Three New Glycosides From the Stems of *Derris elliptica*

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**Abstract**

Three new glycosides, derriacuminosides A-C (1-3), were isolated from the stems of *Derris elliptica* (Wall.) Benth. Their chemical structures were determined by interpretations of HRESIMS and NMR spectra. The anti-inflammatory activity of compounds 1-3 were evaluated by inhibiting NO production in LPS activated RAW264.7 cells. Compounds 1-3 potentially inhibited NO production with IC\(_{50}\) values of 26.54 ± 3.08, 26.35 ± 1.37, and 49.71 ± 2.93 \(\mu\)M, respectively, compared to the positive control, L-NMMA (IC\(_{50}\) 35.56 ± 2.98 \(\mu\)M).

**Keywords**

*Derris elliptica*, Leguminosae, acuminose derivative, derriacuminoside, nitric oxide inhibitor

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**Introduction**

*Derris elliptica* is a climbing shrub belonging to the Leguminosae family. It is widely grown or cultivated in subtropical and tropical regions. The roots of *D. elliptica* have long been used for poisoning fish and plant pests.\(^1\)\(^-\)\(^3\) In traditional medicines, *D. elliptica* is used to treat sickness of breasts, toothache, bleeding, and stomachache.\(^4\) Up to date, several phytochemical studies have been reported on the roots and aerial parts of *D. elliptica*. Flavonoids in several subgroups, such as flavone, isoflavone, pterocarpan, cumaronochromone, and especially rotenoid, were identified as major components of this plant.\(^5\)\(^-\)\(^8\) These types of compounds have been shown to have potential cytotoxic and anti-inflammatory activities.\(^9\)\(^-\)\(^10\) The roots of *D. elliptica* contain rotenoids, such as rotenone, deguelin, and tephrosin, which are toxic ingredients responsible for the plant’s insecticidal property.\(^5\)\(^-\)\(^8\) Other phenolic compounds, including flavone, isoflavone, pterocarpan, and cumaronochromone, have been revealed from the aerial parts of this plant.\(^8\) However, there have been no continuous phytochemical studies on this plant for the past decade. In our program to find natural anti-inflammatory agents, the water extract of *D. elliptica* stems showed potential NO inhibitory activity, which was selected for chemical investigation. Herein, we report the identification of 3 new glycosides and their inhibitory activity on NO production in LPS activated RAW264.7 cells.

**Results and Discussion**

The stems of *D. elliptica* were extracted with methanol. The methanol extract was suspended in water and successively partitioned with dichloromethane and ethyl acetate. The water-soluble extract was fractionated by column chromatography, and purified by semi-preparative HPLC to obtain compounds 1-3 (Figure 1).

Compound 1 was isolated as a white amorphous powder. Its molecular formula, C\(_{31}\)H\(_{44}\)O\(_{13}\), was determined by high-resolution electron spray ionization mass spectrometry (HRESIMS), showing quasi-molecular ion peaks at \(\text{m/z} 623.2699\) [M - H]\(^+\) (calcd. for [C\(_{31}\)H\(_{44}\)O\(_{13}\)]\(^-\), 623.2709) and \(\text{m/z} 659.2485\) [M + Cl]\(^+\) (calcd. for [C\(_{31}\)H\(_{44}\)O\(_{13}\)Cl]\(^-\), 659.2476). The \(^1\)H NMR spectrum of 1 revealed 4 aromatic protons in an AA′BB′ coupled system \(\delta H 7.91\) (2H, d, \(J = 8.0\) Hz) and 6.83 (2H, d, \(J = 8.0\) Hz), one olefinic proton \(\delta H 5.77\) (1H, s), 2 anomic protons \(\delta H 4.28\) (1H, d, \(J = 7.5\) Hz) and \(\delta H 4.28\) (1H, d, \(J = 7.5\) Hz), 3 oxygenated methylene groups \(\delta H 3.54\) (2H, s), 4.04 and 3.86 (each 1H, d, \(J = 8.0\) Hz) \(\delta H 5.04\) (1H, d, \(J = 2.0\) Hz), 3 oxygenated methylene groups \(\delta H 5.04\) (1H, d, \(J = 2.0\) Hz), 3 oxygenated methylene groups \(\delta H 5.04\) (1H, d, \(J = 2.0\) Hz), and 4 methine groups \(\delta H 5.04\) (1H, d, \(J = 7.0\) Hz). The \(^13\)C NMR spectrum of 1 contained signals assigning for 31 carbons and recognized by the HSQC spectrum including 7 non-protonated carbons, 14...
methine groups, 6 methylene groups, and 4 methyl groups. The
signals of the AA’BB’ coupled protons together with the
HMBC correlations between H-2‴ (δ_H 7.91)/H-6‴ (δ_H 7.91)
and C-4‴ (δ_C 163.8)/ C-7‴ (δ_C 167.8) indicated the presence of
a p-hydroxybenzoyl group (Figure 2). Two anomeric protons [δ_H
4.28 and 5.04] suggested the presence of 2 sugar units.
Additionally, the presence of an apiofuranosyl moiety was deter-
mined by a deshielded signal of an anomeric carbon (δ_C
110.7), a tertiary oxygenated carbon (δ_C 79.0, C-3′′), and 4 oxygenated
methylene protons (δ_H 4.04 and 3.86, H2-4′′; δ_H 4.34, H2-5′′).
The presence of a glucopyranosyl moiety was confirmed by axial-
trans coupled protons (J = 7.5-9.0 Hz) in their carbinol protons
(H-1′ to H-5′). The HMBC correlation between Api H-1′′ (δ_H
5.04) and Glc C-6′ (δ_C 68.8) indicated an apiofuranosyl-(1→6)-
glucopyranosyl disaccharide (acuminose) moiety. Moreover,
carbon chemical shifts, values of the coupling constants, and mul-
tiplicity of the anomeric signals agreed with the β-glucopyranosyl (J
= 7.5 Hz) and β-apiofuranosyl (J = 2.0 Hz) linkages, as previously
described.11 The HMBC correlation between Api H2-5′′ (δ_H 4.34)
and carbonyl carbon C-7‴ (δ_C 167.8) confirmed anester linkage
between p-hydroxybenzoyl and Api C-5‴. The remaining 13
carbon signals were assigned to a megastigmane backbone contain-
ing an αβ-unsaturated ketone functional group (showing 3
deshielded carbons at δ_C 202.5, 170.2, 125.4). Of these, the
ketone functional group at C-3 and the double bond at C-4/C-5
were demonstrated by HMBC correlations between H3-13 (δ_H
2.00) and C-4 (δ_C 125.4)/ C-5 (δ_C 170.2)/ C-6 (δ_C 52.4), H3-11
(δ_H 1.04)/ H3-12 (δ_H 0.96) and C-2 (δ_C 48.1), H2-2 (δ_H 2.42
and 1.96) and C-3 (δ_C 202.5). The doublet signals of methyl
protons (H3-10, δ_H 1.14) and HMBC correlation between H3-10
and C-9 (δ_C 76.0)/ C-8 (δ_C 37.7) suggested the presence of an oxy-
gen group at C-9. Furthermore, HMBC correlation between
Glc H-1′′ (δ_H 4.28) and C-9 (δ_C 76.0) indicated the sugar moiety
linked to C-9 of the megastigmane moiety. The absolute configura-
tion of I was elucidated by analysis of its ECD spectrum,13C-NMR
spectral data, and acid hydrolysis. Particularly, the ECD spectrum of
I showed positive Cotton effects at 337 nm (+0.85 mdeg) and
239 nm (+3.65 mdeg) indicating a 6R-configuration, as previously
reported.12 On the other hand, carbon chemical shift values of C-9
(δ_C 76.0), C-10 (δ_C 20.2), and Glc C-1′ (δ_C 102.5) demonstrated a
R configuration, which was identical to that of byzantinoside B (9R; δC-9 75.7, δC-10 19.9, and δC-1 102.3), but significantly different from blumenol C glucoside (9S; δC-9 77.7, δC-10 22.0, and δC-1 104.1). Finally, acid hydrolysis of 1 obtained D-glucose and D-apiose, which were confirmed by HPLC analysis of their thiocarbamoylthiazolidine derivatives by comparison with authentic sugars.13,14 Consequently, the structure of 1 was established and named derriacuminoside A (Supplemental Figures S1-S7).

Compounds 2 and 3 were obtained as white amorphous powders. The molecular formula of 2 was determined as C23H33O12 by HRESIMS ions at m/z 537.1744 [M + Cl]− (calcd. for [C23H33O12Cl]−, 537.1725 [M + Cl]− (calcd. for [C23H33O12Cl]−, 537.1744). The 1H and 13C NMR spectral data of 2 and 3 were identical to those of 1 by signals corresponding to an acuminose disaccharide moiety and a β-hydroxybenzoyl group (Table 1). Differences between them were signals of the aglycone moiety. The aglycone moiety of 2 was determined to be an O-benzyl group showing 5 aromatic protons [δH 7.39 (2H, d, J = 8.5 and 1.5 Hz), 7.30 (2H, dd, J = 8.5 and 1.5 Hz), 7.26 (1H, t, J = 8.5 Hz)] and an oxy-methylene group [δH 4.86 and 4.63 (each 1H, d, J = 11.5 Hz), δC 71.8]. The HMBC correlations between the oxy-methylene protons H-7 (δH 4.86 and 4.63) and C-1 (δC 138.9)/C-2 (δC 129.2)/C-6 (δC 129.2) further confirmed the presence of the O-benzyl group. The HMBC correlation between Glc H-1′ (δH 4.34) and C-7 (δC 71.8) indicated the linkage between the O-benzyl group and the sugar moiety in 2. On the other hand, the aglycone

Table 1. 1H NMR and 13C NMR Spectroscopic Data for Compounds 1-3 in CD3OD.

|    | 1H (δ ppm, J in Hz) | 13C (δ ppm) |
|----|--------------------|-------------|
| 1  |                    |             |
| 2  |                    |             |
| 3  |                    |             |

Measured at 125 MHz and 500 MHz.
moiety of 3 was an α-methylbutoxy group showing 5 saturated carbons (δC 76.1, 36.3, 27.1, 16.9, and 11.6). The HMBC correlations from H-1’ (δH 0.88) to C-3 (δC 27.1)/C-2 (δC 36.3), and H-1’ (δH 0.91) to C-3/C-2/C-1 (δC 76.1) additionally confirmed the α-methylbutoxy group. The HMBC correlations from Glc H-1’ (δH 4.22) to C-1 (δC 76.1) also indicated a linkage between the α-methylbutoxy group and the sugar moiety in 3. However, due to a lack of significant evidence, the absolute configuration of the α-methylbutoxy group is still underdetermined. Later, the presence of D-glucose and D-apiose in both 2 and 3 were also confirmed by acid hydrolysis, HPLC analysis of the thiocarbamoylthiazolidine products, and comparison with authentic sugars.13,14 Thus, the structures of 2 and 3 were established and named as derriacuminosides B and C, respectively (Supplemental Figures S8-S18).

The water-soluble extract of *D. elliptica* (100 μg/mL) was screened for NO inhibitory activity and showed an inhibitory percentage of 70.8 ± 3.5%. Thus, compounds 1-3 were evaluated for their anti-inflammatory activity by inhibition of NO production in LPS activated RAW264.7 cells. At the highest concentration of 100 μM, compounds 1 and 2 were established for their anti-inflammatory property (cell viability of 98.2%, 97.9%, and 98.3% ± 1%, respectively) in 1/3, 1/1, 1/0, v/v to yield 3 fractions, W1-W3. Fraction W1 was chromatographed on a silica gel column, eluting with dichloromethane/acetone (2/1, v/v) to give 5 fractions, W1-A-W1E. Fraction W1A was repeatedly chromatographed on a silica gel column, eluting with dichloromethane/ethyl acetate (1/1, v/v) to give 2 fractions, W1A1 and W1A2. Fraction W1A1 was purified by semi-preparative HPLC using acetonitrile/water (3/7, v/v) to give compound 3 (12 mg, tR 43.7 min). Fraction W1A2 was purified by semi-preparative HPLC using methanol and water (6/4, v/v) to give compound 1 (17 mg, tR 29.3 min). Fraction W1B was chromatographed on reversed phase C-18 column, eluting with methanol/water (1/1, v/v) to give 3 fractions, W1B1-W1B3. Fraction W1B2 was purified by semi-preparative HPLC using acetonitrile/water (3/7, v/v) to give compound 2 (15 mg, tR 26.2 min).

### Material and Methods

#### General Experimental Procedures

Optical rotation was recorded on a JASCO P-2000. HRESIMS were obtained on an AGILENT 6530 Accurate Mass Q-TOF, and NMR spectra on a BRUKER Avance III spectrometer. Semi-preparative HPLC was performed on an AGILENT 1260 Infinity II system using a YMC J’sphere ODS-H80 column (20 mm × 250 mm, 4 μm) and isotropic mobile phase at a flow rate of 3.0 mL/min. Thin layer chromatography (TLC) was carried out on pre-coated plates (silica gel 60 F254 or RP-18 F354S), and column chromatography (CC) using either silica gel, reversed phase (RP-18), or diaion HP-20 resins.

#### Plant Material

Fresh samples of *Derris elliptica* (Wall.) Benth. were collected in October 2020 at the Me Linh station for biodiversity, Vinh Phuc, Vietnam, and identified by Dr Nguyen The Cuong at the Institute of Ecology and Biological Resources, VAST. A voucher specimen (code: NCCT-P105) is kept at the Institute of Marine Biochemistry, VAST.

### Extraction and Isolation

The stems of *D. elliptica* were dried at 60 °C and pulverized to fine powder. The powdered material (15 kg) was ultrasonically extracted with methanol at room temperature, 3 times (10 L of methanol and 30 min each time), to give the methanol extract. The methanol extract (450 g) was then mixed with 3 L of water and successively extracted with dichloromethane and ethyl acetate to give dichloromethane, ethyl acetate, and water-soluble fractions. The water soluble fraction was separated by diaion HP-20 CC eluting with methanol/water (1/3, 1/1, 1/0, v/v) to yield 3 fractions, W1-W3. Fraction W1 was chromatographed on a silica gel column, eluting with dichloromethane/acetone (2/1, v/v) to give 5 fractions, W1-A-W1E. Fraction W1A was repeatedly chromatographed on a silica gel column, eluting with dichloromethane/ethyl acetate (1/1, v/v) to give 2 fractions, W1A1 and W1A2. Fraction W1A1 was purified by semi-preparative HPLC using acetonitrile/water (3/7, v/v) to give compound 3 (12 mg, tR 43.7 min). Fraction W1A2 was purified by semi-preparative HPLC using methanol and water (6/4, v/v) to give compound 1 (17 mg, tR 29.3 min). Fraction W1B was chromatographed on reversed phase C-18 column, eluting with methanol/water (1/1, v/v) to give 3 fractions, W1B1-W1B3. Fraction W1B2 was purified by semi-preparative HPLC using acetonitrile/water (3/7, v/v) to give compound 2 (15 mg, tR 26.2 min).

#### Derriacuminoside A (1)

White amorphous powder, [α]D 20: +71 (c 0.1, MeOH); UV (MeOH): λmax (logε) 253 (4.1) nm; IR (KBr): νmax 3402, 2991, 1694, 1668, 1597, 1191 cm−1; HRESIMS m/z 623.2699 [M - H]+ (calcd. for [C31H43O13]−, 623.2709) and m/z 659.2485 [M + Cl]+ (calcd. for [C31H44O12Cl]−, 659.2476); 1H NMR (CD3OD, 500 MHz), and 13C NMR (CD3OD, 125 MHz) data are given in Table 1.

#### Derriacuminoside B (2)

White amorphous powder, [α]D 20: +54 (c 0.1, MeOH); UV (MeOH): λmax (logε) 260 (3.7) nm; IR (KBr): νmax 3398, 2989, 1697, 1602, 1195 cm−1; HRESIMS m/z 521.1640 [M - H]+ (calcd. for [C25H20O12]−, 521.1664) and m/z 557.1414 [M + Cl]+ (calcd. for [C25H19O12Cl]−, 557.1431); 1H NMR (CD3OD, 500 MHz), and 13C NMR (CD3OD, 125 MHz) data given in Table 1.

#### Derriacuminoside C (3)

White amorphous powder, [α]D 20: +47 (c 0.1, MeOH); UV (MeOH): λmax (logε) 284 (3.0) nm; IR (KBr): νmax 3404, 2987, 2969, 1698, 1596, 1201 cm−1; HRESIMS m/z 501.1954 [M - H]+ (calcd. for [C23H13O12]−, 501.1978) and m/z 537.1725 [M + Cl]+ (calcd. for [C23H12O12Cl]−, 537.1744); 1H NMR (CD3OD, 500 MHz), and 13C NMR (CD3OD, 125 MHz) data given in Table 1.

#### Acid Hydrolysis and Confirmation of Sugar Residue

Compounds 1-3 (each 2.0 mg) were dissolved in 1.0 mL acid solution (1.0 N HCl in dioxane/H2O (1/1, v/v)) and heated...
at 80 °C in a water bath for 3 h. After that, solvent was removed using N₂ gas. After addition of 1.0 mL of water, the solution was extracted twice with chloroform (1.0 mL each). The water portion was neutralized by Amberlite IRA400 resin and then dried in vacuo. The residue was re-dissolved in 100 µL pyridine containing 1.0 mg of L-cysteine methyl ester hydrochloride and heated at 60 °C for 1 h. After that, 100 µL pyridine containing 1.0 mg of o-tolyl isothiocyanate was added to the reaction mixture and continuously heated at 60 °C for an additional 1 h. Thiocarbamoyl-thiazolidine products were analyzed by an Agilent infinity II 1290 HPLC system using a Zorbax extend C18 rapid resolution column (2.1 × 50 mm, 1.8 micron), a flow rate of 300 µL/min of ACN/water (20% ACN in volume), and an UV detector at 250 nm. Peaks at 14.6 and 24.7 min were confirmed to be D-glucose and D-apiose derivatives, respectively, by comparison of their retention times with those of authentic D-glucose and D-apiose derivatives prepared in the same manner.

**Nitric Oxide Assay**

RAW 264.7 cells were cultured in DMEM containing L-glutamine (2 mM), HEPES (10 mM), sodium pyruvate (1 mM), and fetal bovine serum (10%). The cells (2 × 10⁵ cells/well) were incubated in humidified atmosphere (95% air and 5% CO₂) at 37° C. After 24 h incubation, to each well was added either compounds (0.8-100 µM/mL) or vehicle, followed by LPS (1 µg/mL) in the next 2 h. The cells were then incubated for an additional 24 h. After that, cell viability was measured by MTT assay and the amount of NO production in the cell medium was determined by Griess reaction. Culture medium (100 µL) was mixed with an equal volume of Griess reagent and incubated at room temperature for 10 min. Absorbance was measured at 540 nm on a microplate reader. Nitrite concentration as an indicator of NO production was determined using a standard curve, which was built by NaNO₂ serial diluted solutions. Experiments were performed in triplicate. IC₅₀ values were generated by TableCurve 2Dv4 software.

**Conclusions**

From the stems of *D. elliptica* 3 new glycosides were isolated, characterized, and named derriacuminosides A-C (1-3). Compounds 1 and 2 inhibited NO production in LPS activated RAW264.7 cells with IC₅₀ values of 26.54 ± 3.08 and 26.35 ± 1.37 µM, respectively, which are smaller than that of compound 3 (IC₅₀ = 49.71 ± 2.93 µM) and the positive control, N⁰⁵-methyl-L-arginine acetate salt (IC₅₀ = 35.56 ± 2.98 µM).

**List of Abbreviations**

| Abbreviation | Description |
|--------------|-------------|
| Api          | apioufuransyl group |
| COSY         | correlation spectroscopy |
| Glc          | glucopyranosyl group |
| HMBC         | heteronuclear multiple bond correlation |
| HPLC         | high-performance liquid chromatography |
| HRESIMS      | high-resolution electrospray ionization mass spectrometry |
| HSQC         | heteronuclear single quantum coherence |
| NOESY        | nuclear Overhauser effect spectroscopy |
| NMR          | nuclear magnetic resonance |

**Authors’ contributions**

Research idea: NX Nhiem, PV Kiem. Isolation and bioassay: BTT Trang, NT Huong, NT Anh. Structure elucidation and writing: BTT Trang, NTT Mai, NX Nhiem, PV Kiem.

**Declaration of Conflicting Interests**

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Our institution does not require ethical approval for reporting individual cases or case series.

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**Statement of Human and Animal Rights**

This article does not contain any studies with human or animal subjects.

**Statement of Informed Consent**

There are no human subjects in this article and informed consent is not applicable.

**Supplemental Material**

Supplemental material for this article is available online.

**References**

1. Harper SH. Active principles of leguminous fish-poison plants. II. The isolation of 1-elliptone from *Derris elliptica*. *J Chem Soc*. 1939:1099-1105. doi:10.1039/jr9390001099
2. Worsley RRLG, Nutman FJ. Biochemical studies of *Derris* and *Mundulea*. I. Histology of rotenone in *Derris elliptica*. *Ann Appl Biol*. 1937;24:696-702. doi:10.1111/j.1744-7348.1937.tb05050.x
3. Wiwattanapatapee R, Sae-Yun A, Petchjar J, Ovatlarnpon C, Itharat A. Development and evaluation of granule and emulsifiable concentrate formulations containing *Derris elliptica* extract for crop pest control. *J Agric Food Chem*. 2009;57(23):11234-11241. doi:10.1021/jf901862z
4. Khan MR, Omoloso AD, Barewai Y. Antimicrobial activity of the 
*Derris elliptica*, *Derris indica* and *Derris trifoliata* extracts. *Fitoterapia*. 
2006;77(4):327-330. doi:10.1016/j.fitote.2006.03.007

5. Ahmed M, Shireen KF, Rashid MA, Mahmud ul A. A further rote- 
oid from *Derris elliptica*. *Planta Med*. 1989;55(2):207-208. doi:10. 
1055/s-2006-961936

6. Lu HY, Liang JY. Novel N-containing rotenoid and seco-rotenoid 
from the root of *Derris elliptica*. *J Asian Nat Prod Res*. 2009;11(1):58- 
62. doi:10.1080/10286020802514002

7. Lu HY, Liang JY, Yu P, Qu W, Zhao L. Two new rotenoids from 
the root of *Derris elliptica*. *Chin Chem Lett*. 2008;19(10):1218-1220. 
doi:10.1016/j.ccl.2008.06.014

8. Wu X, Song Z, Xu H, Zhang H, Chen W, Liu H. Chemical constitu- 
ents of the aerial part of *Derris elliptica*. *Fitoterapia*. 2012;83(4):732-736. 
doi:10.1016/j.fitote.2012.02.015

9. Ito C, Murata T, Tan HT, Kaneda N, Furukawa H, Itoigawa M. 
Rotenoid derivatives from *Derris trifoliata* with nitric oxide produc- 
tion inhibitory activity. *Nat Prod Commun*. 2012;7(11):1479-1482. 
doi:10.1177/1934578X1200701117

10. Chokchaichamnankit D, Kongiinda V, Khunnawutmanotham N, 
Chimnoi N, Pisutcharoenpong S, Techasakul S. Prenylated flavo- 
noids from the leaves of *Derris malaccensis* and their cytotoxicity. 
*Nat Prod Commun*. 2011;6(8):1934578X1100600813. doi:10. 
1177/1934578X1100600813

11. Dini I, Carlo Tenore G, Dini A. Phenolic constituents of lankolla 
seeds. *Food Chem*. 2004;84(2):163-168. doi:10.1016/S0308-8146(03) 
00185-7

12. Matsunami K, Otsuka H, Takeda Y. Structural revisions of blumenol 
C glucoside and byzantionoside B. *Chem Pharm Bull*. 2010;58(3):438- 
441. doi:10.1248/cpb.58.438

13. Tanaka T, Nakashima T, Ueda T, Tomii K, Kouno I. Facile dis- 
crimination of aldose enantiomers by reversed-phase HPLC. 
*Chem Pharm Bull*. 2007;55(6):899-901. doi:10.1248/cpb.55.899

14. Tai BH, Anh NTH, Cuc NT, et al. Three new constituents from 
the parasitic plant *Balanophora luciflora*. *Nat Prod Commun*. 
2019;14(5):1934578X19849959. doi:10.1177/1934578X19849959

15. Chinh PT, Tham PT, Giang PTT, et al. New nitric oxide inhibitory 
p-coumaroyl flavone glycosides from *Fissistigma bicolor*. *Phytolchim 
Lett*. 2021;44:169-172. doi:10.1016/j.phytol.2021.06.019