kumar, N., Singh, B., Bhandari, P., Gupta, A.P., Uniyal, S.K., and Kaul, V.K., Biflavonoids from *Lonicera japonica*. *Phytochemistry*, **66**, 2740-2744 (2005).

Kwak, W.J., Han, C.K., Chang, H.W., Kim, H.P., Kang, S.S., and Son, K.H., Loniceroside C, an antiinflammatory saponin from *Lonicera japonica*. *Chem. Pharm. Bull*., **51**, 333-335 (2003).

Lee, J.S., Kim, H.J., Woo, E.R., Whang Park Y.A., Lee, Y.S., and Park, H.K., 7-Feruloylloganin : An iridoid glucoside from stem of *Lonicera insularis*. *Planta Med*., **67**, 99-102 (2001).

Lee, S.J., Son, K.H., Chan, H.W., Kang, S.S., and Kim, H.P., Antiinflamatory activity of *Lonicera japonica*. *Phytother. Res*., **12**, 445-447 (1998).

Machida, K., Sasaki, H., Iijima, T., and Kikuchi, M., Studies on the constituents of *Lonicera* species. XVII. New iridoid glycoside of the stems and leaves of *Lonicera japonica* THUNB. *Chem. Pharm. Bull*., **50**, 1041-1044 (2002).

Matsuda, N., Sato, H., Yaoita, Y., and Kikuchi, M., Isolation and absolute structures of the neolignan glycosides with the enantiomeric aglycones from the leaves of *Viburnum awabuki* K. KOCH. *Chem. Pharm. Bull*., **44**, 1122-1123 (1996).

Matsuda, N. and Kikuchi, M., Studies on the constituents *of Lonicera* Species. X. Neolignan glycosides from the leaves of *Lonicera gracilipes* var. *glandulosa* MAXIM. *Chem. Pharm. Bull*., **44**, 1676-1679 (1996a).

Matsuda, N. and Kikuchi, M., Studies on the constituents of *Lonicera* species. XII. On the constituents of the leaves of *Lonicera gracilipes* var. *glandulosa* MAXIM. *Tohoku Yakka Daigaku Kenkyu Nempo*, **43**, 75-78 (1996b).

Ohashi, K., Watanabe, H., Okumura, Y., Uji, T., and Kitagawa, I., Indonesia medicinal plant. XII. Four isomeric lignan-glucosides from the bark of *Aegle marmelos* (Rutaceae). *Chem. Pharm. Bull.,* **42**, 1924-1926 (1994).

Okuyama, E., Suzumura, K., and Yamazaki, M., Pharmacologically active components of Todopon Puok (*Fagraea racemosa*), a medicinal plant from Borneo. *Chem. Pharm. Bull*., **43**, 2200-2204 (1995).

Ouyang, M.A., Wein, Y.S., Su, R.K., and Kuo, Y.H., Rhusemialins A-C, New cyclolignan esters from the root of *Rhus javanica* var. *roxburghiana*. *Chem. Pharm. Bull*., **55**, 804-807 (2007).

Raju, G.V.S. and Pillai, K.R., Lignans from *Justicia teanquebariensis* Linn.f. *Indian J. Chem*., **28B**, 558-561 (1989).

Sakakibara, J., Ina, H., and Yasue, M., Studies on the constituents of *Tripetaleia paniculata* SIEB. et ZUCC. IV. On the constituents of the wood. Structure of lyoniside. *Yakugaku Zasshi*, **94**, 1377-1383 (1974).

Schöttner, M., Reiner, J., and Tayman, F.S.K., (+)-Neo-olivil from roots of *Uritica dioica*. *Phytochemistry*, **46**, 1107-1109 (1997).

Shoji, Y., Naomi, K., and Toshihiro, N., Studies on the triterpenoid glycosides in Lonicerae caulis et folium. *Shoyakugaku Zasshi*, **44**, 339-342 (1990).

Son, K.H., Park, J.O., Chung, K.C., Chang, H.W., Kim, H.P., Kim, J.S., and Kang, S.S., Flavonoids from the aerial of *Lonicera japonica*. *Arch. Pharm. Res*., **15**, 365-370 (1992).

Son, K.H., Kim, J.S., Kang, S.S., Kim, H.P., and Chang, H.W., Isolation of flavonoids from *Lonicera japonica*. *Kor. J. Pharmacogn*., **25**, 24-27 (1994a).

Son, K.H., Jung, K.Y., Chang, H.W., Kim, H.P., and Kang, S.S., Triterpenoid saponins from the aerial parts of *Lonicera japonica*. *Phytochemistry*, **35**, 1005-1008 (1994b).

Takeda, Y., Mima, C., Masuda, T., Hirata, E., Takushi, A., and Otsuka, H., Glochidioboside, a glucoside of (7*S*,8*R*)-dihydrodehydrodiconiferyl alcohol from leaves of *Glochidion obovatum*. *Phytochemistry*, **49**, 2137-2139 (1998).

Ward, R.S., Satyanarayana, P., Row, L.R., and Rao, B.V.G., The case for a revised structure for *Hypophyllanthin* - an analysis of the ^{13}C N.M.R spectra of aryltetralins. *Tetrahedron Lett*., **20**, 3043-3046 (1979).

Wang, R.R., Gu, Q., Wang, Y.H., Zhang, X.M., Yang, L.M., Zhou, J., Chen, J.J., and Zheng, Y.T., Anti-HIV-1 activities of compounds isolated from the medicinal plant *Rhus chinensis*. *J. Ethnopharmacol*., **117**, 249-256 (2008).

Yang, Y.L., Chang, F.R., and Wu, Y.C., Squadinorlignoside : A novel 7,9-dinorlignan from the stem of *Annona squamosa*. *Helv. Chim. Acta*, **88**, 2731-2737 (2005).

Received October 3, 2009
Revised March 3, 2010
Accepted March 5, 2010