

은행잎의 새로운 화학성분 분석에 관한 연구

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A New Chemical Constituent of Green Leaves of *Ginkgo biloba* L.

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요약. 싱싱한 은행잎으로 부터 새로운 화학성분을 분리하여 그 구조식이 3-(펜타데시-8-에닐) 페놀임을 밝혔다.

ABSTRACT. A new chemical constituent was isolated from the green leaves of *Ginkgo biloba* L. and identified as 3-(pentadec-8-enyl) phenol.

INTRODUCTION

The Ginkgo tree, *Ginkgo biloba* L., is the sole surviving species of the group of plants known as *Ginkgoales*^{1,2} and is thus called a fossil tree or living fossil³. Because of this longevity and of its pharmacological usefulness, nearly all the parts of this tree, *i.e.*, root, bark, heartwood, seeds, fruit, pollen and leaves have been subjected to numerous chemical investigations.

Of these, study of the leaves was commenced in 1929 by Furukawa⁴, which led to the isolation of ginnol (10-nonacosanol)⁵, and the following chemical constituents have been afterwards identified: ginnon⁶, 2-hexenal⁷, shikimic acid⁸, quinnic acid⁹, bilobalides¹⁰, ginkgolides¹¹, β -sitosterol¹², ceryyl alcohol¹³, oxalic acid¹⁴, linolenic acid¹⁵, linoleic acid¹⁶, palmitic acid¹⁶, anacardic acid¹⁶, carotenes¹⁷, D-glucaric acid¹⁸, vitamin C¹⁹, hexosamines²⁰ and lignins²¹, *etc.*

The other important components of the

leaves are bisflavonoids^{22~25}, *i.e.*, ginkgetin, isoginkgetin and sciatopitysin. These phenolic compounds have vasodilating and spasmolytic activities^{26,27} and their aqueous solutions have recently been used for the treatment of peripheral arterial circulatory disturbances, intermittent claudication and vascular diseases of the limbs^{28~30}.

In connection with this pharmacological importance, we have reinvestigated the green leaves of Ginkgo tree and isolated a new, hitherto unreported chemical constituent: 3-(pentadec-8-enyl) phenol.

ISOLATION

The methanol extract of the air-dried and stem-free green leaves of male Ginkgo tree was filtered through celite and concentrated to a dark-red syrup, which was extracted with dichloromethane. Thin-layer chromatography of this solution on silica gel plate (Merck, F₂₅₄; 1:1 CHCl₃-EtOAc) showed it was a mixture of at least 6 components, the *rf* values of which

were 0.92, 0.72, 0.54, 0.26, 0.15 and zero. From this mixture the component of *rf* value of 0.54 was separated as a pale yellow liquid (bp: 220~222°C) by successive silica gel column chromatography (1:1 ϕ H-CHCl₃).

CHARACTERIZATION

1. IR and UV spectra were recorded on Jasco DS 710G diffraction grating IR, and Unicam SP 500 UV/VIS spectrophotometers. ¹H-NMR and mass spectra were obtained using Varian EM 360 (60MHz) NMR, and Hewlett-Packard 5985 A mass spectrometers. The spectral data are summarized in the accompanying Table.

2. Acetylation of this liquid with acetic anhydride-pyridine afforded monoacetylated oily product: ¹H-NMR(CDCl₃); δ 7.40~6.75 (*m*, 4H, aromatic), 5.33(*t*, *J*=4.0 Hz, -CH=CH-), 2.60(*t*, *J*=7.0 Hz, 2H, CH₂ ϕ), 2.23 (*s*, 3H, acetyl CH₃), 2.20~1.80(*m*, 4H), 1.75~1.10 (*m*, 18H), 0.90ppm (*t*, *J*=5.0 Hz, 3H, CH₃).

3. Oxidation of the acetylated compound with KMnO₄-MgSO₄ in acetone³¹ and subsequent distillation yielded a colorless liquid boiling at 152~154°C. The ¹H-NMR and IR spectra of this compound were exactly same as those of *n*-heptanal (bp: 153°C).

Table. Spectral data of 3-(pentadec-8-enyl)phenol.

IR(neat)	3380(strong but broad), 1910, 1830, 1695 (weak), 1585, 1450cm ⁻¹ (strong)
Mass(70eV)	<i>m/e</i> =302(M ⁺), 121, 120, 108 (base), 107, 69, 55, 41
UV(CHCl ₃)	273nm, (ϵ =1,440) 279nm (shoulder, ϵ =1,290)
¹ H-NMR (CDCl ₃)	δ 7.20~6.45(<i>t</i> , 4H), 6.65(1H, D ₂ O exchangeable), 5.34(<i>t</i> , <i>J</i> =4.0 Hz, 2H), 2.64~2.32(<i>m</i> , 2H), 2.32~1.80(<i>m</i> , 4H), 1.70~1.04(<i>m</i> , 18H), 0.85 ppm(<i>t</i> , <i>J</i> =5.0 Hz, 3H)

RESULTS AND DISCUSSION

IR Spectral Data. The IR spectrum (neat) exhibited strong absorption bands at about 3380, 1585, 1450cm⁻¹ and relatively weak bands at 1910, 1830 and 1695cm⁻¹, in particular. The broad band centered at 3380 corresponds to the hydrogen-bonded OH stretching vibration. The absorption bands at 1585 and 1450cm⁻¹ indicate the presence of aromatic ring, and the aromatic overtone bands at 1910, 1830 and 1695cm⁻¹ further suggest that the ring is *meta*-disubstituted.

Mass Spectral Data. The mass spectrum revealed an apparent molecular ion peak at *m/e*=302 with fragment ions at 108(base peak), 107, 69, 55, and 41. This corresponds to a probable C₂₁H₃₄O molecular composition, provided that there are no other elements present. The fragment ion peaks at 108 and 107 suggest it is a phenol or benzyl alcohol derivative, but the presence of base peak at 108 excludes the possibility of being a benzyl alcohol derivative. The characteristic fragmentation pattern of alkenes at 41, 55 and 69 also indicates that the *meta*-substituent is an olefinic group.

UV Spectral Data. The UV spectrum (in CHCl₃) shows the phenolic secondary absorption band at 273 nm(ϵ =1,440) with a shoulder at 279nm (ϵ =1,290).

¹H-NMR Spectral Data. Assuming 3-alkenylphenol as a plausible structure for this compound based on the above spectral data, the ¹H-NMR spectrum (CDCl₃, internal TMS) can be analyzed as follows: 4 aromatic protons (δ 7.20~6.45ppm), 1 phenolic proton(6.65) which is D₂O exchangeable, 2 vinylic protons(5.34), 2 methylene protons adjacent to the aromatic ring (2.64~2.32), 4 methylene protons adjacent to a double bond (2.32~1.80), 18 methylene protons (1.70~1.04) and 3 terminal

methyl protons (0.85). Existence of only one methyl group, a double bond and 24 methylene protons indicate that the *meta*-substituent of this phenol is a straight, pentadecenyl group, and the position of its double bond was ascertained by oxidative cleavage. In addition, the ¹H-NMR spectrum of the acetylated compound revealed monoacetylation with the corresponding 3 protons at δ 2.23ppm; which also confirms the presence of only one hydroxyl group in this phenolic compound.

Position of Double Bond. Oxidative cleavage of the acetylated product with KMnO₄-MgSO₄ in acetone³¹ and subsequent distillation yielded *n*-heptanal (bp: 152~154°C) as the lowest boiling fraction. This confirms that the double bond of the pentadecenyl side chain is located at the seventh carbon from terminal methyl group, and thus that the *meta*-substituent of this phenol is pentadec-8-enyl group.

CONCLUSION

The spectral and chemical data of this constituent isolated from the green leaves of *Ginkgo biloba* L. establish its structure as 3-(pentadec-8-enyl) phenol, although the stereochemistry of the double bond could not be clearly verified. 3-(Pentadec-8-enyl) phenol (C₂₁H₃₄O, bp: 220-222°C) happens to be identical with ginkgol (C₂₁H₃₄O, bp: 221~223°C)³², a known constituent of the seeds³² and of the fruit^{33,34} of Ginkgo tree. But ginkgol has never been claimed to be a chemical constituent of the Ginkgo leaves.

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