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A new Amaryllidaceae alkaloid from the bulbs of *Lycoris radiata*

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[ABSTRACT] AIM: To study the Amaryllidaceae alkaloids of the bulbs of *Lycoris radiata*. **METHODS:** The chemical constituents were isolated and purified by various chromatographic techniques, and the chemical structures were elucidated on the basis of spectroscopic methods. In addition, the antiviral activities of alkaloids **1**–**10** were evaluated using flu virus A. **RESULTS:** One new homolycorine-type alkaloid 2α-methoxy-6-*O*-ethyloduline (**1**), together with nine known alkaloids 2α-methoxy-6-*O*-methyloduline (**2**), trisphorine (**3**), 8-*O*-demethylhomolycorine (**4**), homolycorine (**5**), 9-*O*-demethylhomolycorine (**6**), oduline (**7**), lycorenine (**8**), 6α-*O*-methyllycorenine (**9**) and *O*-ethyllycorenine (**10**) were obtained. **CONCLUSION:** Alkaloid **1** is a new compound, and **1–3** were major alkaloids in this plant. Alkaloids **1–3** showed weak antiviral activities against flu virus A with IC_{50} values of 2.06, 0.69, and 2.71 $\mu g \cdot mL^{-1}$ and CC_{50} values of 14.37, 4.79, and 80.12 $\mu g \cdot mL^{-1}$, respectively.

[KEY WORDS] *Lycoris radiata*; Amaryllidaceae alkaloids; Homolycorine-type; 2α-Methoxy-6-*O*-methyloduline; 2α-Methoxy-6-*O*-ethyloduline

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1 Introduction

Amaryllidaceae alkaloids are characteristic constituents of the Amaryllidaceae plant family, whose remarkable biological activities and unique skeletons have attracted great interest as challenging targets for total synthesis and diversity-oriented synthesis [1-9]. A series of new Amaryllidaceae alkaloids was isolated from *Hosta plantaginea* Asch. in a previous phytochemical investigation, which showed some inhibition activities against the tobacco mosaic plant virus (TMV) [10-11]. As a continuation of that research work, an in-depth phytochemical investigation was conducted on *Lycoris radiata* Herb. (Amaryllidaceae), which is widely distributed in the south of China, Vietnam and Malaysia, and is used as a folk medicine to treat mastitis, tympanitis, ulcers, and carbuncles in China [12]. In this work, a new homolycorine-type alkaloid, named 2α-methoxy-6-*O*-ethyloduline (**1**), together with nine known alkaloids **2**–**10** (Fig. 1), were isolated from *L. radiata*. Alkaloids **1**–**3** showed weak antiviral activities against flu virus A with IC_{50} values of 2.06, 0.69, and 2.71 $\mu g \cdot mL^{-1}$ and CC_{50} values of 14.37, 4.79, and 80.12 $\mu g \cdot mL^{-1}$, respectively. Herein, we report the isolation, structure elucidation, and antiviral activities against flu virus A of these ten alkaloids.

2 Results and Discussion

2α-Methoxy-6-*O*-ethyloduline (**1**) was isolated as a yellow amorphous powder with $[\alpha]_D^{19}$ +205.7 (*c* 2.4, MeOH). The positive HR-ESI-MS displayed an ion peak at *m/z* 360.181 1 ($[M + H]^+$, Calcd.: 360.181 0), corresponding to the molecular formula $C_{20}H_{25}NO_5$, which accounted for nine degrees of unsaturation. The UV spectrum showed absorption bands at 203, 238 and 289 nm, which suggested compound **1**

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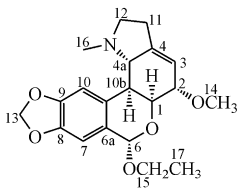
These authors have no conflict of interest to declare.



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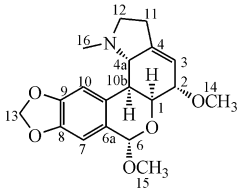

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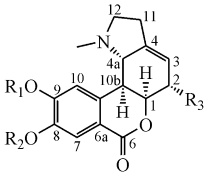
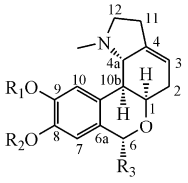


3 R_1, R_2 = -CH_2- ; R_3 = OH
4 R_1 = Me; R_2 = H; R_3 = H
5 R_1, R_2 = Me; R_3 = H
6 R_1 = H, R_2 = Me R_3 = H



7 R_1, R_2 = -CH_2-; R_3 = OH
8 R_1, R_2 = Me; R_3 = OH
9 R_1, R_2 = Me; R_3 = OMe
10 R_1, R_2 = Me; R_3 = OEt

Fig. 1 Chemical structures of compounds 1–10

has the same O-CH_2-O-substituted benzene ring as compound **2**. Comparison of the NMR data of **1** with **2** suggested that **1** exhibited structural similarities with **2**. Notable differences in the NMR spectra with those of **2** inferred that **1** exhibited closely similar signals to **2**, except for the presence of an OEt group and the disappearance of the OMe group in **2**. The presence of an OEt group located at C-6 instead of the OMe group in **1** was confirmed by the HMBC correlation of H-6 to C-15 and ^{1}H-^{1}H COSY correlation from H-15 to H-17. Thus, the structure of **1** was established and named as 2α-methoxy-6-*O*-ethyloduline.

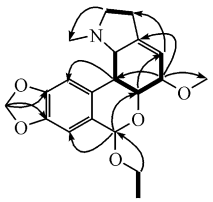


Fig. 2 ^{1}H-^{1}H COSY (bold) and selected HMBC (arrow, H→C) correlations of 1

2α-Methoxy-6-*O*-methyloduline (**2**) was obtained as a white amorphous powder with $[\alpha]_D^{19}$ +225.3 (*c* 1.6, MeOH). The molecular formula of **2** was determined as $C_{19}H_{23}NO_5$ by using HR-ESI-MS ion peak at *m/z* 346.164 6 ([M + H]$^+$, Calcd: 346.165 4), with nine degrees of unsaturation. The UV (MeOH) spectrum exhibited the presence of an O-CH_2-O-substituted benzene ring absorption maximum at 203, 238 and 289 nm [13]. The IR (KBr) spectrum displayed absorption bands for a phenyl functional group (1 656, 1 608 and 905 cm^{-1}) and a double bond (1 562 cm^{-1}). The ^{1}H NMR spectrum (Table) showed one methyl singlet peak at δ 2.16 (3H, s, H-16), two methoxyl groups at δ 3.55 (3H, s, H-15) and δ 3.43 (3H, s, H-14), two aromatic protons at δ 6.96 (1H, s,H-10) and 6.76 (1H, s, H-7), a signal for the H-atom of C=C double bond [δ 5.46 (1H, s, H-6)] and a signal for the O-CH_2-O group [δ 5.93 (2H, br s, H-13)], respectively. The ^{13}C NMR spectrum (Table) revealed 19 signals comprising of five sp^2 quaternary C-atoms, five sp^3 CH, three sp^2 CH and three sp^3 CH_2 groups, as well as two OMe groups and one NMe group. The five sp^2 quaternary C-atoms were assignable to four aromatic C-atoms [δ 147.3 (C-8), 147.1 (C-9), 130.8 (C-6a), 126.9 (C-10a)] and a C-atom of C=C double bond [δ 145.4 (C-4)], 1 of 3 sp^3 CH_2 groups was attributable to a O-CH_2-O group [δ 101.1 (C-13)], another two sp^3 CH_2 groups corresponded to a –CH_2CH_2– group. The above data proved that **2** was a homolycorine-type Amaryllidaceae alkaloid. The NMR data of **2** were closely similar to those of the known alkaloid 2α-hydroxy-6-*O*-methyloduline [14]. The minor difference between them was the presence of an additional methoxyl group signal at δ_C (57.2) in **2**. The HMBC correlation of H-2 to C-14, as well as the downfield shift of C-2 (δ_C 78.1, $\Delta\delta_C$ +9.8) [14] confirmed the structure. Thus, the planar structure of **2** was elucidated as shown in Fig. 2.

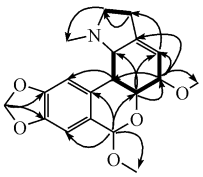


Fig. 3 ^{1}H-^{1}H COSY (bold) and selected HMBC (arrow, H→C) correlations of 2

The relative configuration of **2** was assigned as identical to that of 2α-hydroxy-6-*O*-methyloduline on the basis of the ROESY experiment and coupling constants [14]. Detailed analysis of the 2D NMR data established the structure of compound **2** as 2α-methoxy-6-*O*-methyloduline. This is the first time to report the NMR data of this alkaloid [15] .

Eight known homolycorine-type alkaloids (**3**-**10**) were also isolated and identified as trispherine (**3**) [14], 8-*O*-demethylhomolycorine (**4**) [16], homolycorine (**5**) [17], 9-*O*-demethylhomolycorine (**6**) [18], oduline (**7**) [19], lycorenine (**8**) [20], 6α-*O*-methyllycorenine (**9**) [21], *O*-ethyllycorenine (**10**) [22] by comparison of their 1D-NMR data with those in the literature. All of the alkaloids were evaluated for inhibitory activities against flu virus A *in vitro* [23], and alkaloids **1-3** showed weak antiviral activities with IC_{50} values of 2.06, 0.69 and 2.71 μg·mL^{-1}, and CC_{50} values of 14.37, 4.79 and 80.12 μg·mL^{-1}, respectively.

3 Experimental

3.1 *Apparatus and reagents*

Perkin-Elmer model 241 polarmeter; Bio-Rad FTS-135 spectrometer; Shimadzu UV-2401A spectrometer; Bruker AM-400 or a DRX-500 instrument (using TMS as internal standard); Finnigan MAT 90 instrument and VG Auto Spec-3000 spectrometer; silica gel (SiO_2, 300−400 mesh;

Qingdao Marine Chemical Co., Ltd., China); MCI gel (CHP20P, 75−150 μm; Mitsubishi Chemical Industries Ltd., Japan); Sephadex LH-20 (40−70 μm; Amersham Pharmacia Biotech AB, Uppsala, Sweden); Rp-18 gel (150−200 mesh; Merck, Darmstadt, Germany). Semi-Preparative HPLC was performed on a Zorbax SB-C-18 column (i.d. 9.4 mm × 250 mm; Agilent Co. Ltd., Santa Clara, USA). TLC plates were pre-coated with silica gel GF-254 and HF-254 (Qingdao Marine Chemical Co., Ltd., China).

3.2 *Plant material*

The bulbs of *Lycoris radiata* were bought from Hengyang, Hunan Province, China, in July 2008, and were identified by GONG Xun. A voucher specimen has been deposited with the Kunming Institute of Botany, Chinese Academy of Sciences, China.

3.3 *Extraction and isolation*

The air-dried and powdered sample (180 kg) was extracted with MeOH three times to give a crude extract. The crude extract was adjusted to pH 2–3 by dissolving in 0.5% HCl soln. The aqueous phase was extracted with EtOAc, and then the acidic H_2O-soluble was adjusted to pH 9−10 with 10% aq.NH_3 soln. and extracted with $CHCl_3$ to give an alkaline extract (1.4 kg). The alkaline extract was subjected to CC (SiO_2; $CHCl_3$/MeOH gradient 1 : 0→0 : 1) to afford seven fractions (A_1–A_7). Fraction A_1 (78 g) was applied to MCI gel (MeOH−H_2O, 30/70−100/0), Sephadex LH-20 (MeOH), and then to silica gel CC eluting with petroleum ether(PE)/acetone/diethylamine (5 : 1 : 0.05) to yield **3** (17 g), **4** (41 mg), **7** (20 mg), and **9** (13 mg), respectively. Fraction A_2 (170 g) was subjected to repeated column chromatography (silica gel, Sephadex LH-20 (MeOH), and HPLC) to yield **1** (27 g), **2** (33 g), **10** (11 mg), respectively. Fraction A_3 (15 g) was purified by silica gel and HPLC to give **5** (14 mg), **6** (44 mg) and **8** (8 mg), respectively.

2*α*-Methoxy-6-*O*-ethyloduline (**1**) A yellow amorphous powder; $[\alpha]_D^{19}$ +205.7 (*c* 2.4, MeOH); IR ν_{max} (KBr): 3 045, 2 968, 1 738, 1 696, 1 625, 1 563, 925 cm^{-1}; UV (MeOH) λ_{max} (log ε): 289 (3.59), 238 (3.64), 203 (4.59) nm; ^1H NMR and ^{13}C NMR: see Table; HR-ESI-MS *m/z* 360.181 1 ([M + H]$^+$, $C_{20}H_{26}NO_5^+$; Calcd: 360.181 0).

2*α*-Methoxy-6-*O*-methyloduline (**2**) A white amorphous powder; $[\alpha]_D^{19}$ +225.3 (*c* 1.6, MeOH); IR ν_{max} (KBr): 3 060, 2 966, 1 702, 1 678, 1 656, 1 608, 929 cm^{-1}; UV (MeOH) λ_{max} (log ε): 289 (3.62), 238 (3.65), 203 (4.61) nm; ^1H NMR and ^{13}C NMR: see Table; HR-ESI-MS: 346.1646 ([M + H]$^+$, $C_{19}H_{24}NO_5^+$; Calcd.: 346.165 4).

Trisperine (3) A white amorphous powder; ESI-MS *m/z* 315.1 [M + H]$^+$, $C_{17}H_{17}NO_5$; ^1H NMR (400 MHz, $CDCl_3$) δ: 4.39 (1H, s, H-1), 3.47 (1H, s, H-2), 5.65 (1H, s, H-3), 2.90 (1H, d, *J* = 8.3 Hz, H-4a), 6.74 (1H, s, H-7), 6.95 (1H, s, H-10), 2.63 (1H, d, *J* = 9.0, H-10b), 2.53 (2H, d, *J* = 8.0, H-11), 3.15 (2H, t, *J* = 7.6, H-12), 6.05 (2H, br. s, -OCH_2O-), 4.60 (1H, s, -OH), 2.04 (3H, s, -NCH_3); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 67.1 (C-1), 82.2 (C-2), 118.2 (C-3), 139.3 (C-4), 66.8 (C-4a), 164.7 (C-6), 118.4 (C-6a), 108.7 (C-7), 147.9 (C-8), 151.8 (C-9), 109.8 (C-10), 139.3 (C-10a), 39.7 (C-10b), 27.7 (C-11), 56.0 (C-12), 102.1 (-OCH_2O-), 43.5 (-NCH_3).

8-*O*-Demethylhomolycorine (4) Yellow oil; ESI-MS *m/z* 301.1 [M + H]$^+$, $C_{17}H_{19}NO_4$; ^1H NMR (400 MHz, $CDCl_3$) δ: 4.77 (1H, s, H-1), 3.47 (1H, s, H-2), 5.51 (1H, s, H-3), 3.15 (1H, dd, *J* = 13.0, 5.4 Hz, H-4a), 7.01 (1H, s, H-7), 7.55 (1H, s, H-10), 2.62 (1H, d, *J* = 8.3 Hz, H-10b), 2.51 (2H, d, *J* = 9.8 Hz, H-11), 3.13 (2H, dd, *J* = 8.5, 3.5 Hz, H-12), 3.92 (3H, br. s, -OCH_3), 3.82 (1H, s, -OH), 2.01 (3H, s, -NCH_3); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 67.6 (C-1), 31.2 (C-2), 116.1 (C-3), 136.4 (C-4), 66.6 (C-4a), 165.7 (C-6), 117.4 (C-6a), 110.4 (C-7), 145.8 (C-8), 151.2 (C-9), 115.6 (C-10), 140.3 (C-10a), 43.6 (C-10b), 27.9 (C-11), 56.4 (C-12), 56.2 (-OCH_3), 43.6 (-NCH_3).

Homolycorine (5) A yellow amorphous powder; ESI-MS *m/z* 315.2 [M + H]$^+$, $C_{18}H_{21}NO_4$; ^1H NMR (400 MHz, $CDCl_3$) δ: 4.81 (1H, ddd, *J* = 4.8, 1.8, 1.7 Hz, H-1), 2.49 (1H, m, H-2), 5.50 (1H, m, H-3), 2.72 (1H, dd, *J* = 9.6, 2.0 Hz, H-4a), 7.57 (1H, s, H-7), 6.99 (1H, s, H-10), 2.64 (1H, dd, *J* = 9.6, 1.8 Hz, H-10b), 2.63 (2H, m, H-11), 3.14 (1H, ddd, *J* = 10.0, 7.0, 3.5 Hz, H*α*-12), 2.24 (1H, dd, *J* = 18.0, 9.2 Hz, H*β*-12), 3.92 (3H, s, -OCH_3), 3.95 (3H, s, -OCH_3), 2.00 (3H, s, -NCH_3); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 66.8 (C-1), 31.1 (C-2), 115.9 (C-3), 137.3 (C-4), 66.4 (C-4a), 165.8 (C-6), 116.7 (C-6a), 110.8 (C-7), 148.9 (C-8), 153.1 (C-9), 115.9 (C-10), 137.3 (C-10a), 43.6 (C-10b), 27.9 (C-11), 56.4 (C-12), 56.1 (-OCH_3), 56.4 (-OCH_3), 43.6 (-NCH_3).

9-*O*-Demethylhomolycorine (6) A white amorphous powder; ESI-MS *m/z* 301.1 [M + H]$^+$, $C_{17}H_{19}NO_4$; ^1H NMR (400 MHz, $CDCl_3$) δ: 4.80 (1H, ddd, *J* = 4.8, 1.7, 1.6 Hz, H-1), 2.51 (1H, m, H-2), 5.55 (1H, m, H-3), 2.71 (1H, d, *J* = 10.0 Hz, H-4a), 7.54 (1H, s, H-7), 6.91 (1H, s, H-10), 2.60 (1H, dd, *J* = 10.0, 1.6 Hz, H-10b), 2.61 (2H, m, H-11), 3.15 (1H, ddd, *J* = 10.0, 7.0, 3.5 Hz, Hα-12), 2.30 (1H, dd, *J* = 18.3, 9.2 Hz, H*β*-12), 3.94 (3H, s, -OCH_3), 2.01 (3H, s, -NCH_3); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 77.5 (C-1), 31.2 (C-2), 116.0 (C-3), 140.4 (C-4), 77.3 (C-4a), 165.6 (C-6), 117.5 (C-6a), 110.3 (C-7), 145.7 (C-8), 151.0 (C-9), 115.5 (C-10), 136.5 (C-10a), 43.6 (C-10b), 27.9 (C-11), 56.4 (C-12), 56.3 (-OCH_3), 43.8 (-NCH_3).

Oduline (7) A white amorphous powder; ESI-MS *m/z* 301.1 [M + H]$^+$, $C_{17}H_{19}NO_4$; ^1H NMR (400 MHz, MeOD) δ: 4.35 (1H, d, *J* = 6.0 Hz, H-1), 2.31 (1H, dm, *J* = 19.0, 2.8 Hz, H*α*-2), 2.62 (1H, d, *J* = 19.3 Hz, H*β*-2), 5.46 (1H, br d, *J* = 2.9 Hz, H-3), 2.71 (1H, br. d, *J* = 9.5 Hz, H-4a), 5.99 (1H, s, H-6), 6.85 (1H, s, H-7), 6.90 (1H, s, H-10), 2.46 (1H, m, H-10b), 2.64 (2H, m, H-11), 3.14 (1H, ddd, *J* = 9.2, 6.3, 3.8 Hz, H*α*-12), 2.25 (1H, dd, *J* = 18.7, 9.5 Hz, H*β*-12), 5.97 (2H, d, J = 14.7 Hz, -OCH_2O-), 3.67 (1H, s, -OH), 2.11 (3H, s, -NCH_3); ^{13}C NMR (100 MHz, MeOD) δ: 66.7 (C-1), 31.7 (C-2), 115.7

Table ^{1}H and ^{13}C NMR Data (500 and 100 MHz) of alkaloids 1 and 2 (*J* in Hz) in $CDCl_3$

Position	1		2	
	δ_H	δ_C	δ_H	δ_C
1	4.28, s	69.2	4.23, s	69.2
2	3.70, s	78.3	3.76, s	78.1
3	5.61, s	116.6	5.61, s	117.4
4		146.5		145.1
4a	2.70, d (8.7)	67.6	2.71, d (8.3)	67.8
6	5.58, br s	97.4	5.46, s	98.6
6a		127.1		126.9
7	6.76, br s	107.3	6.75, s	107.3
8		147.1		147.3
9		147.0		147.1
10	6.88, br s	110.0	6.89, s	110.1
10a		131.2		130.8
10b	2.47, d (2.2)	41.3	2.71, d (10.8)	40.6
11	2.49, d (7.9)	28.3	2.50, d (7.9)	28.1
12	3.18, dd (9.7, 6.1) 2.27, dd (9.7, 6.1)	56.7	3.17, s	56.6
13	5.96, br s	101.0	5.95, br s	101.1
14	3.43, br s	57.1	3.43, s	57.1
15	3.92, m 3.94, m	63.6	3.55, s	55.4
16	2.12, br s	44.3	2.11, s	44.0
17	1.30, td (7.0, 3.6)	15.4		

(C-3), 140.6 (C-4), 67.5 (C-4a), 91.8 (C-6), 132.0 (C-6a), 107.4 (C-7), 147.0 (C-8), 147.0 (C-9), 109.8 (C-10), 128.2 (C-10a), 44.0 (C-10b), 28.1 (C-11), 56.7 (C-12), 101.0 (-OCH_2O-), 44.3 (-NCH_3).

Lycorenine (8) A white amorphous powder; ESI-MS *m/z* 317.2 $[M + H]^+$, $C_{18}H_{23}NO_4$; ^1H NMR (400 MHz, $CDCl_3$: MeOD 1 : 1) δ: 4.53 (1H, d, *J* = 5.4 Hz, H-1), 2.50 (1H, m, H-2), 5.70 (1H, s, H-3), 2.68 (1H, br. d, *J* = 9.7 Hz, H-4a), 6.12 (1H, s, H-6), 7.08 (1H, s, H-7), 7.15 (1H, s, H-10), 2.53 (1H, m, H-10b), 2.67 (2H, m, H-11), 3.05 (1H, d, *J* = 8.7 Hz, H*α*-12), 2.31 (1H, m, H*β*-12), 4.04 (3H, s, -OCH_3), 4.05 (3H, s, -OCH_3), 3.50 (1H, s, -OH), 2.13 (3H, s, -NCH_3); ^{13}C NMR (100 MHz, $CDCl_3$: MeOD 1 : 1) δ: 67.1 (C-1), 32.1 (C-2), 117.6 (C-3), 139.4 (C-4), 68.4 (C-4a), 91.9 (C-6), 130.4 (C-6a), 111.0 (C-7), 149.0 (C-8), 149.0 (C-9), 113.0 (C-10), 128.1 (C-10a), 43.6 (C-10b), 28.2 (C-11), 57.1 (C-12), 56.2 (-OCH_3), 56.3 (-OCH_3), 44.0 (-NCH_3).

6*α*-*O*-Methyllycorenine (9) A white amorphous powder; ESI-MS *m/z* 331.2 $[M + H]^+$, $C_{19}H_{25}NO_4$; ^1H NMR (400 MHz, $CDCl_3$: MeOD 1 : 1) δ: 4.13 (1H, d, *J* = 4.2 Hz, H-1), 2.52 (1H, m, H-2), 5.71 (1H, s, H-3), 2.65 (1H, t, *J* = 2.40 Hz, H-4a), 5.71 (1H, s, H-6), 6.87 (1H, s, H-7), 6.98 (1H, s, H-10), 2.54 (1H, m, H-10b), 2.64 (2H, m, H-11), 3.27 (2H, d, *J* = 8.0 Hz, H-12), 3.82 (3H, s, -OCH_3), 3.85 (3H, s, -OCH_3), 4.86 (3H, s, -OCH_3), 2.20 (3H, s, -NCH_3); ^{13}C NMR (100 MHz, $CDCl_3$: MeOD 1 : 1) δ: 67.1 (C-1), 31.9 (C-2), 117.9 (C-3), 138.6 (C-4), 68.7 (C-4a), 98.9 (C-6), 130.2 (C-6a), 111.0 (C-7), 149.1 (C-8), 149.1 (C-9), 113.1 (C-10), 126.3 (C-10a), 42.8 (C-10b), 28.1 (C-11), 56.9 (C-12), 55.7 (-OCH_3), 56.3 (-OCH_3), 55.4 (-OCH_3), 43.9 (-NCH_3).

***O*-Ethyllycorenine (10)** A white amorphous powder; ESI-MS *m/z* 345.2 $[M + H]^+$, $C_{20}H_{27}NO_4$; ^1H NMR (400 MHz, $CDCl_3$) δ: 4.24 (1H, d, *J* = 4.80 Hz, H-1), 2.44 (1H, d, *J* = 1.40, H-2), 5.50 (1H, s, H-3), 2.43 (1H, d, *J* = 1.42 Hz, H-4a), 5.51 (1H, s, H-6), 6.86 (1H, s, H-7), 6.97 (1H, s, H-10), 2.43 (1H, s, H-10b), 2.45 (2H, m, H-11), 3.17 (1H, s, H-12), 3.82 (3H, s, -OCH_3), 3.84 (3H, s, -OCH_3), 2.43 (2H, q, *J* = 9.05, 1.45 Hz, -OCH_2CH_3), 2.31 (3H, t, *J* = 2.50 Hz, -OCH_2CH_3), 2..08 (3H, s, -NCH_3); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 66.7 (C-1), 31.7 (C-2), 116.1 (C-3), 138.6 (C-4), 67.7 (C-4a), 97.2 (C-6), 130.2 (C-6a), 111.1 (C-7), 148.4 (C-8), 148.4 (C-9), 112.7 (C-10), 126.0 (C-10a), 43.8 (C-10b), 28.1 (C-11), 56.8 (C-12), 63.5 (-OCH_2CH_3), 15.5 (-OCH_2CH_3), 55.8 (-OCH_3), 56.1 (-OCH_3), 44.2 (-NCH_3).

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红花石蒜中的一个新石蒜生物碱

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【摘　要】 **目的**: 研究红花石蒜中的石蒜生物碱。**方法**: 采用多种层析柱分离手段, 运用 NMR 和 HR-ESI-MS 等波谱技术鉴定化合物的结构。此外, 生物碱 **1–10** 进行了流感甲型病毒的活性测试。**结果**: 从红花石蒜中分离鉴定了 1 个新石蒜生物碱和 9 个已知的石蒜生物碱: 2α-methoxy-6-*O*-ethyloduline (**1**), 2α-methoxy-6-*O*-methyloduline (**2**), trispherine (**3**), 8-*O*-demethylhomolycorine (**4**), homolycorine (**5**), 9-*O*-demethylhomolycorine (**6**), oduline (**7**), lycorenine (**8**), 6α-*O*-methyllycorenine (**9**) 和 *O*-ethyllycorenine (**10**)。**结论**: 化合物 **1** 为新的高石蒜碱类型的石蒜生物碱, 生物碱 **1–3** 为该植物中的主要成分, 且对流感甲型病毒显示了较弱的抗病毒活性, IC_{50} 分别为 2.06, 0.69, 2.71 μg·mL^{-1}, CC_{50} 分别为 14.37, 4.79, 80.12 μg·mL^{-1}。

【关键词】 红花石蒜; 石蒜生物碱; 高石蒜碱类型; 2α-methoxy-6-*O*-methyloduline; 2α-methoxy-6-*O*-ethyloduline

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