SUPPLEMENTARY MATERIAL

Anti-phytopathogen, multi-target acetylcholinesterase inhibitory, and antioxidant activities of metabolites from endophytic Chaetomium globosum

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Fourteen metabolites with various structure types were isolated from endophytic *Chaetomium globosum*. Five compounds were separated from genus *Chaetomium* for the first time. Some compounds exhibited remarkable inhibition against phytopathogenic fungi causing root rot of *Panax notoginseng*. Compounds 1-5 had significant DPPH free radical-scavenging activity. Compounds 3 and 5 indicated significant inhibitions against the acetylcholinesterase (AChE). From preliminary structure-activity relationship (SAR), it was found that the oxygenic five membered ring of 3 and 5 was crucial in the anti-AChE activity. These structures provide new templates for the potential treatment and management of plant diseases and Alzheimer disease.

**Keywords:** *Chaetomium globosum*, metabolite, anti-phytopathogen, anti-AChE, antioxidant
Experimental

General experimental procedures

Silica gel (200–300 mesh; Qingdao Marine Chemical Group Co., Qingdao, China), and Sephadex LH-20 (GE Healthcare Co., Buckinghamshire, UK) were used for column chromatography. The semipreparative HPLC (Agilent series 1200) was performed on YMC C18 column (250 mm × 10 mm, 5 μm). 1D and 2D NMR spectra were obtained on a Bruker AVANCE 400MHz NMR instrument (Bruker, Karlsruhe, Germany). MS spectra were recorded with Agilent G3250AA (Agilent, Santa Clara, USA).

Fungal material

The endophytic fungus PH30461 was isolated by using PDA medium from the seeds of P. notoginseng that was collected at the Wenshan, Yunnan, China, and was identified as C. globosum by ITS gene sequence. The sequence data derived from the fungal strain have been submitted to and deposited at GenBank under accession no.KP714386. A BLAST search result showed that the sequence was the most similar (100%) to the sequence of C. globosum (compared to JX981455). The strain is preserved at Yunnan Institute of Microbiology, Yunnan University, Kunming, China.
**Fermentation, extraction, and isolation**

Fungus PH30461 was cultured in 500mL Erlenmeyer flasks each containing 200mL potato dextrose broth (PDB) seed culture (1000 mL water, 20 g glucose, 200 g potato). After 3 days of incubation at 28 °C on a rotary shaker (125 r.p.m.), 10mL portion of the culture was inoculated into 1000 mL Erlenmeyer flasks each contained of 300 mL PDB fermentation medium for 7 days at 28 °C on a rotary shaker (125 r.p.m.). The fermented whole broth 50 L was filtered through hospital gauze to separate the culture broth and mycelia. The former was extracted three times with EtOAc to give a crude residue (46 g). The extract was subjected to column chromatography over silica gel eluted with stepwise CHCl₃/MeOH gradient (CHCl₃, CHCl₃/MeOH 50:1, v/v; CHCl₃/MeOH 30:1, v/v, CHCl₃/MeOH 10:1, v/v; MeOH) to yield 7 fractions (Fr1-7) on the basis of TLC analysis. Then Fr 2 and Fr 4 were separated on Sephadex LH-20 (MeOH) to give 4 fractions (Fr 2-1 to 2-4 and Fr 4-1 to 4-4) respectively. In the further purification, silicon gel column chromatography with petroleum ether/ethyl acetate, CHCl₃/MeOH; reversed-phase (RP) silica gel C-18 with H₂O/MeOH; RPHPLC with H₂O/CH₃CN were used. Finally, chaetomugilins A (6, 45 mg) and D (7, 40 mg) were obtained from Fr 2-1, chaetoglobosins A (8, 30 mg), B (9, 15 mg), chaetoglobosin E (10, 3.5 mg), chaetoglobosins F (11, 25 mg) and F_ex (12, 1 mg), penochalasins F (13, 4 mg) and G (14, 1 mg), were obtained from Fr 2-2; flavipin (1, 40 mg) was obtained from Fr 4-4. Fr 6 was separated into two parts as Fr 6S and Fr 6L by filtration. From the Fr 6S, epicoccolide B (5, 20 mg) was obtained after a
reversed-phase silicon gel C-18 column chromatography. Fr 6L was eluted with petroleum ether/ethyl acetate by silica gel column chromatography and was further purified by reversed-phase silica gel C-18 column, and Sephadex LH-20 (MeOH) chromatography to afford epicoccone (2, 10 mg), 3-methoxyepicoccone (3, 26 mg) and epicoccolide A (4, 9 mg).

Spectra data

Flavipin (1): Yellow solid. ESI-MS m/z 195 [M-H]. $^1$H NMR (acetone-d$_6$, 400MHz) δ: 10.58 (1H, s, H-8), 10.39 (1H, s, H-9), 2.55 (1H, s, H-7). $^{13}$C NMR (acetone-d$_6$, 100MHz) δ: 196.6 (C-8), 191.9 (C-9), 150.7 (C-5), 149.4 (C-3), 135.6 (C-4), 128.1 (C-1), 123.7 (C-6), 111.2 (C-2), 9.3 (C-7).

Epicoccone (2): Maple solid. $^1$H NMR (DMSO-d$_6$, 400MHz) δ: 5.09 (2H, s, H-3), 2.33 (3H, s, H-8). $^{13}$C NMR (DMSO-d$_6$, 100MHz) δ: 171.9 (C-1), 145.3 (C-6), 140.3 (C-4), 137.3 (C-5), 126.6 (C-3a), 116.4 (C-7), 112.8 (C-7a), 66.8 (C-3), 10.0 (C-8).

3-methoxyepicoccone (3): $^1$H NMR (MeOD, 400MHz) δ: 6.26 (1H, s, H-3), 3.48 (3H, s, 3-OCH$_3$), 2.12 (3H, s, H-8). $^{13}$C NMR (MeOD, 100MHz) δ: 169.8 (C-1), 151.6
Epicoccolides A (4): Yellow solid. $^1$H NMR (DMSO-$d_6$, 400MHz) $\delta$: 10.31 (1H, s, H-18), 6.81 (1H, s, H-10), 6.36 (1H, s, H-2), 2.31 (3H, s, H-17), 2.25 (3H, s, H-19).

$^{13}$C NMR (DMSO-$d_6$, 100MHz) $\delta$: 197.0 (C-9), 191.2 (C-18), 152.9 (C-5), 148.6 (C-7), 144.2 (C-14), 138.4 (C-15), 135.8 (C-16), 132.5 (C-6), 126.6 (C-3), 121.7 (C-12), 121.7 (C-13), 115.4 (C-4), 112.9 (C-11), 104.1 (C-8), 90.0 (C-2), 68.7 (C-10), 11.8 (C-17), 10.2 (C-19).

Epicoccolides B (5): Yellow solid. ESI-MS $m/z$ 357 [M-H]$^-$. $^1$H NMR (DMSO-$d_6$, 400MHz) $\delta$: 10.37 (1H, s, H-8), 9.45 (1H, s, H-15), 7.45 (1H, s, H-3), 2.57 (3H, s, H-17), 2.00 (3H, s, H-16). $^{13}$C NMR (DMSO-$d_6$, 100MHz) $\delta$: 194.6 (C-15), 189.9 (C-8), 152.0 (C-2), 151.6 (C-13), 150.2 (C-14), 142.6 (C-7a), 141.2(C-6), 137.8 (C-7), 132.8 (C-12), 127.1(C-5), 125.0 (C-9), 123.1 (C-3a), 118.8 (C-11), 116.5 (C-4), 112.5 (C-10), 109.0 (C-3), 12.8 (C-16), 11.1 (C-17).
Chaetomugilins A (6): Yellow solid. $^1$H NMR (CDCl$_3$, 400MHz) δ: 7.27 (1H, s, H-1), 6.61 (1H, m, H-10), 6.55 (1H, s, H-4), 6.14 (1H, d, $J = 16.0$Hz, H-9), 4.29 (1H, m, H-5'), 3.80 (1H, m, H-12), 3.00 (1H, H-8, H-2'), 2.45 (1H, m, H-11), 1.86 (1H, m, H-4'), 1.36 (6H, 7-CH$_3$, H-6'), 1.17 (3H, d, $J = 6.4$Hz, H-13), 1.10 (6H, 4-CH$_3$, 11-CH$_3$). $^{13}$C NMR (CDCl$_3$, 100MHz) δ: 189.2 (C-6), 170.8 (C-1'), 157.3 (C-3), 145.6 (C-1), 142.7 (C-10), 140.4 (C-4a), 122.1 (C-9), 114.5 (C-8a), 110.3 (C-5), 105.4 (C-3'), 104.0 (C-4), 83.7 (C-7), 76.7 (C-5'), 70.9 (C-12), 58.3 (C-2'), 50.4 (C-8), 45.0 (C-4'), 44.2 (C-11), 23.4 (7-CH$_3$), 20.2 (C-13), 18.7 (C-6'), 14.9 (11-CH$_3$), 8.8 (4'-CH$_3$).

Chaetomugilins D (7): Yellow solid. $^1$H NMR (CDCl$_3$, 400MHz) δ: 7.27 (1H, s, H-1), 6.52 (1H, m, H-4), 6.48 (1H, m, H-10), 6.05 (1H, d, $J = 16.0$Hz, H-9), 4.29 (1H, m, H-5'), 3.04 (1H, m, H-4'), 2.98 (1H, d, $J = 10.0$Hz, H-12), 2.45 (1H, d, $J = 10.0$Hz, H-8), 2.24 (1H, m, H-11), 1.88 (1H, m, H-4'), 1.38-1.45 (7H, 7-CH$_3$, H-6', H-12), 1.12 (3H, d, $J = 6.8$Hz, 4'-CH$_3$), 1.06 (3H, d, $J = 6.4$Hz, 11-CH$_3$), 0.88 (3H, t, $J = 7.2$Hz, H-13). $^{13}$C NMR (CDCl$_3$, 100MHz) δ: 189.2 (C-6), 170.8 (C-1'), 157.7 (C-3), 146.8 (C-10), 145.6 (C-1), 140.5 (C-4a), 120.2 (C-9), 114.4 (C-8a), 110.1 (C-5), 105.0 (C-4), 104.1 (C-3'), 83.8 (C-7), 76.9 (C-5'), 58.3 (C-2'), 50.5 (C-8), 45.0 (C-4'), 38.9 (C-11), 29.2 (C-12),
23.4 (7-CH₃), 19.4 (11-CH₃), 18.7 (C-6′), 11.7 (C-13), 8.7 (4′-CH₃).

Cheatoglobosin A (8): Yellow solid. ESI-MS m/z 529 [M+H]⁺. ¹H NMR (MeOD, 400MHz) δ: 7.46 (1H, m, H-4′), 7.24 (1H, m, H-7′), 7.69-7.00 (2H, m, H-5′,6′), 6.93 (1H, s, H-2′), 6.11 (1H, d, J = 16.4Hz, H-21), 6.03 (1H, dd, J = 15.2; 9.6Hz, H-13), 5.50 (1H, d, J = 9.2Hz, H-14), 4.98 (1H, m, H-17), 3.89 (1H, m, H-19), 2.85 (1H, m, H-4), 2.82 (1H, m, H-7), 2.75, 2.22 (2H, m, H-10), 2.43 (1H, br, H-16), 2.00, 1.71 (2H, m, H-15), 1.97 (1H, m, H-8), 1.67 (1H, m, H-5), 1.31 (3H, s, 18-CH₃), 1.27 (3H, s, H-12), 1.05 (3H, d, J = 7.2Hz, 16-CH₃), 0.97 (3H, d, J = 6.8Hz, H-11). ¹³C NMR (MeOD, 100MHz) δ: 202.8 (C-20), 199.8 (C-23), 176.4 (C-1), 141.8 (C-17), 138.9 (C-1’a), 136.9 (C-21), 135.1 (C-22), 134.6 (C-8), 134.2 (C-14), 130.5 (C-13), 129.7 (C-3’a), 126.6 (C-2’), 123.3 (C-5’), 120.9 (C-6’), 120.5 (C-4’), 113.5 (C-7’), 110.4 (C-3’), 83.8 (C-19), 65.9 (C-6), 64.5 (C-7), 60.2 (C-9), 55.0 (C-3), 51.0 (C-8), 48.7 (C-4), 43.7 (C-15), 38.5 (C-22), 34.5 (C-10), 34.0 (C-21), 22.1 (16-Me), 20.6 (C-12), 14.0 (C-11), 11.6 (18-Me).
Cheatoglobosin B (9): Yellow solid. ESI-MS \( m/z \) 529 [M+H]+. \(^1\)H NMR (CDCl\(_3\), 400MHz) \( \delta \): 8.19 (1H, br, 1′-NH), 7.64 (1H, d, \( J = 16.4\)Hz, H-22), 7.41 (1H, d, \( J = 7.6\)Hz, H-4′), 7.28 (1H, d, \( J = 8.4\)Hz, H-7′), 7.12 (1H, dd, \( J = 7.2\)Hz, H-5′), 7.05 (1H, dd, \( J = 7.6\)Hz, H-6′), 6.90 (1H, d, \( J = 2.0\)Hz, H-21), 6.10 (1H, dd, \( J = 15.2; 10\)Hz , H-13), 5.90 (1H, 1′-NH), 3.86 (1H, 19-OH), 3.76 (1H, br, H-7), 3.48 (1H, br, m, H-3), 3.32 (1H, 7-OH), 2.82, 2.59 (2H, m, H-10), 2.43 (1H, br, H-7), 3.48 (1H, br, m, H-3), 3.32 (1H, 7-OH), 2.82, 2.59 (2H, m, H-10), 2.43 (1H, br, H-16), 2.24, (1H, br, d, \( J = 12.4\)Hz , H-8), 2.03 (3H, m, H-15,H-4), 1.66 (3H, s, H-11), 1.57 (3H, s, H-12), 1.29 (3H, s, 18-CH\(_3\)), 0.97 (3H, d, \( J = 7.2\)Hz, 16-CH\(_3\)). \(^{13}\)C NMR (CDCl\(_3\), 100MHz) \( \delta \): 201.4 (C-23), 197.5 (C-20), 173.2 (C-1), 140.2 (C-17), 137.3 (C-21), 136.5 (C-1′a), 136.1 (C-22), 133.2 (C-14), 132.4 (C-18), 127.9 (C-13), 127.0 (C-3′a), 126.3 (C-5), 123.1 (C-2′), 122.6 (C-5′), 120.0 (C-6′), 118.5 (C-4′), 111.6 (C-7′), 111.1 (C-3′), 82.1 (C-19), 68.8 (C-7), 61.5 (C-9), 58.4 (C-4), 52.7 (C-3), 47.9 (C-8), 41.6 (C-15), 33.2 (C-10), 32.4 (C-16), 21.2 (16-CH\(_3\)), 18.0 (C-12), 14.0 (C-11), 10.8 (18-CH\(_3\)).

[Diagram of Cheatoglobosin B]

Cheatoglobosin E (10): Yellow solid. \(^1\)H NMR (DMSO-\( d_6\), 500MHz) \( \delta \): 10.82 (1H,
$^1$H NMR (CDCl$_3$, 400MHz) $\delta$: 8.62 (1H, br, H-1'), 7.49 (1H, d, $J = 8.0$Hz , H-4'), 7.38 (1H, d, $J = 8.0$Hz , H-7'), 7.20 (1H, dd, H-5'), 7.15 (1H, dd, H-6'), 6.98 (1H, d, $J = 2.0$Hz ,H-2'), 6.35 (1H, m, H-13), 6.12 (1H, d, $J = 8.4$Hz , H-17), 5.25 (1H, m, H-14), 4.68 (1H, m, H-20), 3.91 (1H, d, $J = 6.4$Hz , 20-OH), 3.49 (1H, H-3), 2.86, 2.66(2H, m, H-22), 1.94 (1H, m, H-8), 1.62(3H, s, 18-CH$_3$), 1.42 (3H, s, H-11), 1.01 (3H, s, H-12), 0.92 (3H, d, $J = 6.5$Hz, 16-CH$_3$). $^{13}$C NMR (DMSO-$d_6$, 125MHz) $\delta$: 210.5 (C-19), 204.4 (C-23), 174.3 (C-1), 148.6 (C-17), 136.5 (C-1’a), 135.4 (C-18), 133.8 (C-14), 133.8 (C-6), 128.8 (C-13), 127.4 (C-3’a), 125.8 (C-5), 123.9 (C-2’), 121.4 (C-5’), 118.8 (C-6’), 118.4 (C-4’), 111.9 (C-7’), 110.3 (C-3’), 70.5 (C-20), 68.0(C-7), 62.0 (C-9), 57.5 (C-3), 51.3 (C-8), 49.6 (C-4), 42.2 (C-15), 36.8 (C-22), 33.3 (C-16), 32.1 (C-10), 30.8 (C-21), 20.1 (16-CH$_3$), 17.2 (C-12), 15.0 (C-11), 12.4 (18-CH$_3$).

Cheatoglobosin F(11): White solid. ESI-MS $m/z$ 531 [M+H]$^+$. $^1$H NMR (CDCl$_3$, 400MHz) $\delta$: 8.62 (1H, br, H-1’), 7.49 (1H, d, $J = 8.0$Hz , H-4’), 7.38 (1H, d, $J = 8.0$Hz , H-7’), 7.20 (1H, dd, H-5’), 7.15 (1H, dd, H-6’), 6.98 (1H, d, $J = 2.0$Hz ,H-2’), 6.35 (1H, m, H-13), 6.12 (1H, d, $J = 8.4$Hz , H-17), 5.25 (1H, m, H-14), 4.68 (1H, m, H-20), 3.91 (1H, d, $J = 6.4$Hz , 20-OH), 3.49 (1H, H-3), 2.86, 2.66(2H, m, H-22),...
2.85 (1H, H-16), 2.85, 2.66 (2H, H-10), 2.79 (1H, H-7), 2.65 (1H, H-4), 2.38, .2.08 (2H, H-15), 2.23 (1H, m, H-8), 1.82 (4H, H-5, 18-CH₃), 1.70, 1.65 (2H, m, H-21), 1.22 (3H, s, H-12), 1.14 (3H, d, J = 7.2Hz, H-11), 1.05 (3H, d, J = 7.2Hz, 16-CH₃).

13C NMR (CDCl₃, 100MHz) δ: 208.4 (C-19), 203.7 (C-23), 175.0 (C-1), 149.6 (C-17), 136.5 (C-1’a), 134.4 (C-18), 133.6 (C-14), 128.8 (C-13), 127.2 (3’a), 123.5 (C-2’), 122.6 (C-5’), 120.1 (C-6’), 118.3 (C-4’), 111.8 (C-7’), 110.4 (C-3’), 72.0 (C-20), 64.7 (C-9), 61.9 (C-7), 57.5 (C-6), 52.7 (C-3), 49.5 (C-4), 48.6 (C-8), 41.2 (C-15), 38.2 (C-22), 36.5 (C-5), 34.5 (C-10), 33.4 (C-16), 31.6 (C-21), 19.9 (16-CH₃), 19.7 (C-12), 13.0 (C-11), 12.3 (18-CH₃).

Cheatoglobosin Fex (12): Yellow solid. ESI-MS m/z 531 [M+H]+. 1H NMR (CDCl₃, 400MHz) δ: 8.46 (1H, 1’-NH), 7.47 (1H, d, J = 8.0Hz, H-4’), 7.37 (1H, d, J = 8.0Hz, H-7’), 7.20 (1H, m, H-5’), 7.13 (1H, m, H-6’), 7.00 (1H, d, J = 2.0Hz ,H-2’), 6.21 (1H, m, H-13), 6.13 (1H, d, J = 9.2Hz , H-17), 5.81 (1-NH), 5.37 (1H, m, H-14), 5.37, 5.13 (2H, m, H-12), 4.70 (1H, br, H-20), 3.92 (1H, d, J = 10.4Hz , H-7’), 3.79 (1H, br, -OH), 3.45 (1H, m, H-3), 2.90 (2H, H-10), 2.76, 2.63 (2H, m, H-22), 2.78 (1H, H-4), 2.58, 2.07 (2H, m, H-21), 2.42 (1H, m, H-5), 2.41, 2.04 (2H, m, H-15), 1.84 (3H, H-8, 18-CH₃), 1.03 (3H, d, J = 6.4Hz , H-11), 0.96 (3H, d, J = 6.0Hz , 16-CH₃). 13C NMR
(CDCl₃, 100MHz) δ: 208.2 (C-23), 203.9 (C-19), 174.3 (C-1), 149.5 (C-17), 148.5 (C-6), 136.8 (C-1’a), 135.9 (C-14), 134.9 (C-18), 128.9 (C-13), 127.5 (C-3’a), 123.6 (C-2’), 122.9 (C-5’), 120.4 (C-6’), 118.8 (C-12), 111.9 (C-7’), 111.2 (C-3’), 71.9 (C-20), 70.3 (C-7), 63.2 (C-9), 52.7 (C-3), 49.9 (C-8), 47.9 (C-4), 41.4 (C-15), 37.9 (C-22), 34.1 (C-5), 33.8 (C-16), 32.5 (C-10), 31.8 (C-21), 20.3 (18-CH₃), 14.3 (C-11), 12.6 (16-CH₃).

Penochalasin F (13): Needle crystal. ¹H NMR (DMSO-d₆, 500MHz) δ: 8.23 (1’-NH), 7.40 (1H, d, J = 7.7Hz, H-4’), 7.31 (1H, d, J = 7.9Hz, H-7’), 7.08 (2H, m, H-5’, 6’), 6.89 (1H, d, J = 2.0Hz, H-2’), 6.03 (1H, dd, J = 9.9Hz, 15.2Hz, H-13), 5.91 (1H, 2-NH), 5.38 (1H, d, J = 8.8Hz, H-17), 5.13 (1H, m, H-14), 4.39 (1H, d, J = 3.4Hz, H-19), 4.05 (1H, m, H-3), 3.74 (1H, d, J = 3.2Hz, 19-OH), 3.68 (1H, d, J = 3.6Hz, 19-OH), 3.06, 2.59 (2H, m, H-22), 2.87 (2H, m, H-10), 2.74 (1H, d, J = 5.6Hz, H-7), 2.61 (1H, m, H-4), 2.47 (1H, m, H-16), 2.25 (1H, d, H-5), 2.17, 1.86 (2H, m, H-21), 2.16, 1.80 (2H, m, H-15), 1.88 (1H, H-8), 1.61 (3H, s, 18-CH₃), 1.33 (3H, s, H-12), 1.12 (3H, d, J = 7.2Hz, H-11), 0.95 (3H, d, J = 7.2Hz, 16-CH₃). ¹³C NMR (DMSO-d₆, 125MHz) δ: 211.8 (C-23), 207.9 (C-20), 174.9 (C-1), 140.3 (C-17), 136.7 (C-1’a), 134.3 (C-14), 131.5 (C-18), 128.4 (C-13), 127.5 (C-3’a), 124.0 (C-2’), 123.0 (C-5’),
Penochalasin G (14): Needle crystal. ESI-MS m/z 537[M+Na]+. ¹H NMR (CDCl₃, 500MHz) δ: 8.11 (1′-NH), 7.41 (1H, d, J = 7.7Hz , H-4′), 7.31 (1H, d, J = 8.1Hz, H-7′), 7.14 (1H, m, H-5′), 7.07 (1H, m, H-6′), 6.95 (1H, d, J = 2.0Hz, H-2′), 5.94 (1H, dd, J = 15.2; 10.1Hz, H-13), 5.53 (1H, 2-NH), 5.45 (1H, d, J = 8.5Hz , H-17), 5.04 (1H, ddd, J = 14.7; 10.9; 3.3Hz, H-14), 4.43 (1H, d, J = 3.2Hz, H-19), 3.74 (1H, d, J = 3.2Hz, 19-OH), 3.36 (1H, m, H-3), 3.32, 2.60 (2H, m, H-22), 2.69, 2.55 (2H, m, H-10), 2.58 (1H, m, H-4), 2.55 (1H, m, H-5), 2.46 (1H, br, H-16), 2.35, 1.97 (2H, m, H-21), 2.22, 1.89 (2H, m, H-15), 2.17 (1H, m, H-8), 1.70 (3H, s, H-12), 1.34 (3H, s, 18-CH₃), 1.26 (3H, d, J = 7.3Hz, H-11), 0.92 (3H, d, J = 6.7Hz, 16-CH₃). ¹³C NMR (CDCl₃, 125MHz) δ: 212.0 (C-23), 209.0 (C-20), 174.7 (C-1), 140.7 (C-17), 140.6 (C-6), 136.7 (C-1′a), 132.1 (C-13), 131.3 (C-18), 127.5 (C-3′a), 126.3 (C-2′), 123.6 (C-14), 122.9 (C-6′), 120.5 (C-5′), 119.0 (C-4′), 111.9 (C-7′), 111.2 (C-3′), 82.5 (C-19), 67.1 (C-9), 54.1 (C-3), 51.9 (C-4), 48.4 (C-8), 42.0 (C-15), 37.3 (C-22), 35.4 (C-5),
34.6 (C-21), 34.5 (C-10), 32.7 (C-16), 21.5 (16-CH₃), 20.5 (C-12), 14.3 (C-11), 10.9 (18-CH₃).

**Anti-phytopathogenic activity assay**

Antifungal tests were performed as described by Park J.H. with some modification (Park et al. 2005). In the *vitro* antifungal test, PDB was used as incubation medium. 5μL of metabolite’s solutions in dimethyl sulfoxide (DMSO) were added into 96-well sterilised microplates and their final concentrations ranged from 512 to 1 μg/mL by using a twofold serial dilution method. 10 μL spore suspension (10⁵ spores/mL) of *Fusarium flocciferum* and mycelial suspensions (10⁵ spores/mL) of the other fungi (*Phoma herbarum, Cladosporium oxysporum, Plectosphaerella cucumerina, Epicoccum nigrum*) were inoculated in each well. The wells contained fungi suspensions and DMSO were run as negative controls and the wells contained nystatin (Taicheng Pharmaceutical Co., Ltd, Guangdong, China) were introduced as the positive control. The plates contained test strains, and diluted compounds were incubated at 28°C (18-48 h), the minimum inhibitory concentrations of the antifungal metabolites that completely inhibited mycelial growth were defined as the MICs.
Acetylcholinesterase (AChE) inhibition assay

AChE inhibitory activities of the compounds were assayed by the spectrophotometric method developed by Ellman et al with slightly modification (Ellman et al. 1961). S-Acetylthiocholine iodide, S-butyrylthiocholine iodide, 5,5’-dithio-bis-(2-nitrobenzoic) acid (DTNB, Ellman's reagent), acetylcholinesterase derived from human erythrocytes were purchased from Sigma Chemical. Compounds were dissolved in DMSO. The reaction mixture (totally 200 μL) containing phosphate buffer (pH 8.0), test compound (50 μM), and acetyl cholinesterase (0.02 U/mL), was incubated for 20 min (37 °C). Then, the reaction was initiated by the addition of 40 μL of solution containing DTNB (0.625mM) and acetylthiocholine iodide (0.625 mM) for AChE inhibitory activity assay, respectively. The hydrolysis of acetylthiocholine was monitored at 405 nm every 30 seconds for one hour. Tacrine (TA) was used as positive control with final concentration of 0.333 μM. All the reactions were performed in triplicate. The percentage inhibition was calculated as follows: % inhibition = (E - S)/E × 100 (E is the activity of the enzyme without test compound, and S is the activity of enzyme with test compound).

96-Well Plate DPPH Method

The 96-Well plate DPPH method was performed as described by Routray et al. with some modification (Joshi et al. 2014). The DPPH was dissolved in ethanol absolute then prepared to be stock solution at a concentration of 0.507 mM monthly and kept at 4 °C in dark. The 0.264 mM fresh DPPH working solution was made daily by further
diluting the stock solution in ethanol absolute for the test. The stock solutions of all compounds were prepared in DMSO at the concentration of 5.12 mg/mL. Ascorbic acid was used as positive control.

This 96-Well plate DPPH method was carried out using an infinite M200 PRO plate reader. Each well contained 5 μL of sample solution, 95 μL of ethanol and 100 μL of 0.264 mM DPPH solution, a blank with only 5μL of DMSO and 195 μL of ethanol and a control with the mixture of 100μL of ethanol and 100 μL of 0.264 mM DPPH solution, the total volume of each well was 200μL and the final concentration of DPPH is 0.132 mM. The absorptions were determined at 517 nm. The % DPPH quenched was determined according to the equation:

\[
\text{% DPPH quenched} = \left[1 - \frac{(A_{\text{sample}} - A_{\text{blank}})}{(A_{\text{control}} - A_{\text{blank}})}\right] \times 100
\]

A 6 hour preliminary screening was employed to determine the standard type of the compounds (the final concentration of each sample solution was 128 μg/mL). Then the EC\textsubscript{50} of suitable compounds were tested. EC\textsubscript{50} value is the effective concentration that could scavenge 50% of the DPPH radicals.

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Figure S1. HR-ESIMS of compound 1

Figure S2. $^1$H NMR of compound 1
Figure S3. $^{13}$C NMR of compound 1

Figure S4. $^1$H NMR of compound 2
Figure S5. $^{13}$C NMR of compound 2

Figure S6. $^1$H NMR of compound 3
Figure S7. $^{13}$C NMR of compound 3

Figure S8. $^1$H NMR of compound 4
Figure S9. $^{13}$C NMR of compound 4

Figure S10. HR-ESIMS of compound 5
Figure S11. $^1$H NMR of compound 5

Figure S12. $^{13}$C NMR of compound 5
Figure S13. $^1$H NMR of compound 6

Figure S14. $^{13}$C NMR of compound 6
Figure S15. $^1$H NMR of compound 7

Figure S16. $^{13}$C NMR of compound 7
Figure S17. HR-ESIMS of compound 8

Figure S18. $^1$H NMR of compound 8
Figure S19. $^{13}$C NMR of compound 8

Figure S20. HR-ESIMS of compound 9
Figure S21. $^1$H NMR of compound 9

Figure S22. $^{13}$C NMR of compound 9
Figure S23. $^1$H NMR of compound 10

Figure S24. $^{13}$C NMR of compound 10
Figure S25. HR-ESIMS of compound 11

Figure S26. $^1$H NMR of compound 11
Figure S27. $^{13}$C NMR of compound 11

Figure S28. HR-ESIMS of compound 12
Figure S29. $^1$H NMR of compound 12

Figure S30. $^{13}$C NMR of compound 12
Figure S31. $^1$H NMR of compound 13

Figure S31. $^{13}$C NMR of compound 13
Figure S32. HR-ESIMS of compound 14

Figure S33. $^1$H NMR of compound 14
Figure S34. $^{13}$C NMR of compound 14