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ALKALOIDS OF *NELUMBO NUCIFERA**

J. KUNITOMO, Y. YOSHIKAWA, S. TANAKA, Y. IMORI and K. ISOI
Faculty of Pharmaceutical Sciences, Mukogawa Women's University, Nishinomiya, Japan

Y. MASADA, K. HASHIMOTO and T. INOUE
Kyoto College of Pharmacy, Kyoto, Japan

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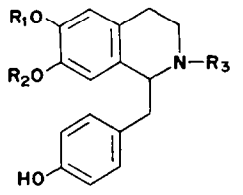
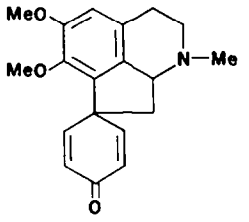
Key Word Index—*Nelumbo nucifera*; Nymphaeaceae; alkaloids; dehydronuciferine; dehydroroemerine; dehydroanonaine; *N*-methylisococlaurine.

Abstract—The alkaloids of leaves of *Nelumbo nucifera* Gaertn. were examined using combined GLC–MS. The occurrence of four new alkaloids, dehydroroemerine (XII), dehydronuciferine (XI), dehydroanonaine (XIII) and *N*-methylisococlaurine (III) were revealed, besides the known roemerine (V), nuciferine (VI), anonaine (VII), pronuciferine (IV), *N*-nornuciferine (VIII), nornuciferine (IX), armepavine (I) and *N*-methylcoclaurine (II).

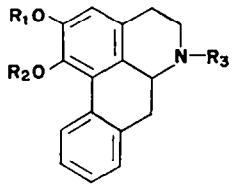
DETAILED studies of the alkaloids of leaves of *Nelumbo nucifera* Gaertn. have resulted in the isolation of six non-phenolic bases, roemerine (V), nuciferine (VI), anonaine (VII), pronuciferine (IV), *N*-nornuciferine (VIII), liriodenine (X), two phenolic bases, nornuciferine (IX), armepavine (I), *N*-methylcoclaurine (II) and one unidentified compound.[1] In the present report, we describe further analysis of the leaves of the plant for alkaloids using combined GLC–MS.



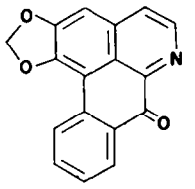
(I) $R_1 = R_2 = R_3 = Me$
(II) $R_1 = R_3 = Me$; $R_2 = H$
(III) $R_1 = H$; $R_2 = R_3 = Me$



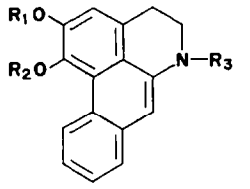
(IV)



(V) $R_1 + R_2 = CH_2$; $R_3 = Me$
(VI) $R_1 = R_2 = R_3 = Me$
(VII) $R_1 + R_2 = CH_2$; $R_3 = H$
(VIII) $R_1 = R_2 = Me$; $R_3 = H$
(IX) $R_1 = H$; $R_2 = R_3 = Me$



(X)



(XI) $R_1 = R_2 = R_3 = Me$
(XII) $R_1 + R_2 = CH_2$; $R_3 = Me$
(XIII) $R_1 + R_2 = CH_2$; $R_3 = H$

* Part XVI in the series "Studies on the Alkaloids of *Nelumbo nucifera* Gaertn.". For Part XV see M. TOMITA, J. KUNITOMO, M. MIYOSHI, T. MARUYAMA and E. YUGE, *Yakugaku Zasshi* **91**, 896 (1971).

[1] J. KUNITOMO, Y. NAGAI, Y. OKAMOTO and H. FURUKAWA, *Yakugaku Zasshi* **90**, 1165 (1970).

RESULT AND DISCUSSION

The alkaloid extracts of the leaves of *Nelumbo nucifera* Gaertn. were examined by GLC–MS after separation of non-phenolic and phenolic bases by usual methods.[1]

Analysis of the Non-phenolic Bases

The major components of the non-phenolic fraction had retention data and MS identical with those of nuciferine (VI) and roemerine (V) and three of the minor components with anonaine (VII), pronuciferine (IV) and *N*-nornuciferine (VIII), respectively. Liriodenine (X) was not detected under these conditions. The GLC data are in agreement with the report[2] that the retention times of *N*-noraporphine alkaloids are greater than those of corresponding aporphines. Three late running components (*ca.* 35–45 min) gave molecular peaks, 293 ($C_{19}H_{19}O_2N$), 277 ($C_{18}H_{15}O_2N$) and 263 ($C_{17}H_{13}O_2N$) respectively, and in MS are characterized by having the following properties: (a) the characteristic base peak due to benzyl group from 1-benzyltetrahydroisoquinoline derivatives was not observed;[3] (b) (M-1) peak which is observed in the MS of 1-benzyltetrahydroisoquinoline or aporphine alkaloids was not present or very weak;[4,5] and (c) the characteristic fragment ion resulted from *retro*-Diels Alder type fragmentation of aporphine or proaporphine alkaloids was not observed.[4,6]

These facts, combined with biogenetic considerations, suggested that these bases were not 1-benzyltetrahydroisoquinolines, but must be 6*a*,7-dehydroaporphine type alkaloids. As the result, it was assumed that these components are dehydronuciferine (XI),[7] dehydroroemerine (XII)[8] and dehydroanonaine (XIII), respectively. These conclusions were also supported by the direct comparison of the GLC retention data and MS with synthetic, samples. However, a question remained whether these alkaloids were natural products or dehydration products of corresponding 7-hydroxyaporphines formed during the GLC–MS run. In order to answer this question, the GLC–MS of ushinsunine (7-hydroxyroemerine) and michelalbine(7-hydroxyanonaine) was carried out and this experiment showed that dehydration of 7-hydroxyaporphine alkaloids does not occur.[9] Thus, dehydronuciferine (XI), dehydroroemerine (XII) and dehydroanonaine (XIII) are not artifacts. The three alkaloids were synthesized several years ago.[7,8] Other natural dehydroaporphine alkaloids, dehydrodicentrine,[10] dehydroocopodine[11] (*Ocotea marcopoda* Mez., Lauraceae) and dehydroglaucine (*Glaucum flavum* Crantz, Papaveraceae)[12] have also been reported.

Analysis of the Phenolic Bases

The results of GLC–MS after trimethylsilylation of the phenolic fraction showed that the major components are nornuciferine (IX), *N*-methylcoclaurine (II) and armepavine (I)

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[9] J. KUNITOMO, unpublished results.
[10] M. P. CAVA, Y. WATANABE, K. BESSHO, M. J. MITCHELL, A. I. DAROCHA, B. DOUGLAS and J. A. WEISBACH, *Tetrahedron Letters* 2437 (1968).
[11] M. P. CAVA and A. VENKATESWARLU, *Tetrahedron* **27**, 2639 (1971).
[12] H. G. KIRYAKOV, *Chem. & Ind.* 1807 (1968).

respectively. A minor component M 443, trimethylsilyl derivative of $C_{18}H_{21}O_3N$, had an M^+-179 base peak, presumably due to the loss of a trimethylsilyloxybenzyl group from a 1-benzyltetrahydroisoquinoline alkaloid.[3] The MS of this alkaloid showed a similar pattern to that of *N*-methylcoclaurine (II), suggesting its structure a *N*-methylisococlaurine (III). Direct comparison with an authentic sample[13] revealed that the retention time and MS were identical. This is the first time that this alkaloid has been shown to occur in nature.

EXPERIMENTAL

GLC. GLC analysis was performed on a Hitachi Model K-53 gas chromatograph with f.i.d. A 2 m × 9 mm glass column packed with 2% OV17 on 60–80 mesh Chromosorb W was, for non-phenolic bases, programmed from 200 to 230° at 1°/min and for phenolic bases run at 220° with N_2 60 ml/min.

GLC–MS. GLC–MS was performed on a combined Hitachi Model K-53 gas chromatograph with a Hitachi RMU-6E Model mass spectrometer. The Watson–Biemann type molecular separator was used for interface. The mass spectra were determined at ionizing energy 70 eV, accelerating voltage 1800 V, and ion source temp. 250°.

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[13] M. TOMITA, K. SAKAI and S. MATSUMURA, *Yakugaku Zasshi* 79, 1121 (1959).