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Chemical constituents and nutritional health functions of *Dendrobium nobile*: a review

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Abstract

Dendrobium nobile is a traditional Chinese medicine and functional food in China, containing phenanthrene, alkaloids, bibenzyl, sesquiterpenes, polysaccharides and other chemical components, with anti-aging, immunity-enhancing, glucose-lowering and lipid-lowering health functions. In recent years, the research value of *D. nobile* has attracted the attention of more and more experts and scholars. This paper reviews the chemical constituents isolated and identified from *D. nobile* and provides reference for further development and utilization of *D. nobile*.

Keywords: *Dendrobium nobile*; isolation and identification; chemical composition.

Practical Application: The review provides a comprehensive information for consumers and researchers to understand D. nobile Chemical constituents and nutritional health functions.

1 Introduction

Dendrobium nobile Lindl. (Orchidaceae) is a famous traditional Chinese medicine and functional food with a long history, and mainly distributed in Guizhou, Yunnan, Guangxi of China and other subtropical areas. *D. nobile* has the effects of promoting the body's vitality, relieving cough, moistening the lungs and stomach, strengthening the eyes and nourishing Yin and clearing heat. Relevant studies have found that most of the compounds isolated from *D. nobile* have good physiological activities, with significant effects in improving memory loss, improving cerebral ischaemia, anti-fatigue, anti-oxidation, hypoglycaemia, anti-tumour and anti-inflammation. Its chemical composition is complex, including phenanthrenes, alkaloids, polysaccharides, sesquiterpenoids, bibenzoids, hand ketones, phenylpropanoids and so on. This paper reviews the nutritional and chemical composition and health functions of *D. nobile*, in order to provide reference for its in-depth research and development.

2 Phytochemical composition

The chemical constituents in medicinal plants play a vital role in human health. Chemical composition research showed that *D. nobile* mainly contains phenanthrene, alkaloids, polysaccharides, flavonoids, phenols, sesquiterpenoids, coumarins and steroidal glycosides. Their structures and names are listed below.

2.1 Phenanthrene

There are numerous reports on the biological activities of phenanthrene compounds from *D. nobile*, which are widely used for their pharmacological activities such as antitumour and antioxidant. Up to now, 51 compounds have been identified from *D. nobile*. Zhou et al. (2016a) isolated and identified 21 compounds from *D. nobile*, including three new phenanthrenes and three new biphenanthrenes, as well as 15 known phenanthrenes (Zhou et al., 2016a). In a study on the antioxidant activity of *D. nobile*, Zhang et al. (2008c) found that the presence of methoxy in the neighboring position of the phenolic hydroxyl group with power supply had a positive effect on the antioxidant activity of phenolic and lignan compounds (Zhang et al., 2008c). The names of the compounds are given in Table 1 and the structures are shown in Figure 1.

2.2 Alkaloids

Alkaloids are the main active compounds and characteristic of Dendrobium spp. Dendrobine was the first alkaloid component isolated from *D. nobile* (Deng et al., 2002), and was currently used as a standard reference for the QC of *D. nobile* in Chinese Pharmacopoeia. Yan et al. (2018) determined the total alkaloid and dendrobine contents of *D. nobile* at different harvesting stages and found that the total alkaloid and dendrobine contents were annual (0.52%, 0.48%) > biennial (0.48%, 0.44%) > triennial (0.32%, 0.22%). It has been reported that 30 alkaloids have been isolated from *D. nobile*, with sesquiterpenoid alkaloids predominating. According to the structural characteristics, the sesquiterpenoid alkaloids in *D. nobile* can be classified into four types: dendrobine type (dendrobine type, I), dendroxine type (dendroxine type, II), nobiline type (nobiline type, III), and other types (IV), and the specific compound names are shown in Table 2 and the compound structures are shown in Figure 2.

2.3 Bibenzyl

Bibenzyls are a class of compounds consisting of two phenylmethyl structural units linked by a C-C single bond to a methyl group. Although the parent nucleus of bibenzylates is

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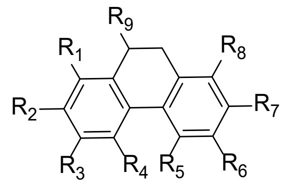
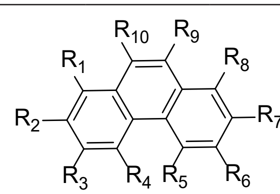
Table 1. Phenanthrene compounds isolated from *D. nobile*.

NO.	Chemical compound	Formula	Molecular weight	Ref.
1	Hircinol	$C_{15}H_{14}O_3$	242.27	Hwang et al., 2010; Zhou et al., 2016a
2	Ephemeranthol A	$C_{16}H_{16}O_4$	272.30	Hwang et al., 2010; Zhou et al., 2016a
3	Erianthridin	$C_{16}H_{16}O_4$	272.30	Hwang et al., 2010; Zhou et al., 2016a
4	4,5-dihydroxy-2-methoxy-9,10-dihydrophenanthrene	$C_{15}H_{14}O_3$	242.27	Zhou et al., 2016a
5	Flavanthridin	$C_{16}H_{16}O_4$	272.30	Hwang et al., 2010; Zhou et al., 2016a
6	2,5-dihydroxy-7-methoxy-9,10-dihydrophenanthrene(L usianthridin)	$C_{15}H_{14}O_3$	242.27	Hwang et al., 2010; Zhou et al., 2016a
7	3-hydroxy- 2,4,7-trimethoxy-9,10-dihydrophenanthrene	$C_{17}H_{18}O_4$	286.12	Yang et al., 2007
8	2,8-dihydroxy-3,4,7-trimethoxy-9,10-dihydrophenanthrene	$C_{17}H_{18}O_5$	302.12	Yang et al., 2007
9	2-hydroxy- 4,7-dimethoxy-9,10-dihydrophenanthrene	$C_{16}H_{16}O_3$	256.11	Yang et al., 2007
10	3,7-dihydroxy-2,4-dimethoxy- 9,10-dihydrophenanthrene	$C_{16}H_{16}O_4$	272.10	Zhang et al., 2019b
11	4,7-dihydroxy-2- methoxy-9,10-dihydrophenanthrene	$C_{15}H_{14}O_3$	242.09	Lee et al., 1995
12	4,5-Dihydroxy-3,7-dimethoxydihydrophenanthrene	$C_{16}H_{16}O_4$	272.10	Ye & Zhao, 2002
13	Coelonin	$C_{15}H_{14}O_3$	242.09	Hwang et al., 2010
14	Ephemeranthol C	$C_{15}H_{14}O_4$	258.09	Hwang et al., 2010
15	7-methoxy-9,10-dihydrophenanthrene-2,4,5-triol	$C_{15}H_{14}O_4$	258.09	Xia et al., 2018
16	9,10-dihydro-2,7-dimethoxyphenanthrene-4,5-diol	$C_{16}H_{16}O_4$	272.10	Liu et al., 2007
17	5-methoxy-4,7,10R-trihydroxy-9,10-dihydrophenanthrene-7-O-β-D-glucopyranoside	$C_{21}H_{24}O_9$	420.14	Zhou et al., 2017
18	Moscatin	$C_{15}H_{12}O_3$	240.26	Zhou et al., 2018b; Zhou et al., 2016a
19	Confusarin	$C_{17}H_{16}O_5$	300.31	Xia et al., 2018; Zhang et al., 2008c; Zhang et al., 2019b; Zhou et al., 2016a
20	Nudol	$C_{16}H_{14}O_4$	270.28	Xia et al., 2018; Zhang et al., 2019b; Zhou et al., 2016a
21	Lusianthrin	$C_{15}H_{12}O_4$	256.26	Xia et al., 2018; Zhou et al., 2016a
22	2,8-dihydroxy-3,4,7-trimethoxyphenanthrene	$C_{17}H_{16}O_5$	300.10	Yang et al., 2007
23	2,3,5-trihydroxy-4,9-dimethoxyphenanthrene	$C_{16}H_{14}O_5$	286.08	Yang et al., 2007
24	3,7-dihydroxy-2,4-dimethoxyphenanthrene	$C_{16}H_{14}O_4$	270.09	Zhang et al., 2008c; Zhang et al., 2019b
25	3,7-dihydroxy-2,4,8-trimethoxyphenanthrene	$C_{17}H_{16}O_5$	300.10	Zhang et al., 2019b; Zhou et al., 2018b
26	Flavanthrinin	$C_{15}H_{12}O_3$	240.08	Zhang et al., 2008c
27	2,5-dihydroxy-4,9-dimethoxyphenanthrene	$C_{16}H_{14}O_4$	270.09	Zhang et al., 2008c
28	3,4,8-trimethoxyphenanthrene-2,5-diol	$C_{17}H_{16}O_5$	300.10	Hwang et al., 2010; Xia et al., 2018
29	5,7-dimethoxyphenanthrene- 2,6-diol	$C_{16}H_{14}O_4$	270.09	Hwang et al., 2010
30	Fimbriol-B	$C_{15}H_{12}O_4$	256.07	Hwang et al., 2010
31	1,5,7-trimethoxy phenanthrene-2,6-diol	$C_{17}H_{16}O_5$	300.10	Zhou et al., 2018b
32	4,5-dihydroxy-2,10-dimethoxyphenanthrene	$C_{16}H_{14}O_5$	286.08	Zhang et al., 2008c
33	2,4-dimethoxyphenanthrene-3,7-diol	$C_{16}H_{14}O_4$	270.09	Zhang et al., 2008c
34	1,5,6-trimethoxyphenanthrene-4,7-diol	$C_{17}H_{16}O_5$	300.10	Hwang et al., 2010
35	2-hydroxy-9,10-dihydro-5,8-phenanthrenedione	$C_{14}H_{10}O_3$	226.06	Zhou et al., 2016a
36	6,7-dihydroxy-2-methoxy-1,4-phenanthrenedione	$C_{15}H_{10}O_5$	270.24	Zhou et al., 2016a
37	Densiflorol B	$C_{15}H_{10}O_4$	254.06	Zhou et al., 2018b
38	Denbinobin	$C_{16}H_{12}O_5$	284.07	Lee et al., 1995; Xia et al., 2018; Zhou et al., 2018b
39	Denobilones B	$C_{15}H_{16}O_4$	260.29	Zhou et al., 2016a
40	Denobilones C	$C_{15}H_{14}O_5$	274.27	Zhou et al., 2016a
41	Fimbriatone	$C_{16}H_{10}O_5$	282.05	Zhang et al., 2008c
42	Denthyrsinol A	$C_{31}H_{26}O_7$	510.54	Zhou et al., 2016a
43	Denthyrsinol B	$C_{30}H_{24}O_6$	480.52	Zhou et al., 2016a
44	Denthyrsinol C	$C_{31}H_{24}O_7$	508.53	Zhou et al., 2016a
45	Denthysinol	$C_{30}H_{22}O_6$	478.50	Zhou et al., 2016a
46	Phochinenin G	$C_{30}H_{26}O_6$	482.53	Zhou et al., 2016a
47	4,4′,7,7′-tetrahydroxy-2,2′-dimethoxy-9,9′,10,10′-tetrahydro-1,1′-phenanthrene	$C_{30}H_{26}O_6$	482.53	Zhou et al., 2016a
48	2,2′-dihydroxy-3,3′,4,4′,7,7′-hexamethoxy-9,9′,10,10′-tetrahydro-1,1′- biphenanthrene	$C_{34}H_{34}O_8$	570.23	Yang et al., 2007
49	Phochinenin D	$C_{30}H_{26}O_6$	482.53	Zhou et al., 2016a
50	Dendronbibisline A	$C_{30}H_{26}O_7$	498.17	Cheng et al., 2020
51	Dendronbibisline B	$C_{25}H_{24}O_7$	436.15	Cheng et al., 2020

Table 1. Continued...



	R1	R2	R3	R4	R5	R6	R7	R8	R9
1	H	OH	H	OCH_3	OH	H	H	H	H
2	H	OH	H	H	OH	OCH_3	OCH_3	H	H
3	H	OH	H	H	OCH_3	OCH_3	OH	H	H
4	H	OCH_3	H	OH	OH	H	H	H	H
5	H	OH	H	H	OCH_3	OH	OCH_3	H	H
6	H	OH	H	H	OH	H	OCH_3	H	H
7	H	OCH_3	H	H	OCH_3	OH	OCH_3	H	H
8	OH	OCH_3	H	H	OCH_3	OCH_3	OH	H	H
9	H	OCH_3	H	H	OCH_3	H	OH	H	H
10	H	OH	H	H	OCH_3	OH	OCH_3	H	H
11	H	OH	H	H	OH	H	OCH_3	H	H
12	H	H	OCH_3	OH	OH	H	OCH_3	H	H
13	H	OH	H	OCH_3	H	H	OH	H	H
14	H	OH	OH	OCH_3	OH	H	H	H	H
15	H	OCH_3	H	OH	OH	H	OH	H	H
16	H	OCH_3	H	OH	OH	OCH_3	H	H	H
17	H	H	H	OH	OCH_3	H	OGlc	H	β-OH



	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
18	H	OH	H	OCH_3	OH	H	H	H	H	H
19	OCH_3	OH	H	H	OCH_3	OCH_3	OH	H	H	H
20	H	OH	H	H	OCH_3	OCH_3	OH	H	H	H
21	H	OH	H	OH	OH	H	OCH_3	H	H	H
22	OH	OCH_3	H	H	OCH_3	OCH_3	OH	H	H	H
23	H	H	H	OH	OCH_3	OH	OH	H	H	OCH_3
24	H	OH	H	H	OCH_3	OH	OCH_3	H	H	H
25	OCH_3	OH	H	H	OCH_3	OH	OCH_3	H	H	H
26	H	OH	H	OCH_3	H	H	OH	H	H	H
27	H	OH	H	OCH_3	OH	H	H	H	OCH_3	H
28	H	OH	OCH_3	OCH_3	OH	H	H	OCH_3	H	H
29	H	OCH_3	OH	OCH_3	H	H	OH	H	H	H
30	H	OH	OH	OCH_3	OH	H	H	H	H	H
31	OCH_3	OH	H	H	OCH_3	OH	OCH_3	H	H	H
32	H	OCH_3	H	OH	OH	H	OH	H	H	OCH_3
33	H	OCH_3	OH	OCH_3	H	H	OH	H	H	H
34	OCH_3	H	H	OH	OCH_3	OCH_3	OH	H	H	H

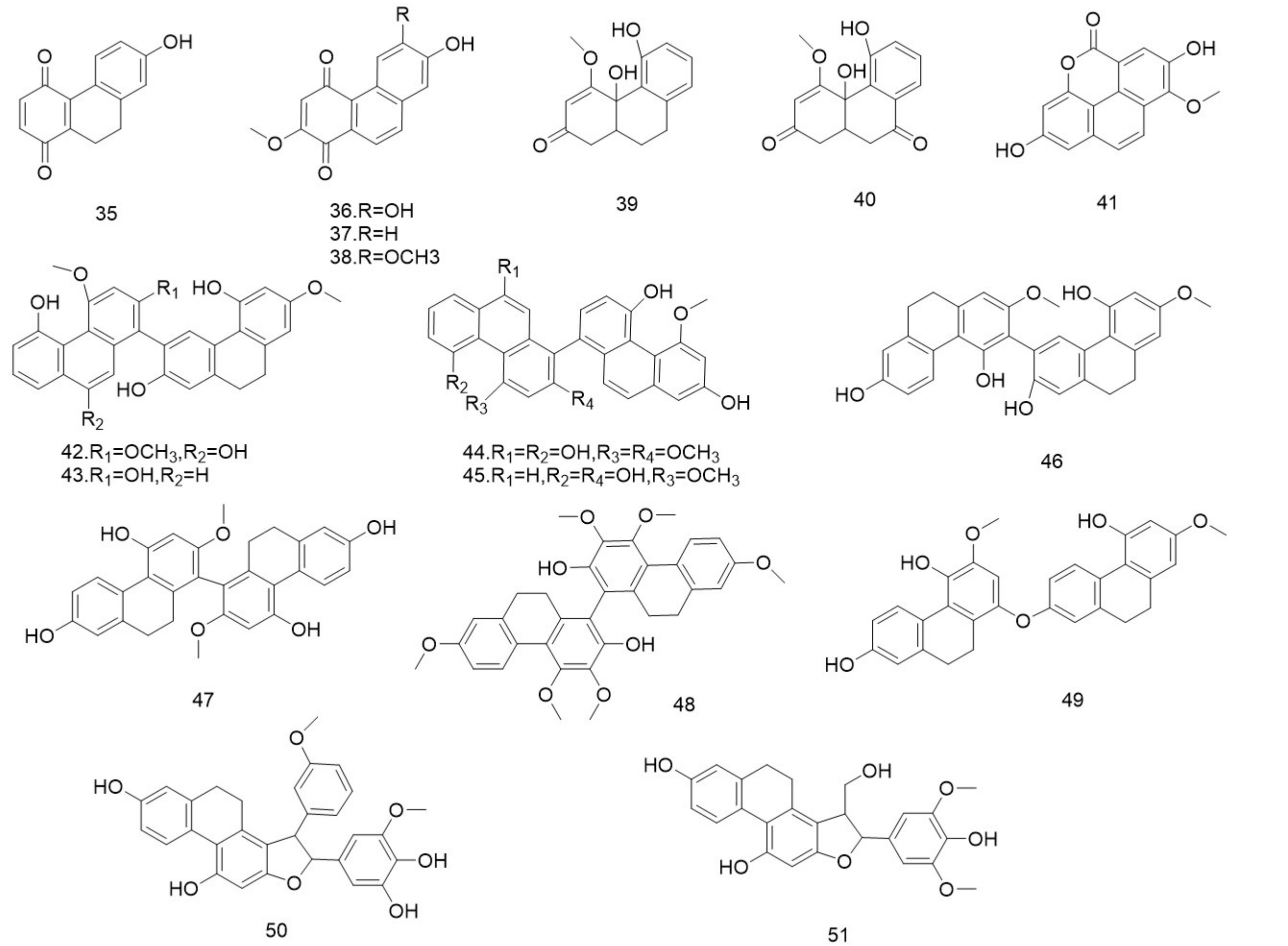


Figure 1. Chemical structure of phenanthrene compounds in *D. nobile*.

simple, they are diverse due to variations in the aromatic ring and the substituents on the carbon of the bridge chain connecting the aromatic ring. The bibenzylates isolated from *D. nobile* can be divided into two major groups: simple bibenzylates and bibenzylates. In recent years, the good anticancer, antioxidant and antibacterial activities of the bibenzyl compounds have become a hot topic of research. At present, 32 bibenzyl compoundsas shown in Table 3 have been isolated from *D. nobile*, and their structures are shown in Figure 3.

2.4 Sesquiterpenes

Up to now, 49 known sesquiterpenes were isolated from *D. nobile*, most of them have more significant biological activities, such as anti-tumour, neuroprotection, immunomodulation, treatment of diabetes, improvement of acute cerebral ischaemia and other effects (Li et al., 2017a; Liu, 2017). Sesquiterpenes from *D. nobile* could be classified as picrotoxane sesquiterpenes, all-aromadendrane sesquiterpenes, cyclocopacamphane sesquiterpenes, copacamphane sesquiterpenes, juniperane sesquiterpenes, cadaverene sesquiterpenes, muurolene sesquiterpenes, axane sesquiterpenes. Picrotoxane sesquiterpenes are mainly present as Picrotoxane-type alkaloids and non-alkaloids (Wang et al., 2019b). The specific compound names are shown in Table 4 and the structures are shown in Figure 4.

2.5 Phenolic acid

Phenolic acids are aromatic carboxylic acid compounds with multiple phenolic hydroxyl substitutions on a benzene ring, which are widely distributed in nature, especially in some common Chinese medicines, and exist mainly in the form of various esters and organic acids, rarely in free form (Kaska et al., 2021; Luo et al., 2022). The phenolic acids in *D. nobile* have numerous pharmacological activities. In recent years, 33 phenolic acid compounds have been isolated from *D. nobile*. Zhang et al. (2008b) obtained 13 phenolic acids in the ethanolic extract of *D. nobile*. Secondly, the phenolic acid components of Dendrobium chinense were also including Protocatechuic acid (Ye & Zhao, 2002), Chrysophanic acid (Zhang et al., 2006), Naringenin (Zhou et al., 2018b), Isoliquiritin (Luo et al., 2006a). The composition and structure are shown in Table 5 and Figure 5.

2.6 Lignans

Lignans are a kind of natural products formed by oxidative polymerization of phenylpropanoid, and *D. nobile* contains a small amount of lignans. Zhang et al. (2008b) separated and identified the chemical components of 60% ethanol extract of *D. nobile* by modern chromatography and spectroscopy, and obtained four compounds. The antioxidant activity of these four compounds was

Table 2. Alkaloids isolated from *D. nobile*.

NO.	Chemical compound	Formula	Molecular weight	Ref.
52	Dendrobine	$C_{16}H_{25}NO_2$	263.19	Meng et al., 2017; Wang et al., 2016; Ye & Zhao, 2002
53	Mubironine B	$C_{15}H_{23}NO_2$	249.17	Wang et al., 2016
54	Dendramine	$C_{16}H_{25}NO_3$	279.18	Chen et al., 2021; Okamoto et al., 1966b; Wang et al., 2016
55	(-)-(1R,2S,3R,4S,5R,6S,9S,11R)-11-Carboxymethyldendrobine	$C_{18}H_{27}NO_4$	321.19	Meng et al., 2017
56	Dendrine	$C_{19}H_{29}NO_4$	335.21	Meng et al., 2017
57	Dendronobiline A	$C_{19}H_{29}NO_3$	319.21	Chen et al., 2021
58	9-hydroxy-10-oxodendrobine	$C_{16}H_{23}NO_4$	293.16	Okamoto et al., 1966b
59	N-methyldendrobinium	$C_{17}H_{28}NO_2^+$	278.21	Wang et al., 2016
60	N-isopentenyldendrobinium	$C_{21}H_{34}NO_2^+$	332.26	Wang et al., 2016
61	Dendrobine-N-oxide	$C_{17}H_{28}NO_4^+$	310.20	Chen et al., 2021
62	N-isopentenyl-dendrobine	$C_{21}H_{34}NO_2^+$	332.26	Chen et al., 2021
63	Dendroxine	$C_{17}H_{25}NO_3$	291.18	Okamoto et al., 1966a
64	6-hydroxy-dendroxine	$C_{17}H_{25}NO_4$	307.18	Okamoto et al., 1966b
65	4-hydroxy-dendroxine	$C_{17}H_{25}NO_4$	307.18	Chen et al., 2021; Wang & Zhao, 1986
66	N-isopentenyl-6-hydroxydendroxinium	$C_{22}H_{33}NO_4^+$	375.24	Wang et al., 2016
67	N-Isopentenyldendroxinium	$C_{22}H_{33}NO_3^+$	359.25	Wang et al., 2016
68	N-Isopentenyldendroxinium chloride	$C_{22}H_{34}NO_3^+$	360.25	Hedman & Leander, 1972
69	N-Isopentenyl-6-hydroxydendroxinium chloride	$C_{22}H_{34}NO_4^+$	376.25	Hedman & Leander, 1972
70	N-isopentenyl-dendroxine	$C_{22}H_{34}NO_3^+$	360.25	Chen et al., 2021
71	N-isopentenyl-6-hydroxy-dendroxine	$C_{22}H_{34}NO_4^+$	376.25	Chen et al., 2021
72	Nobilonine	$C_{17}H_{27}NO_3$	293.20	Wang et al., 2016
73	6-hydroxynobiline	$C_{17}H_{27}NO_4$	309.19	Wang et al., 2016
74	Dendroterpene A	$C_{15}H_{21}NO_3$	263.15	Wang et al., 2019a
75	Dendroterpene B	$C_{15}H_{21}NO_4$	279.15	Wang et al., 2019a
76	Adenosine	$C_{10}H_{13}N_5O_4$	267.10	Zhou et al., 2017
77	N-trans-cinnamoyl tyramine	$C_{17}H_{17}NO_2$	267.13	Wang et al., 2012
78	N-trans-feruloyl tyramine	$C_{18}H_{19}NO_4$	313.13	Wang et al., 2012
79	N-trans-p-coumaroyl tyramine	$C_{17}H_{17}NO_3$	283.12	Wang et al., 2012
80	N-cis-p-coumaroyl tyramine	$C_{17}H_{17}NO_3$	283.14	Wang et al., 2012
81	N-cis-feruloyl tyramine	$C_{18}H_{19}NO_4$	313.15	Wang et al., 2012

evaluated by DPPH free radical scavenging method. See Table 6 and Figure 6 for chemical composition and structure.

2.7 Fluorenones

At present, six fluorenones were isolated from *D. nobile*. Among them, four fluorenone compounds were isolated from ethyl acetate of *D. nobile*, including Nobilone,Denchrysan A,Dengibsin and Dengibsinin F (Zhou et al., 2018a). Two new fluorenones were discovered for the first time during the study of the chemical composition of *D. nobile* by Yang & Xin (2006). The name of the compound is shown in Table 7, and the chemical composition and structure is shown in Figure 7.

2.8 Coumarins

Coumarin is one of the active ingredients of *D. nobile*. Coumarins are a group of substances with benzoic α-pyrone as the parent nucleus, coumarins have antibacterial, antitumour, vasodilating and anticoagulant effects. At present, the coumarins isolated from *D. nobile* are dendrocoumarinh and itolide A (Zhou et al., 2018c). Their names, formula and molecular weights are shown in Table 8 and their structures are shown in Figure 8.

2.9 Amides

Five amides were separated and purified from *D. nobile* by normal phase and reversed phase silica gel column chromatography, gel column chromatography and preparative high performance liquid chromatography. Their names and structures are shown in Table 9 and Figure 9 (Wang et al., 2012).

2.10 Phenylpropanoids

Phenylpropanoids is a naturally occurring compound composed of benzene ring and three straight-chain carbon groups (C6-C3 groups) to form the precursor of lignans. It mainly includes chlorogenic acid, eugenin, caffeic acid, cypress and so on. The name and molecular size of Phenylpropanoids are shown in Table 10, and the structural formula is shown in Figure 10.

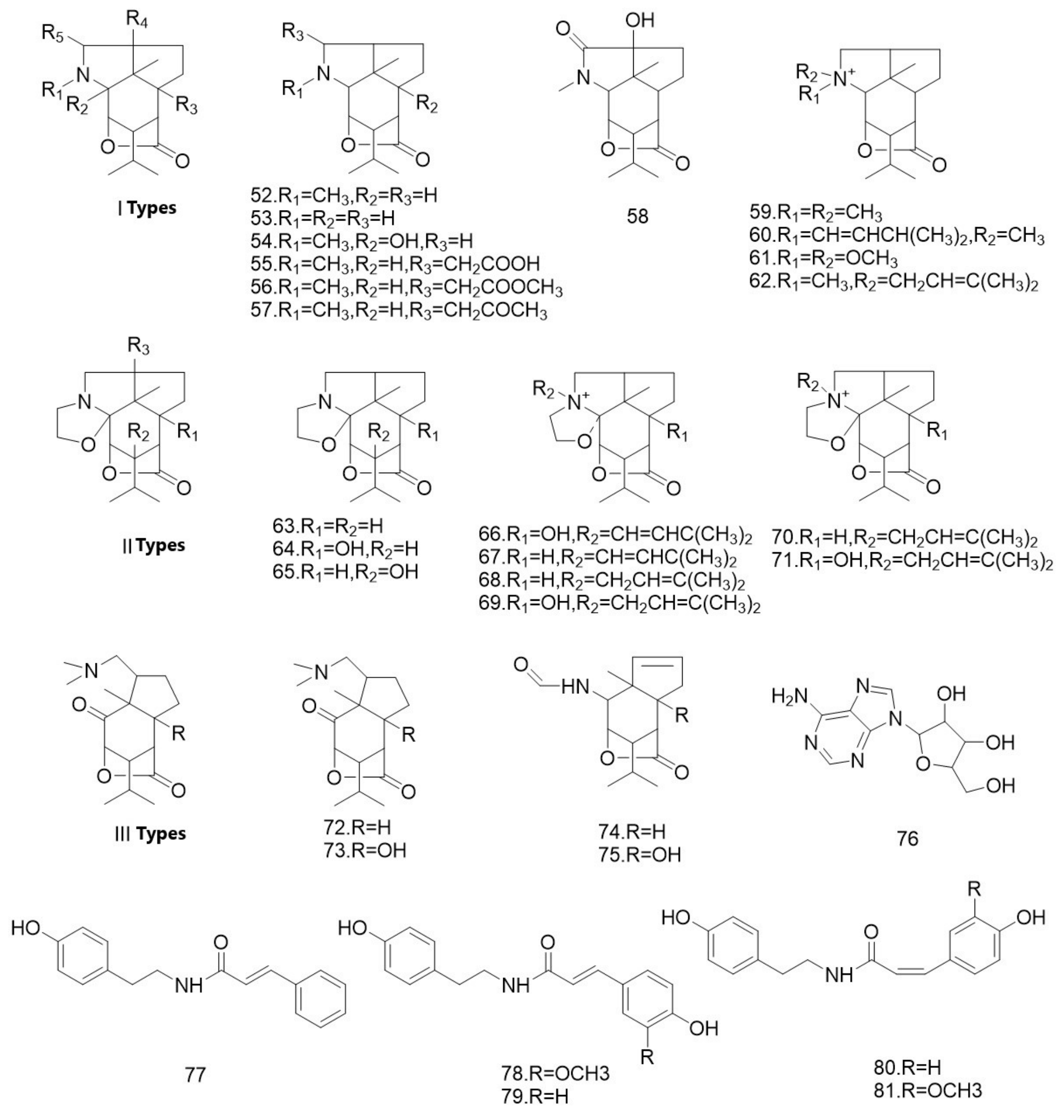


Figure 2. Chemical structure of alkaloids components in *D. nobile*.

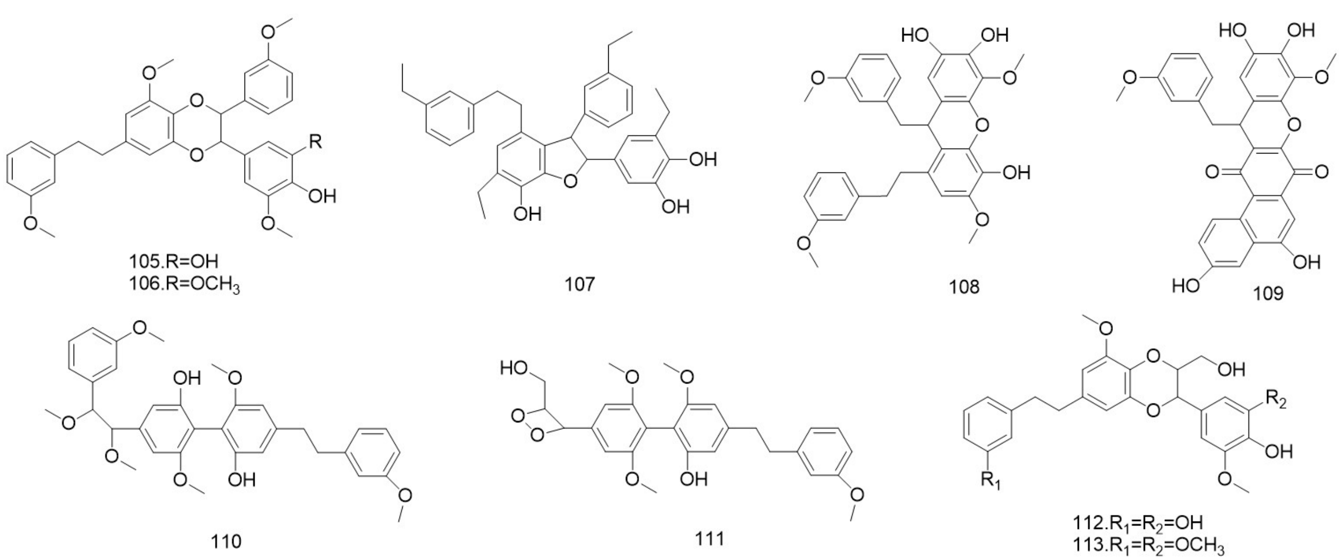
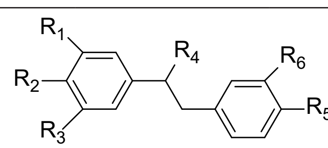


Figure 3. Chemical structure of bibenzyl compounds in *D. nobile*.

Table 3. Bibenzyl compounds isolated from *D. nobile*.

NO.	Chemical compound	Formula	Molecular weight	Ref.
82	3'4-dihydroxy-3,5'-dimethoxybibenzyl	$C_{16}H_{18}O_4$	274.32	Zhou et al., 2016a
83	3-hydroxy-5-methoxybibenzyl	$C_{15}H_{16}O_2$	228.29	Zhou et al., 2016a
84	Batatasin III	$C_{15}H_{16}O_3$	244.29	Wang et al., 2012; Zhou et al., 2016a
85	Tristin	$C_{15}H_{16}O_4$	260.29	Zhou et al., 2016a
86	3,3′,5-trihydroxybibenzyl	$C_{14}H_{14}O_3$	230.26	Zhou et al., 2016a
87	Crepidatin	$C_{18}H_{22}O_5$	318.15	Zhang et al., 2007c
88	Chrysotobibenzyl	$C_{19}H_{24}O_5$	332.16	Zhang et al., 2007c
89	3,4'-dihydroxy-5,5'-dimethoxydihydrostilbene	$C_{16}H_{18}O_4$	274.12	Hwang et al., 2010
90	3-O-methylgigantol	$C_{17}H_{20}O_4$	288.14	Hwang et al., 2010
91	4-hydroxy-3,3′,5-trimethoxybibenzyl	$C_{17}H_{20}O_4$	288.14	Ye & Zhao, 2002
92	Erianin	$C_{18}H_{22}O_5$	318.15	Zhou et al., 2016a
93	4,4'-dihydroxy-3,5,3'-trimethoxybibenzyl;Moscatilin	$C_{17}H_{20}O_5$	304.13	Hwang et al., 2010; Luo et al., 2006b; Miyazawa et al., 1999; Xiao et al., 2016a; Zhang et al., 2007c
94	4,5-dihydroxy-3,3'- dimethoxybibenzyl	$C_{16}H_{18}O_4$	274.12	Xiao et al., 2016a; Ye & Zhao, 2002
95	4,3'-dihydroxy-3,5-dimethoxybibenzyl	$C_{16}H_{18}O_4$	274.12	Xiao et al., 2016a
96	5,3'-dihydroxy-3-methoxybibenzyl	$C_{15}H_{16}O_3$	244.11	Xiao et al., 2016a
97	Dendrobin A	$C_{16}H_{18}O_4$	274.12	Zhang et al., 2007c
98	Chrysotoxine	$C_{18}H_{22}O_5$	318.15	Zhang et al., 2007c
99	Gigantol	$C_{16}H_{18}O_4$	274.12	Zhang et al., 2007c
100	Nobilin A	$C_{17}H_{20}O_5$	304.13	Zhang et al., 2008b
101	Nobilin B	$C_{18}H_{22}O_6$	334.14	Zhang et al., 2008b
102	Nobilin C	$C_{19}H_{24}O_6$	348.16	Zhang et al., 2008b
103	4,α-dihydroxy-3,5,3'-trimethoxybibenzyl	$C_{17}H_{20}O_5$	304.13	Xiao et al., 2016a
104	Nobilin D	$C_{17}H_{20}O_6$	320.13	Zhang et al., 2007c
105	Didendronbiline A	$C_{32}H_{32}O_8$	544.21	Zhang et al., 2019a
106	Dendronbibisline D	$C_{33}H_{34}O_8$	558.23	Cheng et al., 2020
107	Dendronbibisline C	$C_{32}H_{32}O_8$	544.21	Cheng et al., 2020
108	Nobilin E	$C_{32}H_{32}O_8$	544.21	Wang et al., 2019a; Zhang et al., 2007c
109	Dendrocandin V	$C_{30}H_{22}O_9$	526.13	Wang et al., 2019a
110	Dendronophenol A	$C_{34}H_{38}O_8$	574.26	Liu et al., 2007
111	Dendronophenol B	$C_{27}H_{30}O_8$	482.19	Liu et al., 2007
112	Dendronbiline B	$C_{25}H_{26}O_8$	454.16	Zhang et al., 2019a
113	Dendronbiline C	$C_{27}H_{30}O_8$	482.19	Zhang et al., 2019a



	R1	R2	R3	R4	R5	R6
82	OCH_3	H	OH	H	OH	OCH_3
83	OCH_3	H	OH	H	H	H
84	OCH_3	H	OH	H	H	OH
85	OH	H	OH	H	OH	OCH_3
86	OH	H	OH	H	H	OH
87	OCH_3	OCH_3	OCH_3	H	OH	OCH_3
88	OCH_3	OCH_3	OCH_3	H	OCH_3	OCH_3
89	OCH_3	H	OH	H	OCH_3	OH
90	OCH_3	H	OH	H	OCH_3	OCH_3
91	OCH_3	OH	OCH_3	H	H	OCH_3
92	OCH_3	OCH_3	OCH_3	H	OCH_3	OH
93	OCH_3	OH	OCH_3	H	OH	OCH_3
94	OCH_3	OH	OH	H	H	OCH_3
95	OCH_3	OH	OCH_3	H	H	OH
96	OCH_3	H	OH	H	H	OCH_3
97	OH	OH	OCH_3	H	H	OCH_3
98	OCH_3	OH	OCH_3	H	OCH_3	OH
99	OH	OH	OCH_3	H	OH	OCH_3
100	OCH_3	OH	OH	OCH_3	H	OCH_3
101	OCH_3	OH	OCH_3	OCH_3	OH	OCH_3
102	OCH_3	OH	OCH_3	OCH_3	OCH_3	OCH_3
103	OCH_3	OH	OCH_3	OH	H	OCH_3
104	OCH_3	OH	OCH_3	OH	OH	OCH_3

Table 4. Sesquiterpenes isolated from *D. nobile*.

NO.	Chemical compound	Formula	Molecular weight	Ref.
114	Dendronobilin B	$C_{15}H_{24}O_5$	284.16	Zhang et al., 2007b
115	Dendronobilin C	$C_{15}H_{22}O_6$	298.14	Zhang et al., 2007b
116	Dendronobilin D	$C_{15}H_{24}O_5$	284.16	Liu & Zhao, 2003
117	Dendronobilin E	$C_{15}H_{24}O_5$	284.16	Zhang et al., 2007b
118	Dendronobilin F	$C_{15}H_{22}O_5$	282.34	Zhang et al., 2007b
119	Dendronobilin J	$C_{15}H_{22}O_6$	298.14	Zhang et al., 2007a
120	Dendronobilins K(2β,11,12-trihydroxycopacamphan-15-one)	$C_{15}H_{24}O_4$	268.17	Zhang et al., 2008a
121	Dendronobilins L (2β,3β,4β,5β)-2,4,11,12-tetrahydroxypicrotoxan-3(15)-olactone)	$C_{15}H_{24}O_6$	300.16	Zhang et al., 2008a
122	Dendronobilins M (2β,3β,5β)-2,11,12,13-tetrahydroxypicrotoxan-3(15)-olactone)	$C_{15}H_{24}O_7$	316.15	Zhang et al., 2008a
123	Dendroterpene A	$C_{15}H_{21}NO_3$	263.15	Wang et al., 2019a
124	Dendroterpene B	$C_{15}H_{21}NO_4$	279.15	Wang et al., 2019a
125	Dendroterpene C	$C_{15}H_{20}O_4$	264.14	Wang et al., 2019a
126	Dendroterpene D	$C_{15}H_{20}O_5$	280.13	Wang et al., 2019a
127	Dendroterpene E	$C_{15}H_{22}O_4$	266.15	Wang et al., 2022
128	dendronobilosides A (10,12-dihydroxypicrotoxane 10,12-di-O-β-D-glucopyranoside)	$C_{27}H_{48}O_{12}$	564.31	Ye & Zhao, 2002; Zhao et al., 2001
129	Dendronobilosides B (6α,10,12- trihydroxypicrotoxane 10-O-β-D-glucopyranoside)	$C_{21}H_{38}O_8$	418.26	Ye & Zhao, 2002; Zhao et al., 2001
130	(+)-(1R,2S,3R,4S,5R,6S,9R)-3,11,12-trihydroxypicrotoxane-2(15)-lactone	$C_{15}H_{24}O_5$	284.16	Ma et al., 2019
131	Dendrosides F (7-hydroxy-5-hydroxymethyl-11-isopropyl-6-methyl-9-oxatricyclo[6.2.1.0^{2,6}]undecan-10-one-15-O-β-D-glucopyranoside)	$C_{21}H_{34}O_9$	453.21	Ye et al., 2002
132	Dendrosides G (7,11-dihydroxy-5-hydroxymethyl-11-isopropyl-6-methyl-9-oxatricyclo[6.2.1.0^{2,6}]undecan-10-one-15-O-β-D-glucopyranoside)	$C_{21}H_{34}O_{10}$	469.20	Ye et al., 2002
133	7,12-dihydroxy-5-hydroxymethyl-11-isopropyl-6-methyl-9-oxatricyclo[6.2.1.0^{2,6}]undecan-10-one-15-O-β-D-glucopyranoside	$C_{21}H_{34}O_{10}$	446.22	Shu et al., 2004
134	(−)-(1S,2R,3S,4R,5S,6R,9S,12R)-3,11,13-trihydroxypicrotoxane-2(15)-lactone	$C_{15}H_{24}O_5$	284.16	Ma et al., 2019
135	(+)-(1R,5R,6S,8R,9R)- 8,12-dihydroxy-copacamphan-3-en-2-one	$C_{15}H_{22}O_3$	250.16	Ma et al., 2019
136	Dendrodensiflorol	$C_{15}H_{24}O_5$	284.16	Zhang et al., 2007a
137	Nobilomethylene	$C_{15}H_{20}O_3$	248.32	Okamoto et al., 1972
138	Findlayanin	$C_{15}H_{24}O_5$	284.35	Meng et al., 2017
139	10,12-Dihydroxypicrotoxane	$C_{15}H_{28}O_3$	256.20	Zhang et al., 2007a
140	6α,10,12-Trihydroxypicrotoxane	$C_{15}H_{28}O_4$	272.20	Zhang et al., 2007a
141	(+)-(1R,2S,3S,4R,5R,6S,9R)-2,4,11-Trihydroxypicrotoxane-3(15)-lactone	$C_{15}H_{24}O_5$	284.16	Meng et al., 2017
142	(+)-(1R,2S,3R,4S,5R,6S,9R)-2,11,12-Trihydroxypicrotoxane-3(15)-lactone	$C_{15}H_{24}O_5$	284.16	Meng et al., 2017
143	Dendroside A 10β,12,14-trihydroxyalloaromadendrane 14-O-β-D-glucopyranoside)	$C_{21}H_{36}O_8$	416.24	Ye & Zhao, 2002; Zhao et al., 2001
144	Dendroside B	$C_{27}H_{46}O_{13}$	578.29	Ye & Zhao, 2002
145	Dendrosides D	$C_{27}H_{44}O_{14}$	615.26	Ye et al., 2002
146	10β,12,14-trihydroxyalloaromadendrane	$C_{15}H_{26}O_3$	254.19	Ye & Zhao, 2002
147	Dendrobiumane A	$C_{15}H_{26}O_3$	254.19	Zhang et al., 2007b
148	Dendronobilin H	$C_{15}H_{26}O_3$	254.19	Zhang et al., 2007b
149	Dendroside C	$C_{21}H_{36}O_8$	416.24	Ye & Zhao, 2002
150	10β,13,14-Trihydroxyalloaromadendrane	$C_{15}H_{26}O_3$	254.19	Zhang et al., 2007a
151	Dendronobilin A	$C_{15}H_{24}O_3$	252.17	Zhang et al., 2007b
152	Dendronobilins N (5β,8β)-cyclocopacamphane-5,8,12,15-tetrol)	$C_{15}H_{24}O_4$	268.17	Zhang et al., 2008a
153	Dendronobiloside E	$C_{21}H_{34}O_8$	414.24	Ye & Zhao, 2002
154	Dendrobane A	$C_{15}H_{24}O_3$	252.17	Ye & Zhao, 2002
155	Dendronobilin I	$C_{15}H_{24}O_3$	252.17	Zhang et al., 2007b
156	Dendronobiloside C	$C_{27}H_{44}O_{12}$	560.28	Ye & Zhao, 2002
157	Dendronobiloside D	$C_{27}H_{44}O_{12}$	560.28	Ye & Zhao, 2002
158	(+)δ-cadinen-12,14-diol	$C_{15}H_{24}O_2$	236.18	Xiao et al., 2016b
159	cadalene-12-O-β-D-glucopyranoside	$C_{21}H_{28}O_6$	376.19	Wu et al., 2019
160	Dendronobilin G	$C_{15}H_{26}O_3$	254.19	Zhang et al., 2007b
161	Dendrosides E (1α,13,14-trihydroxyemmotin 14-O-β-D –glucopyranoside)	$C_{21}H_{36}O_8$	439.23	Ye et al., 2002
162	Bullatantriol	$C_{15}H_{28}O_3$	256.20	Zhang et al., 2007a

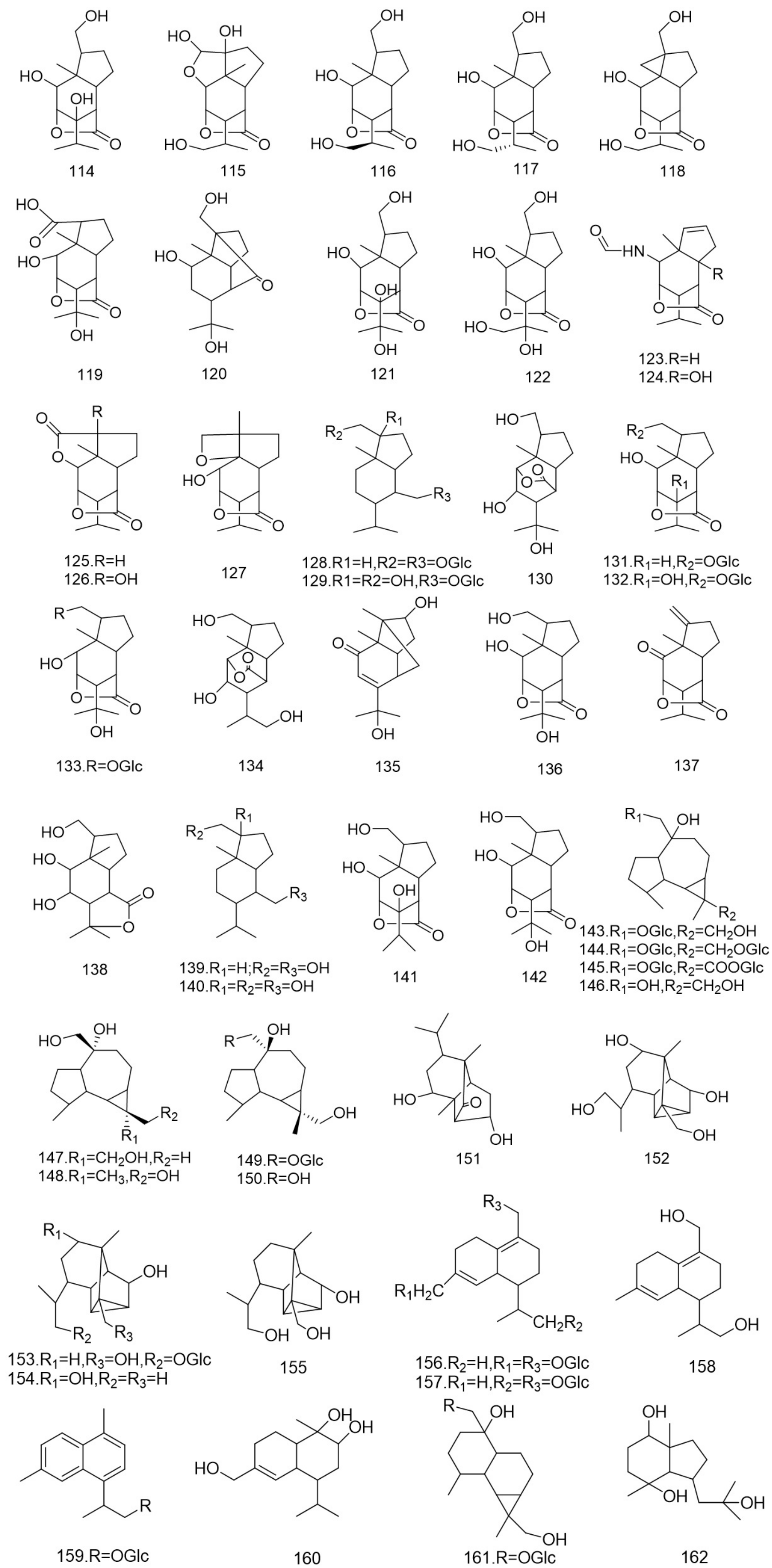


Figure 4. Chemical structure of sesquiterpenes in *D. nobile*.

Table 5. Phenolic acids isolated from *D. nobile*.

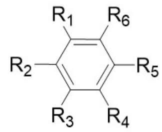
NO.	Chemical compound	Formula	Molecular weight	Ref.
163	3,4-dihydroxybenzoic acid	$C_7H_6O_4$	154.03	Wang et al., 2022
164	syringic acid	$C_9H_{10}O_5$	198.05	Zhang et al., 2008b
165	2-hydroxyphenylpropanol	$C_9H_{12}O_2$	152.08	Zhang et al., 2008b
166	vanillin	$C_8H_8O_3$	152.05	Wang et al., 2022; Zhang et al., 2008b
167	apocynin	$C_9H_{10}O_3$	166.06	Zhang et al., 2008b
168	coniferyl aldehyde	$C_{10}H_{10}O_3$	178.06	Zhang et al., 2008b
169	syringaldehyde	$C_9H_{10}O_4$	182.06	Zhang et al., 2008b
170	syringylethanone	$C_{10}H_{12}O_4$	196.07	Zhang et al., 2008b
171	p-hydroxybenzaldehyde	$C_7H_6O_2$	122.04	Zhang et al., 2008b
172	3-hydroxy-4-methoxyphenylethanol	$C_9H_{12}O_3$	168.08	Zhang et al., 2008b
173	α-hydroxysyringylethanol	$C_{11}H_{14}O_5$	226.08	Zhang et al., 2008b
174	Dihydroxyconiferyl alcohol	$C_{10}H_{14}O_3$	182.09	Zhang et al., 2008b
175	p-hydroxybenzoic acid	$C_7H_6O_3$	138.03	Zhang et al., 2008b
176	p-hydroxyphenylpropionic acid	$C_9H_{10}O_3$	166.06	Zhang et al., 2008b
177	(E)-4-(2-methoxyvinyl) benzene-1,2-diol	$C_9H_{12}O_3$	168.08	Zhou et al., 2018b
178	5-hydroxyphenylpropanol	$C_9H_{12}O_2$	152.08	Zhang et al., 2006
179	5-hydroxy-6-methoxyphenylethanol	$C_9H_{12}O_3$	168.08	Zhang et al., 2006
180	1,2-dihydroxybenzoicacid	$C_7H_6O_4$	154.03	Ye & Zhao, 2002
181	cinnamic acid	$C_9H_8O_2$	148.05	Wang et al., 2022
182	[3-hydroxy-1-(3-methoxy-4-hydroxyphenyl)-propan-1-one]	$C_{10}H_{12}O_4$	196.07	Zhou et al., 2016b
183	methyl(E)-3-(4-hydroxyphenyl)acrylate	$C_{10}H_{10}O_3$	178.06	Wang et al., 2022
184	(E)-4-(4-Hydroxy- 3-methoxyphenyl)but-3-en-2-one	$C_{11}H_{12}O_4$	208.07	Wang et al., 2022
185	dihydroconiferyl dihydro-p-coumarate	$C_{19}H_{22}O_5$	330.15	Cheng et al., 2020
186	dihydrosinapyl dihydro-p-coumarate	$C_{20}H_{24}O_6$	360.16	Cheng et al., 2020
187	isoliquiritin	$C_{21}H_{22}O_9$	418.13	Luo et al., 2006a
188	(7S,8R)dehydrodiconiferyl alcohol 9′-β-glucopyranoside	$C_{26}H_{32}O_{11}$	520.19	Zhou et al., 2017
189	Chrysophanic acid	$C_{15}H_{10}O_4$	254.06	Yang & Xin, 2006
190	di-[2-(4-hydroxyphenyl)] ethyl ether	$C_{16}H_{18}O_3$	258.13	Wang et al., 2019a
191	4-methoxy-2,5,9R-trihydroxy-9,10-dihydrophenan-threne 2-O-β-D-glucopyranoside	$C_{21}H_{24}O_9$	420.14	Zhou et al., 2017
192	narcissin	$C_{28}H_{34}O_{16}$	626.18	Zhou et al., 2017
193	isorhamentin-3-O-β-D-rutinoside	$C_{28}H_{32}O_{16}$	624.17	Zhou et al., 2017
194	koaburaside	$C_{14}H_{20}O_9$	332.11	Zhou et al., 2017
195	naringenin	$C_{15}H_{12}O_5$	272.07	Zhou et al., 2018b

Table 6. Lignans isolated from *D. nobile*.

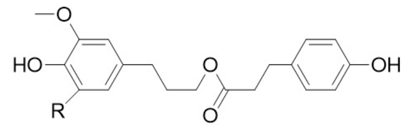
NO.	Chemical compound	Formula	Molecular weight	Ref.
196	syringaresinol	$C_{22}H_{26}O_8$	418.16	Zhang et al., 2008c
197	pinoresinol	$C_{20}H_{22}O_6$	358.14	Wang et al., 2012; Zhang et al., 2008c
198	medioresinol	$C_{21}H_{24}O_7$	388.15	Zhang et al., 2008c
199	lirioresinol-A	$C_{22}H_{26}O_8$	418.16	Zhang et al., 2008c
200	(+)-syringaresinol-O-β-D-glucopyranoside	$C_{28}H_{36}O_{13}$	580.22	Liu et al., 2007
201	(7S,8R)-dehydrodiconiferyl alcohol-9′-β-glucopyranoside	$C_{26}H_{32}O_{11}$	520.19	Zhou et al., 2017
202	dehydrodiconiferyl alcohol-4-β-D-glucoside	$C_{26}H_{32}O_{11}$	520.19	Zhou et al., 2017

2.11 Polysaccharides

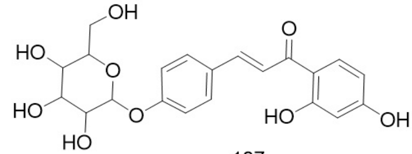
The chemical structure of polysaccharides includes the composition of monosaccharide residues, the order of monosaccharide residues, the heterocapital carbon configuration, the way of connecting adjacent sugar residues, the branching of sugar chains, etc., and the resulting spatial structure, which is the basis for the pharmacological activity of polysaccharides (Li et al., 2022; Wu et al., 2022). Due to the complexity of the chemical structure, the current research on the chemical structure of *D. nobile* is only limited to the simple composition and molecular weight distribution of monosaccharides and the preliminary primary structure. Modern pharmacological studies have shown that *D. nobile* polysaccharides have immune modulating, anti-tumour and antioxidant functions, and relevant studies have shown that



163.$R_1=R_2=OH,R_3=R_5=R_6=H,R_4=COOH$
164.$R_1=COOH,R_2=R_6=H,R_3=R_5=OCH_3,R_4=OH$
165.$R_1=(CH_2)_3OH,R_2=OH,R_3=R_4=R_5=R_6=H$
166.$R_1=CHO,R_2=R_3=R_6=H,R_4=OH,R_5=OCH_3$
167.$R_1=COCH_3,R_2=R_5=R_6=H,R_3=OCH_3,R_4=OH$
168.$R_1=CH=CHCHO,R_2=R_5=R_6=H,R_3=OCH_3,R_4=OH$
169.$R_1=CHO,R_2=R_6=H,R_3=R_5=OCH_3,R_4=OH$
170.$R_1=COCH_3,R_2=R_6=H,R_3=R_5=OCH_3,R_4=OH$
171.$R_1=CHO,R_2=R_3=R_5=R_6=H,R_4=OH$
172.$R_1=(CH_2)_2OH,R_2=R_5=R_6=H,R_3=OH,R_4=OCH_3$
173.$R_1=COCH(OH)CH_3,R_2=R_6=H,R_3=R_5=OCH_3,R_4=OH$
174.$R_1=(CH_2)_3OH,R_2=R_5=R_6=H,R_3=OCH_3,R_4=OH$
175.$R_1=COOH,R_2=R_3=R_5=R_6=H,R_4=OH$
176.$R_1=(CH_2)_2COOH,R_2=R_3=R_5=R_6=H,R_4=OH$
177.$R_1=R_2=R_5=H,R_3=R_4=OH,R_6=(CH_2)_3OH$
178.$R_1=OH,R_2=(CH_2)_3OH,R_3=R_4=R_5=R_6=H$
179.$R_1=OH,R_2=OCH_3,R_3=R_5=R_6=H,R_4=(CH_2)_2OH$
180.$R_1=COOH,R_3=R_4=OH,R_2=R_5=R_6=H$
181.$R_1=CH=CHCOOH,R_2=R_3=R_4=R_5=R_6=H$
182.$R_1=OCH_3,R_2=OH,R_3=R_4=R_6=H,R_5=CO(CH_2)_2OH$
183.$R_1=OH,R_2=R_3=R_5=R_6=H,R_4=CH=CHCOOCH_3$
184.$R_1=OH,R_2=OCH_3,R_3=R_5=R_6=H,R_4=CH=CHCOOCH_3$



185.R=H
186.$R=OCH_3$



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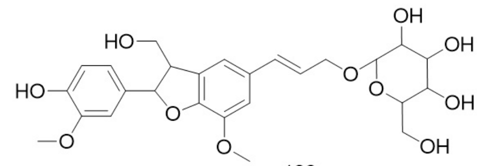

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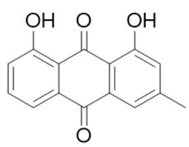

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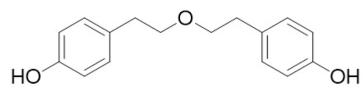

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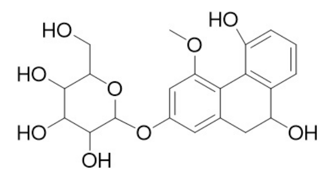

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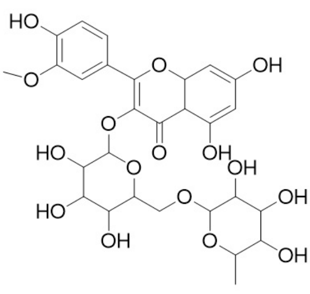

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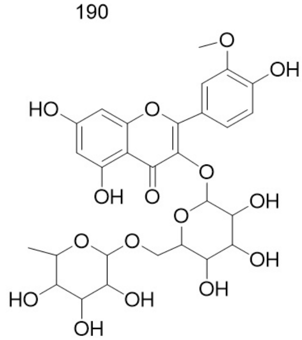

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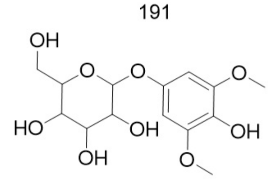

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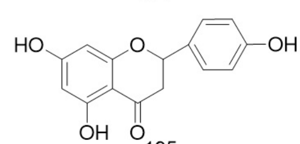
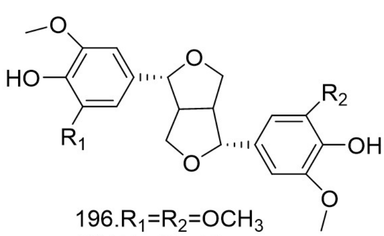
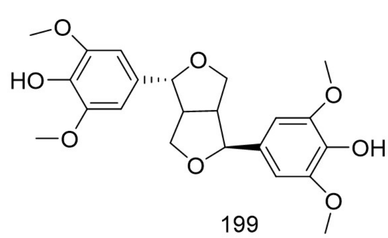


195

Figure 5. Chemical structure of phenolic acids in *D. nobile*.



196.$R_1=R_2=OCH_3$
197.$R_1=R_2=H$
198.$R_1=H,R_2=OCH_3$



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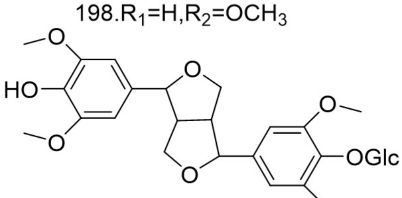

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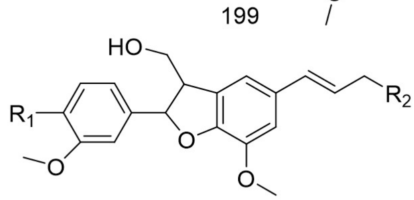

201.R1=OH;R2=OGlc
202.R1=OGlc;R2=OH

Figure 6. Chemical structure of lignans in *D. nobile*.

Table 7. Fluorenone compounds isolated from *D. nobile*.

NO.	Chemical compound	Formula	Molecular weight	Ref.
203	nobilone	$C_{14}H_{10}O_4$	242.06	Zhang et al., 2007c; Zhou et al., 2018a
204	dendroflorin	$C_{14}H_{10}O_5$	258.05	Zhang et al., 2007c
205	1,4,7-trihydroxy-5-methoxy-9H-fluoren-9-one	$C_{14}H_{10}O_5$	258.05	Xia et al., 2018
206	2,4,7-thihydroxy-5-methoxy-9-fluorenone; denchrysan A	$C_{14}H_{10}O_5$	258.05	Yang & Xin, 2006; Zhou et al., 2018a
207	Dengibsn	$C_{14}H_{10}O_4$	242.06	Yang & Xin, 2006; Zhou et al., 2018a
208	dengibsinin	$C_{15}H_{12}O_5$	272.07	Zhou et al., 2018a

Table 8. Coumarins isolated from *D. nobile*.

NO.	Chemical compound	Formula	Molecular weight	Ref.
209	dendrocoumarin	$C_{13}H_8O_5$	244.04	Zhou et al., 2018c
210	itolide A	$C_{13}H_8O_5$	244.04	Zhou et al., 2018c
211	Coumarin	$C_9H_6O_2$	146.04	Xu et al., 2018
212	moellendorffiline	$C_{26}H_{20}O_{10}$	492.11	Zhou et al., 2018b
213	isopimpinellin	$C_{13}H_{10}O_5$	246.05	Zhou et al., 2018b

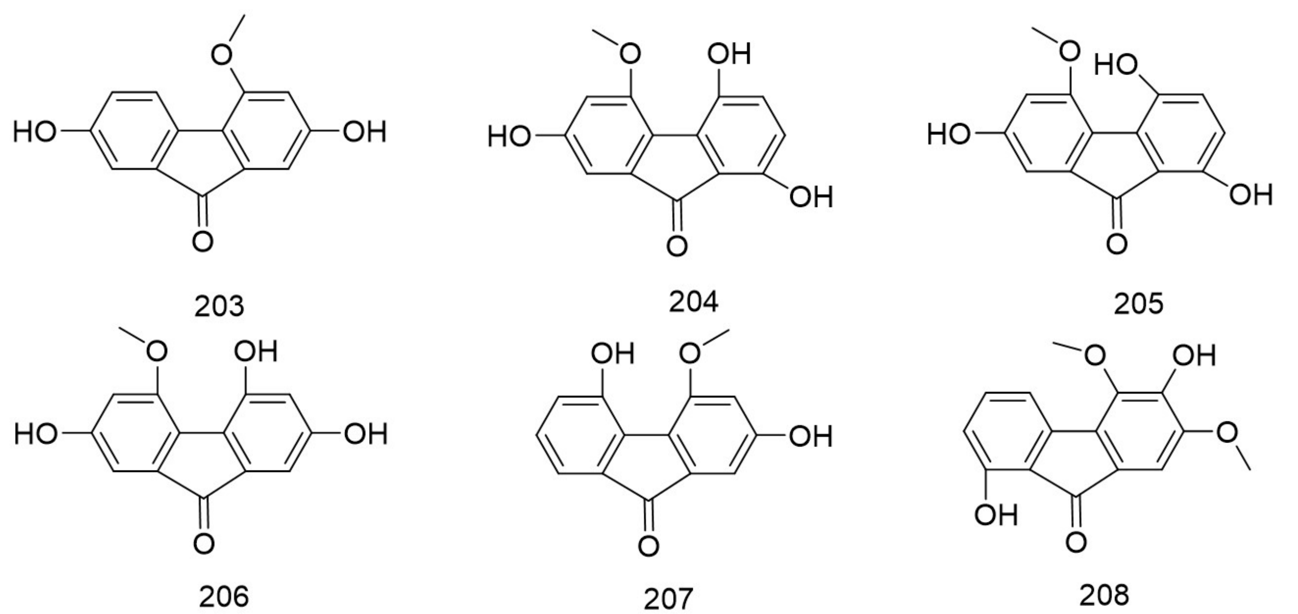

Figure 7. Chemical structure of fluorenones in *D. nobile*.

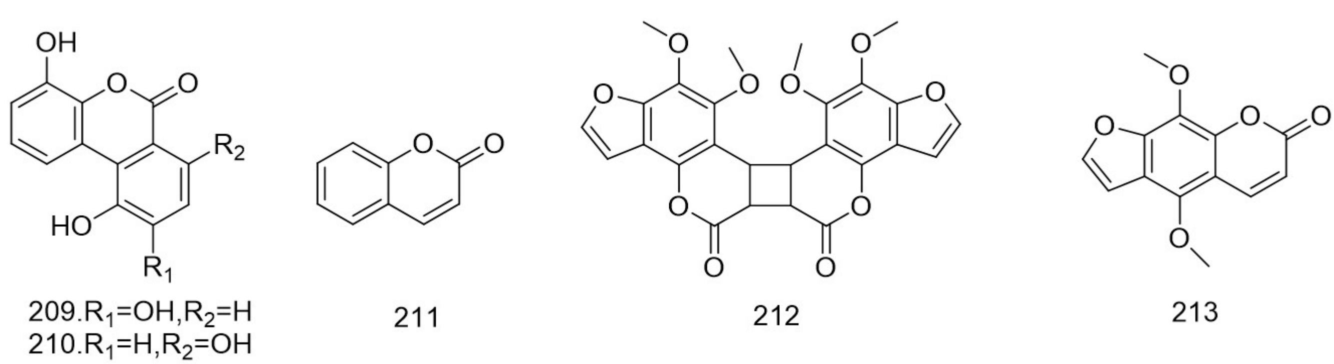

Figure 8. Chemical structure of coumarins in *D. nobile*.

Table 9. Amides isolated from *D. nobile*.

NO.	Chemical compound	Formula	Molecular weight	Ref.
214	N-trans-feruloyltyramine	$C_{18}H_{19}NO_4$	313.13	Wang et al., 2012
215	N-cis-feruloyltyramine	$C_{18}H_{19}NO_4$	313.13	Wang et al., 2012
216	N-trans-p-coumaroyltyramine	$C_{17}H_{17}NO_3$	283.12	Wang et al., 2012
217	N-cis-p-coumaroyltyramine	$C_{17}H_{17}NO_3$	283.12	Wang et al., 2012
218	N-trans-cinnamoyltyramine	$C_{17}H_{17}NO_2$	267.13	Wang et al., 2012

Table 10. Phenylpropanoids isolated from *D. nobile*.

NO.	Chemical compound	Formula	Molecular weight	Ref.
219	Decumbic acid A	$C_{10}H_{16}O_4$	200.10	Zhou et al., 2016b
220	Decumbic acid B	$C_{10}H_{16}O_4$	200.10	Zhou et al., 2016b
221	(-)-Decumbic acid	$C_{10}H_{16}O_4$	200.10	Zhou et al., 2016b
222	(-)-Dendrolactone	$C_{14}H_{16}O_6$	280.09	Zhou et al., 2016b
223	(+)-Dendrolactone	$C_{14}H_{16}O_6$	280.09	Zhou et al., 2016b

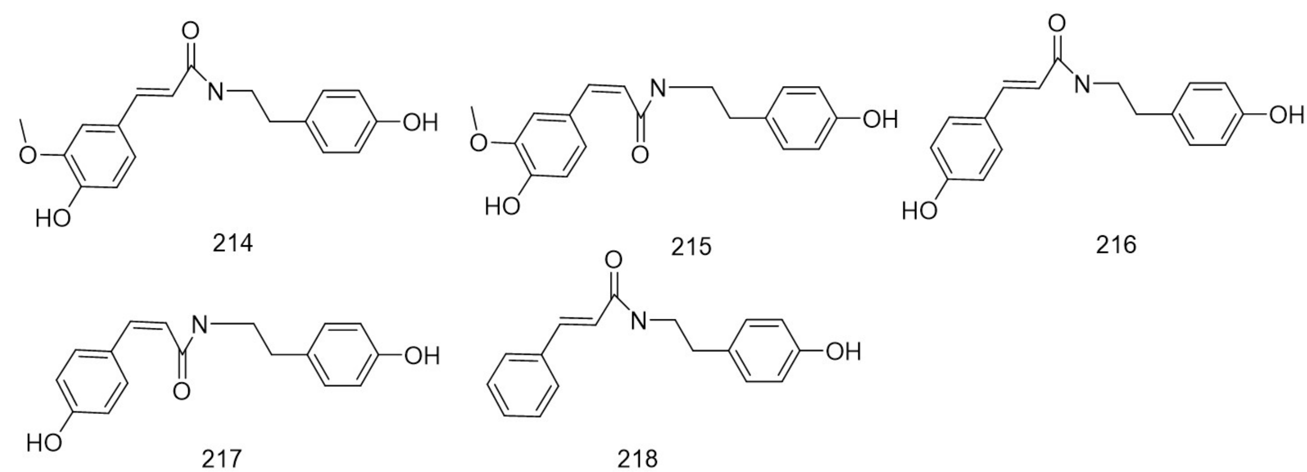

Figure 9. Chemical structures of amides in *D. nobile*.

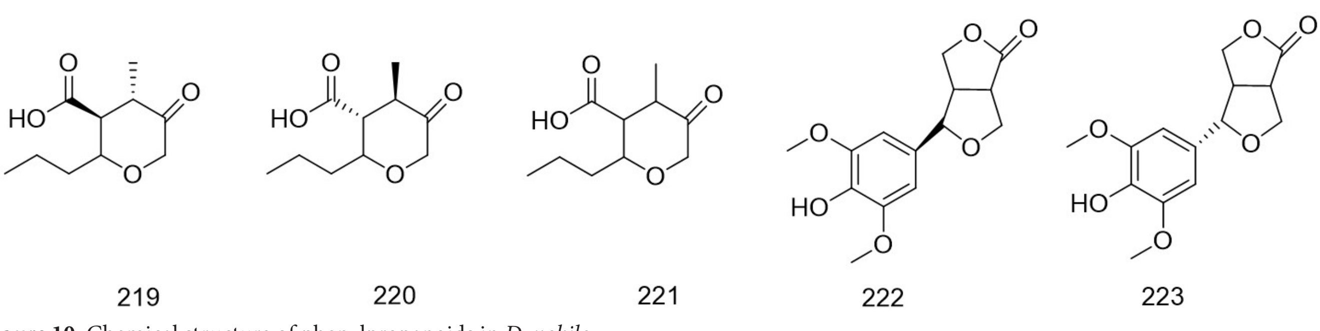

Figure 10. Chemical structure of phenylpropanoids in *D. nobile*.

D. nobile crude polysaccharides also have certain anti-cataract effects in vitro, which has attracted extensive attention from many experts and scholars. The composition and preparation method of *D. nobile* polysaccharide are shown in Table 11.

2.12 Others

In addition to the above chemical constituents, some scholars have also isolated butyl phthalate, trans-2-heptenal, nonenal, 2-n-pentylfuran, linalool, tearberry alcohol, and violetone from *D. nobile*. Their structures are shown in Table 12 and Figure 11.

3 Nutritional health functions

3.1 Main nutrient composition

D. nobile is rich in nutrition and contains a variety of amino acids, proteins, reducing sugars, trace elements and other important nutrients. Amino acids play an important role in the growth and

Table 11. Polysaccharides isolated from *D. nobile*.

name	compose	The molar ratio(%)	molecular weight(Da)	preparation method	Source	Ref.
DNP1-1	Rhamnose, Arabinose, Xylose, Mannose, Glucose, Galactose	2.11: 3.54: 0.89: 12.97: 44.65: 35.85	136000	Crude water-soluble polysaccharides were extracted from the stem of Dendrobium nobile Lindl. Using boiling-water. The polysaccharides were successively purified by chromatography on DEAE-cellulose and Sephadex G-200 column, giving four major polysaccharide fractions termed DNP1-1, DNP2-1, DNP3-1, DNP4-2.	stem	Luo et al., 2010
DNP2-1	Mannose, Glucose, Galactose	16.99: 53.26: 29.74	27700		stem	Luo et al., 2010
DNP3-1	Rhamnose, Arabinose, Mannose, Glucose, Galactose	3.76: 8.48: 6.55: 12.58: 68.63	11800		stem	Luo et al., 2010
DNP4-2	Rhamnose, Arabinose, Mannose, Glucose, Galactose	12.59: 4.20: 11.64: 23.47: 48.1	11400		stem	Luo et al., 2010
DNP-W	Mannose, Glucose, Galactose, Rhamnose, Arabinose, Xylose	42.2: 31.1: 13.6: 2.8: 7.4: 2.9	413000	Polysaccharides were sequentially extracted from the stems of D. nobile to obtain three fractions, i.e. water extract fraction (DNP-W), 5% NaOH extract fraction (DNP-OH) and 5% HCl extract fraction (DNP-H). Further the DNP-W was isolated to give six sub-fractions (DNP-W1, DNP-W2, DNP-W3, DNP-W4, DNP-W5 and DNP-W6) by anion-exchange chromatography.	stem	Wang et al., 2010a
DNP-OH	Mannose, Glucose, Galactose, Rhamnose, Arabinose, Xylose	16.1: 23.3: 51.2: 3.4: 1.8: 4.2	176000		stem	Wang et al., 2010a
DNP-H	Mannose, Glucose, Galactose, Rhamnose, Arabinose, Xylose	9.1: 30.6: 53.3: 3.7: 1.3: 2	219000		stem	Wang et al., 2010a
DNP-W1	Mannose, Glucose, Galactose, Arabinose	64.2: 28.1: 6.6: 1.1	92000		stems	Wang et al., 2010a
DNP-W2	Mannose, Glucose, Galactose, Arabinose	21.1: 65.3: 11.2: 1.9	101000		stems	Wang et al., 2010a; Wang et al., 2010d
DNP-W3	Mannose, Glucose, Galactose, Rhamnose, Arabinose, Xylose	21.2: 52.6: 14.3: 5.9: 4.6: 1.1	1073000		stems	Wang et al., 2010b; Wang et al., 2010a
DNP-W4	Mannose, Glucose, Galactose, Rhamnose, Arabinose	12.8: 54.9: 23.6: 4.6: 3.9	421000		stems	Wang et al., 2010a; Wang et al., 2017
DNP-W5	Mannose, Glucose, Galactose, Rhamnose, Arabinose, Xylose	7.5: 52.5: 29.3: 4.7: 2.1: 3.9	463000		stem	Wang et al., 2010c; Wang et al., 2010a
DNP-W6	Mannose, Glucose, Galactose, Rhamnose, Arabinose, Xylose	10.6: 41.2: 42.3: 3.1: 1.2: 1.6	541000		stem	Wang, 2011; Wang et al., 2010a

Table 12. Other compounds isolated from *D. nobile*.

NO.	Chemical compound	Formula	Molecular weight	Ref.
224	Stigmasterol	$C_{29}H_{48}O$	412.37	Li et al., 2010
225	dendroside	$C_{30}H_{34}O_{13}$	602.20	Zhou et al., 2017
226	β-sitosterol	$C_{29}H_{50}O$	414.39	Talapatra et al., 1982
227	daucosterol	$C_{35}H_{60}O_{6}$	576.44	Luo et al., 2006a
228	dehydrodiconiferyl- alcohol-4-β-d-glucoside	$C_{26}H_{34}O_{11}$	522.21	Zhou et al., 2017
229	juniperoside	$C_{18}H_{26}O_{9}$	386.16	Zhou et al., 2018a; Zhou et al., 2017
230	Dibutylphthalate	$C_{16}H_{22}O_{4}$	278.15	Wang et al., 2012
231	S(+)dehydrovomifoliol	$C_{13}H_{18}O_{3}$	222.13	Wang et al., 2019a
232	(+)-denobilone A	$C_{15}H_{14}O_{4}$	258.09	Zhou et al., 2016a
233	(−)-denobilone A	$C_{15}H_{14}O_{4}$	258.09	Zhou et al., 2016a
234	Ionone	$C_{13}H_{20}O$	192.15	Xu et al., 2010
235	zhepiresinol	$C_{14}H_{16}O_{6}$	280.09	Zhou et al., 2016b
236	Manool	$C_{20}H_{34}O$	290.26	Xu et al., 2010
237	3′,4′,5′-trimethoxycinnamyl acetate	$C_{14}H_{18}O_{5}$	266.12	Zhou et al., 2016b
238	Linalool	$C_{10}H_{18}O$	154.14	Zheng et al., 2016
239	2-amyl furan	$C_{9}H_{14}O$	138.10	Zheng et al., 2016
240	methyl ester	$C_{17}H_{34}O_{2}$	270.26	Wang et al., 2012
241	Nonenal	$C_{9}H_{16}O$	140.12	Zheng et al., 2016
242	Trans-2-heptenal	$C_{7}H_{12}O$	112.09	Zheng et al., 2016
243	1-tetracosanol	$C_{24}H_{50}O$	354.39	Zhou et al., 2018a
244	1-hexacosanol	$C_{26}H_{54}O$	382.42	Zhou et al., 2018a

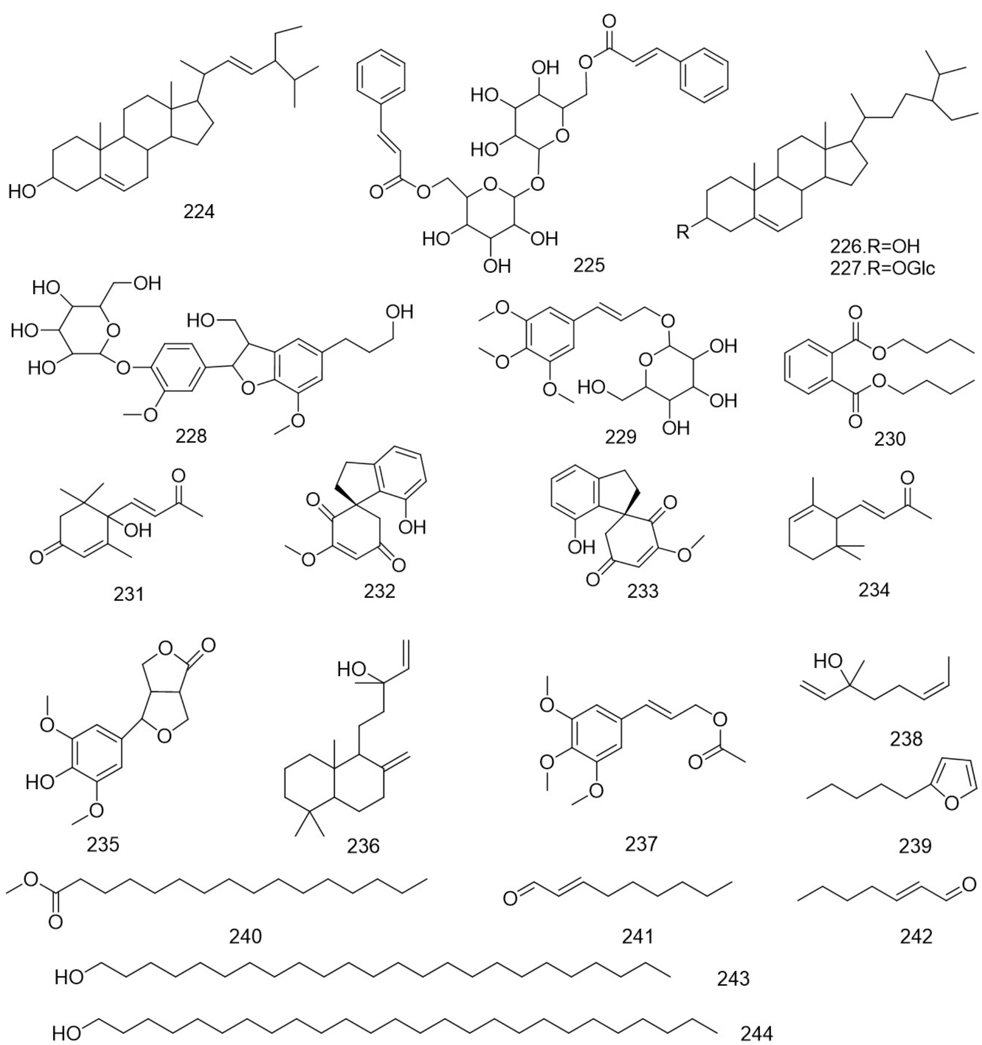

Figure 11. Chemical structures of other compounds in *D. nobile*.

development of human body, and the composition of amino acids is balanced, which will be beneficial to human health. According to analysis, *D. nobile* contains all kinds of amino acids, including 17 kinds of amino acids, including 7 essential amino acids and 5 semi-essential amino acids (Qu et al., 2018). The total amount of amino acids in different Dendrobium was different, *D. nobile* was the highest, *D. candidum* was the second, and *D. drumstick* was the lowest. According to the analysis of nutritional composition of D. nobile, it was found that there was little difference in general nutritional composition among different cultivation models, with the highest water content, between 90.1% and 91.1%, ash 0.5% and 0.6%, total dietary fiber about 4.6%. Crude protein is between 0.27% and 0.36%, crude fat between 0.2% and 0.4%. It also contains major elements such as phosphorus, calcium, magnesium and trace elements such as zinc, iron and manganese needed by the human body (Reng et al., 2019). By analyzing the nutritional components of *D. nobile* in Chishui City, Guizhou Province, Lu et al. (2013) identified 6 fatty acids from the fatty acids of *D. nobile*, which were palmitic acid, stearic acid, oleic acid, linoleic acid, eicosenoic acid and erucic acid (Lu et al., 2013). In addition, the mature fresh stem of *D. nobile* planted in the fourth year contains 4.34% crude ash, 0.832% calcium, 0.019% magnesium, 0.227% total nitrogen and 0.154% phosphorus (Li et al., 2017b). Comprehensive analysis showed that *D. nobile* has potential value in the development and utilization of health products.

3.2 Health and medicinal functions

Anti-ageing

Ageing is a continuous and complex process that occurs spontaneously in the body. Free radical reactions and lipid peroxidation within the body can reduce cellular function and are key factors in causing ageing (Miwa et al., 2022). *D. nobile* can scavenge oxygen free radicals, delay DNA damage, inhibit apoptosis and alter DNA methylation, thus exhibiting important activities to delay ageing. Jin et al. (2008) found that Dendroflorin, the active compound extracted from *D. nobile*, contributes to the degradation of reactive oxygen species and is a potential drug for antioxidant activity.

Immunity boosting

Polysaccharides from *D. nobile* can promote lymphocyte mitosis. Related studies have found that *D. nobile* can inhibit the expression of cytokines, protein signaling pathways and immune cells, thus improving the inflammatory symptoms of mice (Hong et al., 2022). In addition, *D. nobile* can restore the balance of intestinal flora in mice with allergic rhinitis, improve pulmonary inflammation in mice with allergic rhinitis, and predict a new treatment method of using traditional Chinese medicine to improve allergic rhinitis (Duan et al., 2022). And polysaccharides from *D. nobile* can also enhance its immunity (Fan et al., 2020). Therefore, it is of great significance to develop the health food of *D. nobile*.

Hypoglycemic and lipid lowering

Diabetes is a metabolic disease caused by absolute and relative deficiency of insulin secretion. At present, it is still a research hotspot (Bailes, 2002). Related studies have shown that polysaccharides from *D. nobile* can significantly reduce the increase of blood glucose induced by epinephrine, promote the uptake and utilization of glucose in peripheral tissue, and thus reduce blood glucose (Pan et al., 2014). In addition, it was found that *D. nobile* could improve the abnormal lipid profile in the liver of HFD-fed mice in two ways: (1) enhance taurine binding to bile acid, which is highly hydrophilic and contribute to cholesterol excretion; (2) reduce the CA/CDCA ratio, which is positively correlated with cholesterol absorption (Huang et al., 2019).

4 Conclusion

D. nobile is one of the most valuable traditional Chinese medicines and functional food in China, and it is rich in resources and contains a variety of chemical components. Up to now, 13 polysaccharides and 244 small molecular compounds have been isolated from *D. nobile*, including alkaloids, sesquiterpenes, bibenzyl, phenanthrene, phenolic acids and so on. It is found that the stem of *D. nobile* is one of the main components to obtain chemical constituents, and this part is also rich in nutrient and mineral elements, which can be developed and utilized as a new resource food and cosmetics. Although the chemical composition of *D. nobile* has been studied for many years, the mechanism and effective parts of *D. nobile* have not been fully studied, and the relationship between chemical composition and efficacy needs to be further studied. Modern studies have also shown that it has a variety of structural types of pharmacological active components, with antihypertensive and lipid-lowering, anti-inflammatory, anti-aging, antibacterial and immunomodulatory effects, so it is worth further studying its potential utilization value.

Conflict of interest

All authors have no conflicts of interest to declare.

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