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MAGNOSTELLIN A AND B, NOVEL LIGNANS FROM *MAGNOLIA STELLATA*

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Key Word Index—*Magnolia stellata*, Magnoliaceae, lignans, sesamin, kobusin, eudesmin, (+)-piperitol, magnostellin A, magnostellin B, vomifoliol (blumenol A), ^{13}C NMR

Abstract—The phytochemistry of fresh leaves of *Magnolia stellata* was compared with that of *M kobus* Two new lignans, viz magnostellin A and magnostellin B were isolated together with sesamin, kobusin, eudesmin and (+)-piperitol The structures of magnostellin A and B were determined An α-ionone, vomifoliol (blumenol A) was also isolated from the same source

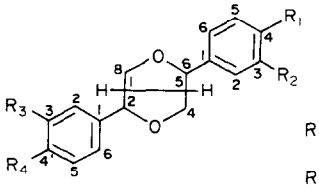
INTRODUCTION

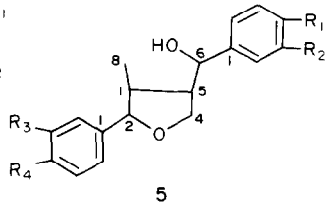
In a preceding paper, we investigated sesamin-type lignans and hydroperoxides of 9-oxonerolidol from *Magnolia kobus* [1] The title species (Japanese name Shide-kobushi), a valuable decorative plant, is only distributed in central districts of Japan The leaves and stems of *M stellata* were found to contain many mono- and sesquiterpenes [2] and a quarternary alkaloid, salicifoline [3]

Extensive chromatography on Si gel of chloroform extracts of fresh leaves of *M stellata* led to the isolation of a phenolic lignan, (+)-piperitol (**4**) and alcoholic tetrahydrofuranoid lignans, which were named magnostellin A (**5**) and magnostellin B (**6**), along with three known lignans [sesamin (**1**), kobusin (**2**), eudesmin (**3**)] and an α-ionone derivative [vomifoliol (**7**)] [4]

RESULTS AND DISCUSSION

The first lignan, was a colorless oil, $C_{22}H_{20}O_6$ (M^+, 356), $[\alpha]_D$ +45 2°($CHCl_3$) having a phenolic hydroxyl group and the same functional groups as those of kobusin (**2**) It shows a very similar ^1H NMR spectrum to that of (−)-piperitol which was isolated from *Xanthoxylum*





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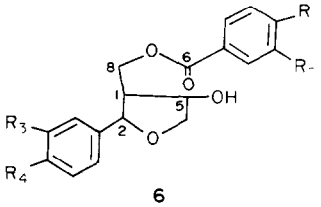
1 R_1, R_2 = $-OCH_2O-$, R_3, R_4 = $-OCH_2O-$

2 R_1, R_2 = $-OCH_2O-$, R_3 = R_4 = OMe

3 R_1 = R_2 = R_3 = R_4 = OMe

3a R_1 = R_2 = R_3 = R_4 = OMe, 2 β-H, 6 α-H

4 R_1 = OH, R_2 = OMe, R_3, R_4 = $-OCH_2O-$



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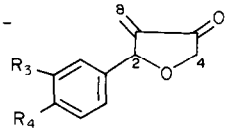

6a R_1 = R_2 = R_3 = R_4 = OMe

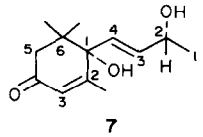

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Table 1 ^{13}C NMR data (δ-values) for magnostellin A (**5**) and magnostellin B (**6**)

Carbon no	**5**	**6**
1	44 0 *d*	56 0 *d*
2	87 8 *d*	83 5 *d*
4	69 5 *t*	74 6 *t*
5	48 1 *d*	75 0 *d*
6	73 1 *d*	166 3 *s*
8	13 0 *q*	63 4 *t*
1′	135 5 *s*	122 1 *s*
1″	136 4 *s*	133 2 *s*
2′	109 0 *d*	109 1 *d*
2″	109 6 *d*	110 3 *d*
3′	148 3 *s*	149 2 *s*
3″	148 6 *s*	148 9 *s*
4′	149 0 *s*	153 3 *s*
4″	149 1 *s*	148 7 *s*
5′	111 0 *d*	111 0 *d*
5″	111 2 *d*	112 1 *d*
6′	118 0 *d*	119 1 *d*
6″	118 4 *d*	123 6 *d*

Run in $CDCl_3$ at 25 MHz, *s*, singlet, *d*, doublet, *t*, triplet, *q*, quartet Assignment establishment by frequency off-resonance decoupling

piperitum [5, 6] When **4** was methylated with diazomethane it yielded kobusin (**2**) Hence, **4** was identified as (+)-piperitol

The second lignan, magnostellin A was obtained as a colorless oil, $C_{22}H_{28}O_6$ (M^+, 388), $[\alpha]_D$ + 68 0°($CHCl_3$) and showed IR absorption for a hydroxyl group at 3600 cm^{-1} The ^1H NMR spectrum revealed the presence of one secondary methyl, two methine protons (H-1, H-5) and two benzylic methine protons (H-2, H-6) attached to a carbon atom bearing a hydroxyl group and a furan oxygen group, along with six aromatic methoxyl groups and six aromatic protons In the ^1H NMR spectrum of its acetate, one benzylic methine proton signal [δ 5 82, (*d*, J = 6 5 Hz, H-6)] was shifted by 1 04 ppm downfield and the other signal (H-2) did not change These ^1H NMR data showed that magnostellin A had an α-substituted (3′,4′-dimethoxy)benzyl alcohol moiety and a veratryl group linked to the C-2 atom of the tetrahydrofuran ring From the above physical data and ^{13}C NMR spectral data (Table 1), the plane structure **5** is proposed

The relative stereostructure of **5** was determined by NOE experiments Irradiation at the frequency of the methine proton (H-8) enhanced 11 6% and 10 0% of the area intensity of the H-2 and H-6 signals, respectively Hence, the relationship between C-5–C-6, C-1–C-8 and H-2 was found to be *cis* in the plane of the tetrahydro ring (1*S*, 2*S*, 5*S*) Furthermore, the configuration (R) of the hydroxyl group attached to C-6 was also established using Horeau's method [7]

The third lignan, magnostellin B, colorless oil, $C_{22}H_{26}O_8$ $[\alpha]_D$ + 32 0°($CHCl_3$), showed a hydroxyl at 3500 cm^{-1} and ester group absorptions at 1720 cm^{-1} in its IR spectra Magnostellin B, on acetylation gave a monoacetate [*m/z* 460 $[M]^+$, IR ν_{max} ($CHCl_3$) cm^{-1} 1735, 1720] Oxidation with PPC in methylene chloride at room temperature afforded an exomethylene keto derivative (**6a**) [*m/z* 234 $[M]^+$, 203, 176, 161, 151, IR ν_{max} ($CHCl_3$) cm^{-1} 1740, 1650, 1610, 1600, ^1H NMR ($CDCl_3$) δ 4 24 (2H, *dd*, J = 16, 24 Hz, H-4), 5 24, 6 24 (2H, each *d*, J = 2 Hz, H-8), 5 64 (1H, *m*, H-2)] From the above experiments, ^{13}C NMR data (Table 1) and decoupling technique magnostellin B was found to have secondary hydroxyl, veratryl and veratric ester groups Therefore, a plane structure **6** is proposed

The relative stereostructure of **6** is proposed as follows In epieudesmin (**3a**) the coupling constant indicating a *cis* relation ($J_{1H\ 2H}$ = 7 Hz) is much larger than that of a *trans* relation ($J_{5H\ 6H}$ = 4 Hz) [1] From this result it is anticipated that the relation between H-1 and H-2 should be *cis* by the coupling constant ($J_{1H\ 2H}$ = 8 Hz) of **6** Furthermore, according to biogenetic considerations the formation of **6** should be from the oxidation of 5-hydroxyepieudesmin The *rel*-(1*S*,2*S*,5*S*) configuration is, therefore, proposed for **6**

EXPERIMENTAL

Mps are uncorr ^1H NMR (100 MHz) and ^{13}C NMR (25 MHz) $CDCl_3$ MS (70eV) direct insertion IR and $[\alpha]_D$ $CHCl_3$ UV MeOH Spots were detected on TLC in UV light (254 nm) after spraying with 10% H_2SO_4 and then heating at 100° Si gel 60 (70–230 mesh) was used for CC and Si gel F-254 for TLC (0 25 mm) and prep TLC (0 5 mm)

Extraction and separation of compounds The MeOH extract of fr leaves (6 6 kg) of *M stellata* Maxim collected in October 1980 at Nagoya, was divided into *n*-hexane and $CHCl_3$-soluble fractions The $CHCl_3$ fraction was extracted repeatedly with 2% HCl soln and taken-up as the base Evaporation of the solvent from the dried extract afforded a gummy residue (130 g) which was chromatographed on Si gel (500 g), using C_6H_6 with gradually increasing proportions of EtOAc as eluent, and further purified by prep TLC The known compounds were characterized by spectroscopic methods (IR, ^1H NMR, MS)

The first fraction (C_6H_6–EtOAc, 20 1) gave sesamin (**1**, 13 g), kobusin (**2**, 10 g), eudesmin (**3**, 4 g) and (+)-piperitol (**4**, 0 5 g) The second fraction (C_6H_6–EtOAc, 1 1) gave magnostellin A (**5**, 0 3 g) The third fraction (EtOAc) gave magnostellin B (**6**, 0 15 g) and vomifoliol (**7**, 0 7 g)

(+)-Piperitol (**4**) Colorless oil, $[\alpha]_D$ + 45 2°($CHCl_3$, *c* 1 0) IR $\nu_{max}^{CHCl_3}$ cm^{-1} 3570 1615 UV λ_{max}^{MeOH} nm 208, 232, 283 MS *m/z* 356 $[M]^+$ ($C_{20}H_{20}O_6$), 325, 151, 149 ^1H NMR δ 2 88–3 24 (2H, *m*, H-1, H-5), 3 88 (3H, *s*, OMe), 3 74–3 94 (2H, *m*, H-4, H-8), 4 18 (2H, *dd* J = 7, 9 Hz, H-4, H-8), 4 71 (2H, *d*, J = 4 Hz, H-2, H-6), 5 58 (1H, *s*, OH), 5 92 (2H, *s*, OCH_2O), 6 70–6 94 (6H, *m*, Ar-H) ^{13}C NMR δ 54 3 (*d*, C-1), 85 8 (*d*, C-2, C-6), 71 7 (*t*, C-4, C-8), 54 1 (*d*, C-5), 132 9 (*s*, C-1′), 135 1 (*s*, C-1″), 108 1 (*d*, C-2′), 106 5 (*d*, C-2″), 146 8 (*s*, C-3′), 148 0 (*s*, C-3″), 145 3 (*s*, C-4′), 147 1 (*s*, C-4″), 114 4 (*d*, C-5′), 108 7 (*d*, C-5″), 118 9 (*d*, C-6′), 119 3 (*d*, C-6″)

Magnostellin A [rel-(1S, 2S, 5S)-1-*methyl*-2-*veratryl*-5[6R(α-*hydroxy*-3′, 4′-*dimethoxybenzyl*)]*tetrahydrofuran*] (**5**) Colorless oil, $[\alpha]_D$ + 68 0° ($CHCl_3$, *c* 0 75) IR $\nu_{max}^{CHCl_3}$ cm^{-1} 3620, 1610, 1600 UV λ_{max}^{MeOH} nm (ε) 206, 230, 278 (21 973, 16 382, 5924) MS *m/z* 388 $[M]^+$ ($C_{22}H_{28}O_6$), 370, 250, 222, 194, 177, 167 ^1H NMR δ 1 1 (3H, *d*, J = 7 Hz, Me-1), 2 0 (1H, *m*, OH-6), 2 08 (1H, *m*, H-1), 2 66 (1H, *m*, H-5), 3 84 (12H, *s*, OMe), 3 94–4 30 (2H, *m*, H-4), 4 56 (1H, *d*, J = 6 Hz, H-2), 4 78 (1H, *d*, J = 6 5 Hz, H-6), 6 76–6 88 (6H, *m*, Ar-H) ^{13}C NMR Table 1

Magnostellin B [rel-(1S, 2S, 5S)-1-*veratroyloxymethyl*-2-*veratryl*-5-*hydroxytetrahydrofuran*] (**6**) Colorless oil, $[\alpha]_D$ + 32 0° ($CHCl_3$, *c* 0 8) ^1H NMR δ 2 5 (1H, *m*, H-1), 3 82, 3 84, 3 89 (12H, each *s*, OMe), 4 0 (2H, *d*, J = 4 Hz, H-4), 4 4 (2H, *d*, J = 6 Hz, H-8), 4 58 (1H, *d*, J = 8 Hz, H-2), 6 7–7 0 (4H, *m*, Ar-H), 7 36–7 56 (2H, *m*, Ar-H) ^{13}C NMR Table 1

Vomifoliol (*blumenol A*) (7) Mp 107–109° $[\alpha]_D$ +178 6° ($CHCl_3$, *c* 1 65) IR $\nu_{max}^{CHCl_3}$ cm^{-1} 3650–3200, 1665 UV λ_{max}^{MeOH} nm 236 MS *m/z* 224 $[M]^+$ ($C_{13}H_{20}O_3$), 206, 124 ^1H NMR δ 1 02, 1 08 (6H, each *s*, Me-6′), 1 28 (3H, *d*, *J* = 7 Hz, Me-2), 1 89 (3H, *s*, Me-2′), 2 30 (2H, *dd*, *J* = 17,26 Hz, H-5′), 2 6 (2H, *br s*, OH), 4 36 (1H, *m*, H-2), 5 8 (2H, *dd*, *J* = 16, 18 Hz, H-3, H-4), 5 88 (1H, *br s*, H-3′)

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