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Review

Research Progress on Chemical Composition, Pharmacological Effects and Compound Preparations of *Dracocephalum tanguticum* Maxim.: A Review

Tingting Wang [1,2,3], Ammara Khalid [3], Yongsheng Wei [4], Hong Quan [1,2], Zhaoyue Dong [3], Fancheng Meng [3,*] and Xiaozhong Lan [1,2,*]

1 The Provincial and Ministerial Co-founded Collaborative Innovation Center for R&D in Xizang Characteristic Agricultural and Animal Husbandry Resources, Xizang Agriculture and Animal Husbandry University, Nyingchi 860000, China
2 Key Laboratory of Xizang Medicine Resources Conservation and Utilization of Xizang Autonomous Region, Xizang Agriculture and Animal Husbandry University, Nyingchi 860000, China
3 College of Pharmaceutical Sciences, Southwest University, No. 2 Tiansheng Road, Beibei, Chongqing 400715, China; ammarak_17@yahoo.com (A.K.)
4 Chongqing Key Lab. of Chinese Medicine Resources, Chongqing Academy of Chinese Materia Medica, Chongqing 400065, China
* Correspondence: mengfc@swu.edu.cn (F.M.); lanxiaozhong@163.com (X.L.)

Abstract

Dracocephalum tanguticum Maxim. is a perennial herb in the family Lamiaceae and is a regionally distributed species occurring mainly in the Qinghai–Tibet Plateau. Its documented medicinal use is specifically rooted in traditional Tibetan medicine. The aerial parts have been traditionally used for hepatitis, gastritis, gastric ulcers, arthritis, cutaneous wounds, and bleeding disorders, while the seedlings have been used for ascites and edema. The plant contains various chemical constituents, including triterpenoids, flavonoids, phenylpropanoids, and alkaloids. Its extracts have shown anti-hypoxic, antiviral, antioxidant, anticancer, and other pharmacological activities in preclinical studies. Although research on *D. tanguticum* has increased, the available evidence remains fragmented, and a comprehensive synthesis integrating its traditional uses, chemical constituents, pharmacological activities, and formulations is still needed. Accordingly, this review summarizes these aspects, with particular attention to traditional Tibetan medicinal formulations containing *D. tanguticum*, including compound prescriptions and dosage forms such as powders and pills. Studies were retrieved from Web of Science, the China National Knowledge Infrastructure (CNKI), and SciFinder. By integrating current evidence and identifying knowledge gaps, this review provides a reference for future phytochemical, pharmacological, and clinical research on *D. tanguticum*.

Keywords: *Dracocephalum tanguticum* Maxim.; chemical composition; pharmacological action; compound preparations

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Academic Editors: Iulia Varzaru and Arabela Elena Untea

Received: 21 September 2026
Revised: 29 October 2026
Accepted: 2 November 2026
Published: 6 November 2026

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1. Introduction

Dracocephalum tanguticum Maxim. is a perennial herb of the genus *Dracocephalum* (Lamiaceae), a genus comprising about 70 species distributed mainly in southwestern Gansu, eastern Qinghai, western Sichuan, and southeastern Tibet [1]. It is commonly known as Longsai Qinglan or Tanggute Qinglan, and its Tibetan name is 'Zhi Yang Gu'. It is a commonly used medicinal herb in Tibetan medicine [2,3]. The *Jing Zhu Ben Cao* records

the following properties: 'Zhi Yang Gu taste sweet, bitter, clearing liver heat, stopping bleeding, healing sores, drying yellow water, both yin and Yang slopes are born, flowers and leaves are orchid colour' [4]. In Tibetan medicine, the above-ground parts and seedlings of *D. tanguticum* are used in medicine, with the above-ground parts used to treat hepatitis, gastritis, gastric ulcers, arthritis, cutaneous wounds, and bleeding disorders, healing sores, stopping bleeding, etc. The seedlings have been found to have a positive effect on treating ascites and edema [5]. There are 30 kinds of commonly used Tibetan patent medicines that involve the use of *D. tanguticum*, and at the same time, *D. tanguticum* has a long history of consumption in the folklore of Tibet [6]. This review focuses on the Tibetan medical system because *D. tanguticum* is used only in Tibetan medicine.

To facilitate further research and the establishment of quality standards for this plant, this paper provides a comprehensive review of the chemical constituents, pharmacological effects, and compound preparations of *D. tanguticum*. The review covers the period from January 1990 to December 2025 and is based on databases including Web of Science, CNKI, SciFinder, PubMed/MEDLINE, Embase, Scopus, Google Scholar and PubChem. The search terms used were 'Dracocephalum tanguticum', its Chinese name 'Gan-Qing-Qing-Lan', 'Tanggute Qinglan' and the Tibetan name 'Zhi Yang Gu', each combined with 'chemical constituents', 'isolation', 'pharmacological activity' or 'compound preparation'. Only studies reporting the isolation and structural identification of compounds from *D. tanguticum*, studies reporting pharmacological activities of its extracts, fractions or isolated compounds, and officially approved Tibetan compound preparations containing *D. tanguticum* were included; studies in which the plant material could not be verified as *D. tanguticum*, conference abstracts lacking full data, and duplicate reports were excluded. A series of chemical constituents, including terpenoids, flavonoids, phenylpropanoids, steroids and volatile oils, were identified, and a total of 113 compounds previously isolated and reported from *D. tanguticum* were compiled. The pharmacological activities of these compounds include antioxidant, anti-inflammatory, cardioprotective, antihyperglycemic, antibacterial, antiviral and antitumor properties. In addition, 30 Tibetan medicinal compound preparations containing *D. tanguticum* are in clinical use.

2. Chemical Composition of *D. tanguticum*

Unless otherwise specified, all phytochemical studies cited in this section were conducted on the aerial parts of *D. tanguticum*, which correspond to the medicinally used portion of the plant as recorded in traditional Tibetan medicine.

2.1. Triterpenoids

Phytochemical investigations of *D. tanguticum* have resulted in the isolation of 11 triterpenoids to date from this plant species, all of which are related to the class of pentacyclic triterpenes (Table 1, Figure 1). In an initial study, Xie et al. [7] isolated four compounds from the ethyl acetate fraction, which were initially identified as triterpenoids by their purple-red color reaction with sulfuric acid and ethanol. NMR analysis then revealed the presence of four triterpenoids, namely uvaol (1), ursolic acid (2), oleanolic acid (3), and betulin (4). In a related work, Zeng et al. [8] isolated three triterpenes, of which oleanolic acid (3) was the most abundant and a major constituent. In another study, Zheng et al. [9] isolated 14 monomeric compounds using supercritical CO_2 fluid extraction from the herb, of which six were triterpenoids, namely uvaol (1), ursolic acid (2), oleanolic acid (3), betulin (4), 3β,20α-dihydroxyurs-21-en-28-oic acid (5), and betulinic acid (6).

Table 1. Triterpenoid details and references.

No.	Compounds	Molecular Formula	Reference
1	uvaol	$C_{30}H_{50}O_2$	[10]
2	ursolic acid	$C_{30}H_{48}O_3$	[10,11]
3	oleanolic acid	$C_{30}H_{48}O_3$	[10,11]
4	betulin	$C_{30}H_{50}O_2$	[10]
5	3β,20α-dihydroxyurs-21-en-28-oic acid	$C_{30}H_{48}O_3$	[12]
6	betulinic acid	$C_{30}H_{48}O_3$	[11,12]
7	(12-en)-3-oxo-olean-28-oic acid	$C_{30}H_{46}O_3$	[13]
8	2*α*,3*β*-dihydroxyursolic acid	$C_{30}H_{48}O_4$	[13]
9	3*β*, 24-dihydroxyursolic acid	$C_{30}H_{48}O_4$	[13]
10	2*α*, 3*β*, 23-trihydroxyursolic acid	$C_{30}H_{48}O_4$	[13]
11	*β*-amyrin	$C_{30}H_{50}O$	[14]

Note: All compounds listed in this table were isolated from the aerial parts of *D. tanguticum*.

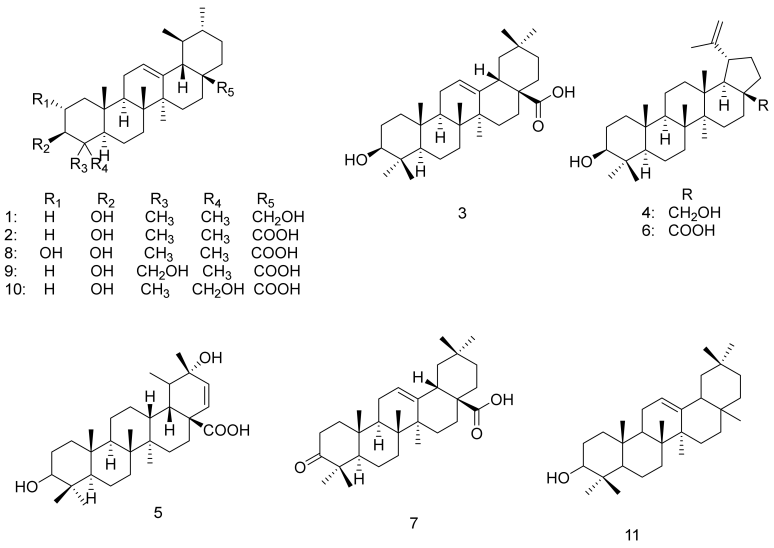


Figure 1. The structure of triterpenoids. The chemical structures of triterpenoids (**1**–**11**) isolated from the aerial parts of D. tanguticum. The general pentacyclic triterpene skeleton is shown at the top left, with the substituents (R1–R5) of compounds **1**, **2**, and **8**–**10** listed in the adjacent table; the structures of compounds **3**–**7** and **11**, which do not fit the general skeleton, are depicted individually. The name of each compound corresponding to its number is given in Table 1.

2.2. Flavonoids and Their Glycosides

Flavonoids and flavonoid glycosides are a class of metabolites that have been found to be isolated from *D. tanguticum* most frequently. To date, 41 compounds have been isolated from this species, most of which are flavonoid glycosides with high polarity. The detailed description of these flavonoids and references to the corresponding literature can be found in Table 2 [15–26]. The structures of these compounds are shown in Figure 2. In addition, Zeng et al. [8] studied the petroleum ether, dichloromethane, and ethyl acetate fractions of *D. tanguticum*. From these fractions, the authors isolated 22 compounds, among which a number of flavonoids were identified. In particular, genkwanin (**20**), acanthopanaxin (**21**), pectolinarigenin (**22**), diosmetin-7-O-*α*-*L*-arabinose-(1→6)-*β*-*D*-glucoside (**23**), diosmetin-7-O-*β*-*D*-xylose-(1→6)-*β*-*D*-glucoside (**24**), and luteolin-7-methoxyl-3′-O-(3″-O-acetyl)-*β*-*D*-glucopyranuronic acid-6″-methyl ester (**25**) were determined. Finally, in the study by Wang et al. [15], 17 flavonoids were isolated from the dichloromethane and n-butanol fractions of *D. tanguticum*.

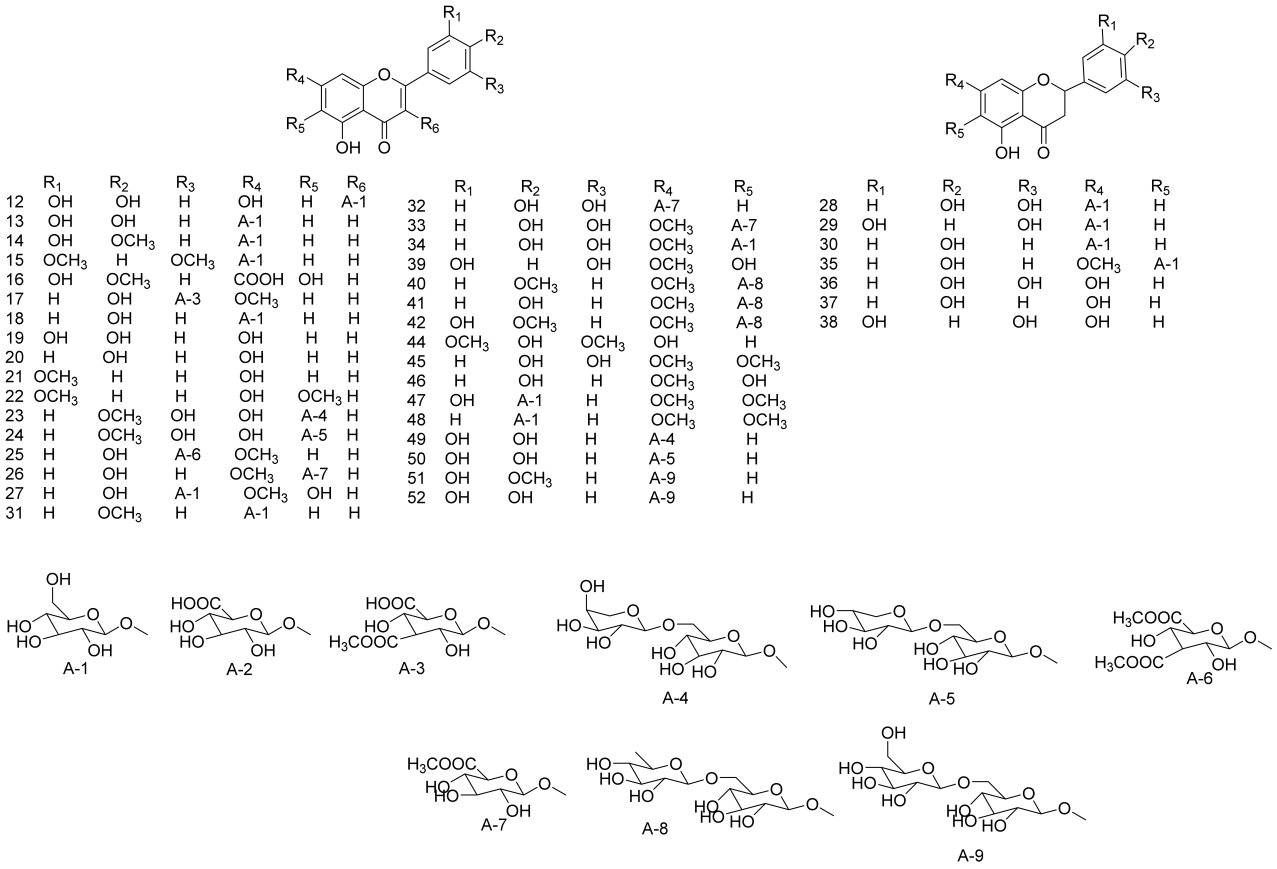


Figure 2. The structure of Flavonoids. The chemical structures of flavonoids (**12**–**52**) isolated from the aerial parts of *D. tanguticum*. The general skeletons are shown at the top; the substituents (R1–R6) corresponding to each compound number are listed in the table, and the glycosyl moieties A-1 to A-9 are depicted at the bottom. The name of each compound corresponding to its number is given in Table 2.

Table 2. Flavonoid details and references.

No.	Compounds	Molecular Formula	Reference
12	isoquercitrin	$C_{21}H_{20}O_{12}$	[15–17]
13	luteolin-7-*O*-*β*-glucopyranoside	$C_{21}H_{20}O_{11}$	[16,17]
14	diosmetin-7-*O*-*β*-*D*-glucopyr	$C_{22}H_{22}O_{11}$	[17]
15	tricin 7-*O*-glucoside	$C_{23}H_{24}O_{12}$	[17]
16	diosMetin-7-*O*-*β*-*D*-Glucuronide	$C_{22}H_{20}O_{12}$	[17]
17	*O*-methylluteolin-*O*-(acety)-glucuronide(isomer)	$C_{24}H_{22}O_{13}$	[14,17]
18	cosmosiin	$C_{21}H_{20}O_{10}$	[13]
19	luteolin	$C_{15}H_{10}O_6$	[13]
20	genkwanin	$C_{15}H_{10}O_5$	[11]
21	acanthopanaxin	$C_{16}H_{12}O_5$	[11]
22	pectolinarigenin	$C_{17}H_{14}O_6$	[11]
23	diosmetin-7-*O*-*α*-*L*-arabinose-(1→6)-*β*-*D*-glucoside	$C_{27}H_{30}O_{15}$	[11,17]
24	diosmetin-7-*O*-*β*-*D*-xylose-(1→6)-*β*-*D*-glucoside	$C_{27}H_{30}O_{15}$	[11]
25	luteolin-7-methoxyl-3′-*O*-(3″-*O*-acetyl)-*β*-*D*-glucopyranuronic acid-6″-methyl ester	$C_{26}H_{26}O_{12}$	[11,18]
26	ladanetin-6-*O*-*β*-(6-‴′*O*-acetyl)glucoside	$C_{24}H_{24}O_{12}$	[19]
27	pedalitin-3′-*O*-*β*-glucoside	$C_{22}H_{22}O_{12}$	[19]
28	eriodictyol-7-*O*-glucoside	$C_{21}H_{22}O_{11}$	[19,20]
29	5,7,3′,5′-tetrahydroxyflavanone-7-*O*-*β*-*D*-glucopyranoside	$C_{21}H_{22}O_{11}$	[19]
30	naringenin-7-*O*-*β*-*D*-glucopyranoside	$C_{21}H_{22}O_{11}$	[19]

Table 2. *Cont.*

No.	Compounds	Molecular Formula	Reference
31	tilianin	$C_{22}H_{22}O_{11}$	[19]
32	luteolin-7-*O*-*β*-*D*-glucoside ethyl ester	$C_{22}H_{20}O_{12}$	[19]
33	pedaliin-6″-acetate	$C_{23}H_{22}O_{12}$	[19,21]
34	pedalitin-6-*O*-glucoside	$C_{21}H_{20}O_{11}$	[19,22,23]
35	ldanetin-6-*O*-*D*-glucopyranoside	$C_{22}H_{24}O_{10}$	[19]
36	eriodictyol	$C_{15}H_{12}O_6$	[19]
37	naringenin	$C_{15}H_{12}O_5$	[19]
38	3′,5,5′,7-tetrahydroxyflavanone	$C_{15}H_{12}O_6$	[19]
39	7-*O*-methyl-seutellarein	$C_{16}H_{12}O_7$	[19]
40	5-hydroxy-40-methoxyflavone-7-*O*-rutinoside	$C_{28}H_{32}O_{14}$	[23]
41	narirutin	$C_{27}H_{30}O_{14}$	[24]
42	diosmin	$C_{28}H_{32}O_{15}$	[25]
43	pedalitin	$C_{16}H_{14}O_7$	[21,24]
44	5,7,4′-trihydroxy-3′,5′-dimethoxyflavone	$C_{17}H_{14}O_7$	[21]
45	5,3′,4′-trihydroxy-6,7-dimethoxyflavone	$C_{17}H_{14}O_7$	[21]
46	5,6,4′-trihydroxy-7-methoxyflavone	$C_{16}H_{12}O_6$	[21]
47	cirsiliol-4′-glucoside	$C_{23}H_{24}O_{12}$	[24]
48	cirsimaritin	$C_{23}H_{24}O_{11}$	[21]
49	luteolin -7-*O*-*L*-arabinose-*D*-glucoside	$C_{26}H_{28}O_{15}$	[26]
50	luteolin -7-*O*-*D*-xylose-*D*-glucoside	$C_{26}H_{28}O_{15}$	[26]
51	diosmetin- 7-*O*-*D*-glucose-*D*-glucoside	$C_{28}H_{32}O_{16}$	[26]
52	luteolin -7-*O*-*D*-glucose-*D*-glucoside	$C_{27}H_{30}O_{16}$	[26]

Note: All compounds listed in this table were isolated from the aerial parts of *D. tanguticum*.

2.3. Phenylpropanoids

A total of 21 phenylpropanoid compounds were isolated from *D. tanguticum*. The detailed information on these isolated phenylpropanoids and their corresponding references was summarized in Table 3, and their chemical structures were displayed in Figure 3. Among them, chlorogenic acid (**53**) and rosmarinic acid (**66**) were revealed as two of the most abundant components and regarded as major constituents of *D. tanguticum* [9].

Table 3. Phenylpropanoids details and references.

No.	Compounds	Molecular Formula	Reference
53	chlorogenic acid	$C_{16}H_{18}O_9$	[3,15,20]
54	cryptochlorogenic acid	$C_{16}H_{18}O_9$	[3,15]
55	lithospermic acid B	$C_{37}H_{32}O_{15}$	[3,15]
56	eugeny1-*β*-*D*-glucopyranoside	$C_{17}H_{24}O_6$	[16]
57	2-methoxy-4-(2-propen-l-yl)peny1 -6-acetate-*β*-*D*-glucopyranoside	$C_{19}H_{26}O_7$	[16]
58	2-methoxy-4-(2-propen-1-yl)penyl-6-[(2*E*)-2-butenoate]-*β*-*D*-glucopyranoside	$C_{21}H_{28}O_7$	[16]
59	dratanguticumide A	$C_{42}H_{51}NO_{18}$	[25]
60	dratanguticumide B	$C_{31}H_{39}NO_{12}$	[25]
61	dratanguticumide C	$C_{29}H_{37}NO_{12}$	[25]
62	dratanguticumide D	$C_{29}H_{37}NO_{11}$	[25]
63	dratanguticumide G	$C_{25}H_{32}O_{14}$	[26]
64	dratanguticumide H	$C_{18}H_{28}O_9$	[26]
65	neochlorogenic acid	$C_{16}H_{18}O_9$	[15]
66	rosmarinic acid	$C_{18}H_{16}O_8$	[15,20]
67	(*R*, *S*)-butyl rosmarinate	$C_{22}H_{24}O_8$	[19]
68	Methyl rosmarinate	$C_{19}H_{18}O_8$	[19]

Table 3. *Cont.*

No.	Compounds	Molecular Formula	Reference
69	Methyl chlorogenate	$C_{17}H_{20}O_9$	[19]
70	syringaresinol-4″-*O*-*β*-glucopyranoside	$C_{30}H_{40}O_{13}$	[19]
71	5,7-dihydroxy-chromone	$C_9H_6O_4$	[19]
72	p-Coumaric acid	$C_9H_8O_3$	[19]
73	Skimmin	$C_{15}H_{16}O_8$	[11]

Note: All compounds listed in this table were isolated from the aerial parts of *D. tanguticum*.

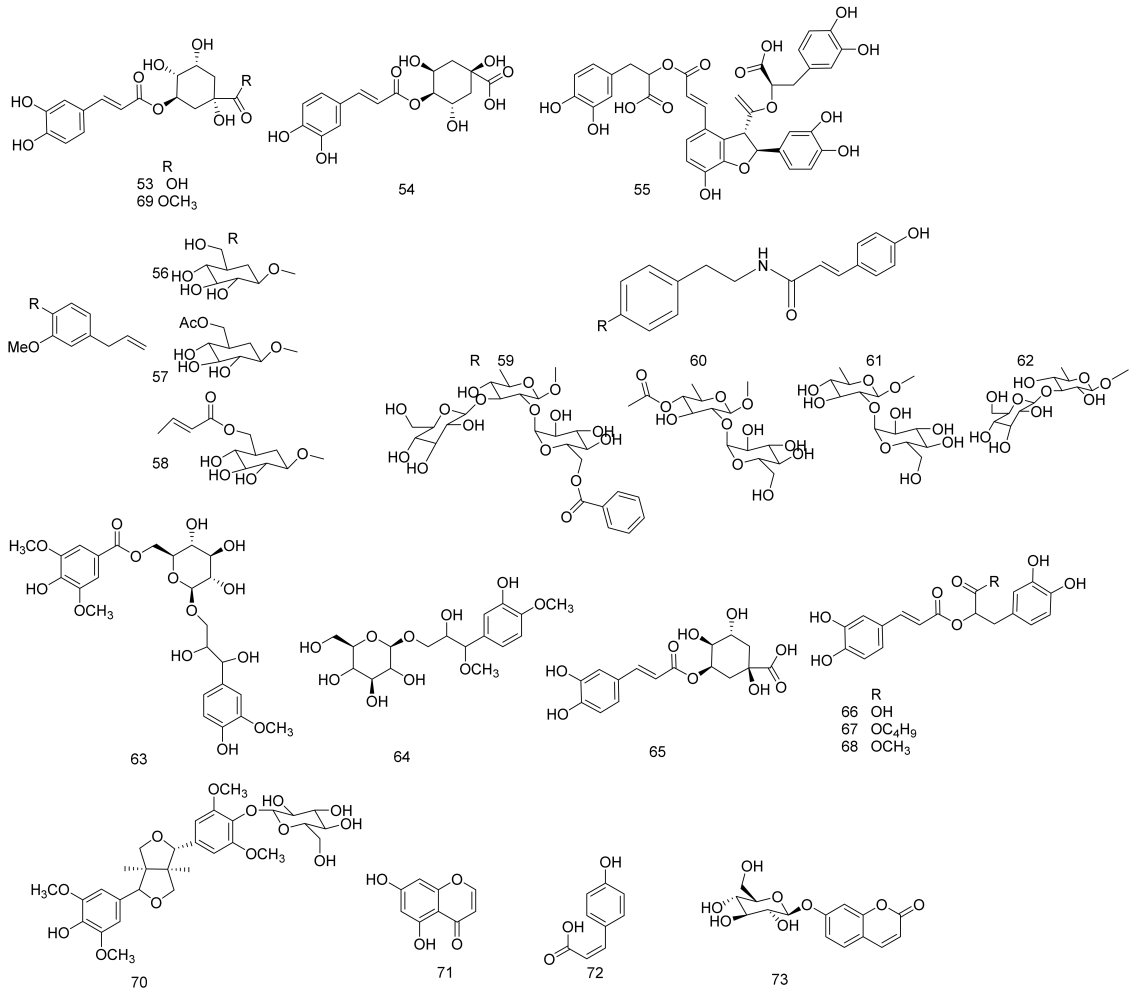


Figure 3. The structure of phenylpropanoids. The chemical structures of phenylpropanoids (**53**–**73**) isolated from the aerial parts of *D. tanguticum*. Most compounds are shown as individual structures; the substituents (R) of compounds **53**, **66**–**68**, and **69** are listed in the corresponding substituent tables. The name of each compound corresponding to its number is given in Table 3.

2.4. Steroids

From the given *D. tanguticum*, a total of eight sterols were isolated. Detailed information on the isolated compounds and the reference literature sources are presented in Table 4, while the chemical structures of the isolated compounds were demonstrated in Figure 4. Thus, the isolated sterols include stigmasterol (**74**), *β*-sitosteroli (**75**), stigmastan-3-one (**76**), stigmast-4-en-3, 6-dione (**77**), 24*R*-ethyl-5*α*-cholestane-3β,6α-diol (**78**), ergost-6,22-dien-3*β*, 5*α*, 8*α*-triol (**79**), sitoindoside I (**80**) and daucosterol (**81**).

Table 4. Steroid details and references.

No.	Compounds	Molecular Formula	Reference
74	stigmasterol	$C_{30}H_{50}$	[10]
75	*β*-sitosteroli	$C_{29}H_{50}$	[10,27]
76	stigmastan-3-one	$C_{29}H_{50}O$	[11]
77	stigmast-4-en-3, 6-dione	$C_{29}H_{46}O_2$	[11,28]
78	24*R*-ethyl-5*α*-cholestane-3β,6α-diol	$C_{29}H_{52}O_2$	[11]
79	ergost-6,22-dien-3*β*, 5*α*, 8*α*-triol	$C_{28}H_{46}O_3$	[11,29]
80	sitoindoside I	$C_{51}H_{90}O_7$	[11]
81	daucosterol	$C_{31}H_{52}O_3$	[10,11,30]

Note: All compounds listed in this table were isolated from the aerial parts of *D. tanguticum*.

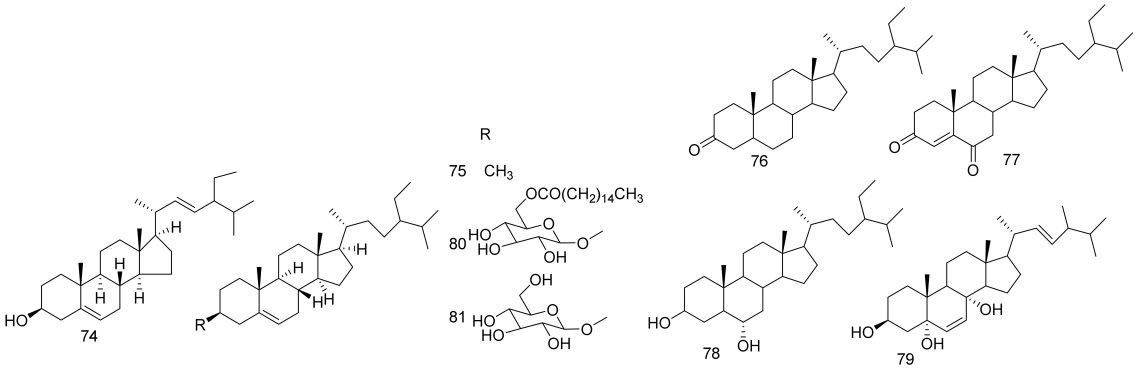


Figure 4. The structure of steroids. The chemical structures of sterols (**74**–**81**) isolated from the aerial parts of *D. tanguticum*. The compounds are shown as individual structures; the substituents (R) of compounds **74**, **75**, and **80** are indicated in the structures or the adjacent substituent table. The name of each compound corresponding to its number is given in Table 4.

2.5. Alkaloids

In total, six alkaloids have been isolated from *D. tanguticum*. The detailed information and the corresponding references about these alkaloids were summarized in Table 5. The chemical structures of these compounds are shown in Figure 5. Five alkaloid compounds were isolated and identified from the dichloromethane extract of *D. tanguticum* by Wang et al. [16]. The isolation procedure consisted of adjusting the pH to 3–4 and 9–10 with ammonia, followed by gradient elution with chloroform–methanol, dextran gel chromatography, and semi-preparative HPLC. These five isolated alkaloids were dracotanoside E (**82**), dracotanoside A (**83**), dracotanoside B (**84**), dracotanoside C (**85**), and dracotanoside D (**86**).

Table 5. Alkaloid details and references.

No.	Compounds	Molecular Formula	Reference
82	dracotanoside E	$C_{25}H_{31}N_3O_3$	[19,31]
83	dracotanoside A	$C_{44}H_{55}N_3O_{13}$	[19,31]
84	dracotanoside B	$C_{44}H_{55}N_3O_{13}$	[19,31]
85	dracotanoside C	$C_{31}H_{41}N_3O_7$	[19,31]
86	dracotanoside D	$C_{31}H_{41}N_3O_7$	[19,31]
87	*β*-Indolylaldehyde	$C_9H_7NO_3$	[16]

Note: All compounds listed in this table were isolated from the aerial parts of *D. tanguticum*.

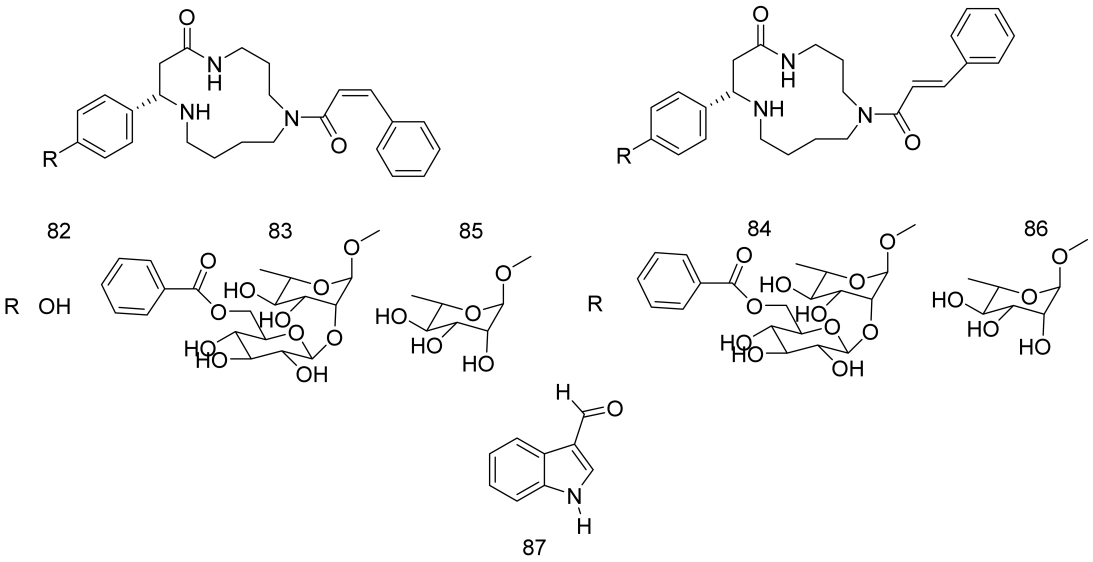


Figure 5. Structure of alkaloids. Chemical structures of alkaloids (**82**–**87**) isolated from the aerial parts of *D. tanguticum*. The compounds are shown as individual structures; the substituent (R) of compounds **82** and **84** is indicated in the structures. The name of each compound corresponding to its number is given in Table 5.

2.6. Sesquiterpenes

The phytochemical studies by Wang et al. [26,27] contributed to the first isolation of 10 sesquiterpenoids from *D. tanguticum*. Moreover, these studies extended the knowledge about the chemical constituents of *D. tanguticum*. Detailed information and the corresponding references about these sesquiterpenoids were summarized in Table 6. The chemical structures of these compounds were shown in Figure 6.

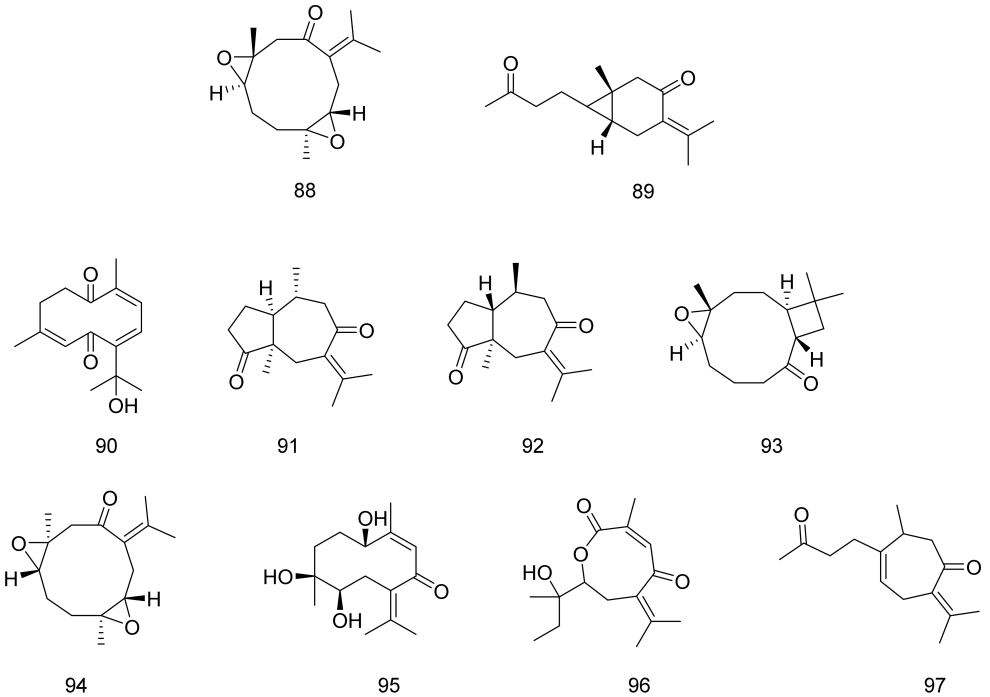


Figure 6. Structure of sesquiterpenes.

Table 6. Sesquiterpenoid details and references.

No.	Compounds	Molecular Formula	Reference
88	(1S, 10S), (4S, 5S) -(+)-germacrone-1(10)-4-diepoxide	$C_{15}H_{22}O_3$	[32]
89	Curcumenone	$C_{15}H_{22}O_2$	[32]
90	(4Z, 7Z, 9Z)-11-Hydroxy-4,7,9-germacratriene-1,6-dione	$C_{15}H_{20}O_3$	[32]
91	dracotangusion A	$C_{15}H_{22}O_2$	[32]
92	dracotangusion B	$C_{15}H_{22}O_2$	[32]
93	Kobusone	$C_{15}H_{24}O_2$	[32]
94	(1R, 10R), (4S, 5S)- (+)-germacrone-1(10)-4-diepoxide	$C_{15}H_{22}O_3$	[33]
95	1*β*,4*β*,5*β*-trihydroxy-7(11),9-germacradien-8-one	$C_{15}H_{24}O_4$	[33]
96	dracotangusion C	$C_{15}H_{22}O_4$	[33]
97	Curcumadione	$C_{15}H_{22}O_2$	[33]

Note: All compounds listed in this table were isolated from the aerial parts of *D. tanguticum*.

2.7. Other Compounds

Moreover, phytochemical studies of *D. tanguticum* have isolated 17 compounds of other classes of chemicals. The detailed descriptions of these compounds with the corresponding references are provided in Table 7, while their chemical structures are given in Figure 7.

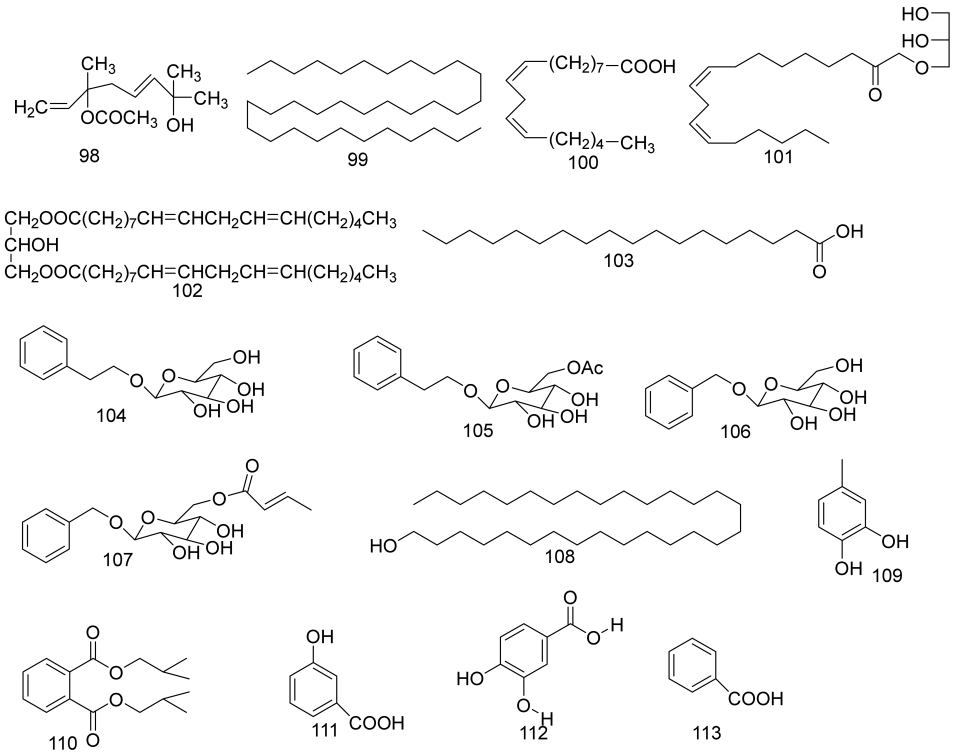


Figure 7. Structure of other compounds.

Table 7. Other compound details and references.

No.	Compounds	Molecular Formula	Reference
98	7-hydroxy-3,7-dimethylocta-1,5-dien-3-yl acetate	$C_{12}H_{20}O_3$	[10]
99	n-Triacontane	$C_{33}H_{68}$	[10]
100	linoleic acids	$C_{18}H_{32}O_2$	[11]
101	1,3-di(9,12-octadecadienoate) -glycerol	$C_{40}H_{72}O_5$	[11]
102	1-(9,12-octadecadienoate)-glycerol	$C_{21}H_{38}O_4$	[11]

Table 7. *Cont.*

No.	Compounds	Molecular Formula	Reference
103	hexacosane acid	$C_{18}H_{36}O_2$	[11]
104	2-phenylethyl-*β*-*D*-glucopyranoside	$C_{14}H_{20}O_6$	[16]
105	2-phenylethyl-6-acetate-*β*-D-glucopyranoside	$C_{16}H_{22}O_7$	[16]
106	benzyl-*O*-*β*-*D*-glucopyranoside	$C_{13}H_{18}O_6$	[16]
107	benzyl-6-[(2*E*-2-butenoate]-*β*-*D*- glucopyranoside	$C_{17}H_{22}O_7$	[16]
108	triacontanol	$C_{30}H_{62}O$	[16]
109	p-methylcatechol	$C_7H_8O_2$	[16]
110	phthalic acid isodibutyl ester	$C_{16}H_{22}O_4$	[16]
111	3-hydroxy-2-methylbenzoicacid	$C_7H_6O_3$	[19]
112	4 -hydroxy -3 -methoxy benzoic acid	$C_7H_6O_4$	[19]
113	Benzoic acid	$C_7H_6O_2$	[19]

Note: All compounds listed in this table were isolated from the aerial parts of *D. tanguticum*.

In total, 113 compounds have been reported from *D. tanguticum*, which represent a variety of chemical classes. These include triterpenoids, flavonoids, phenylpropanoids, sterols, alkaloids, and others. However, flavonoids were the most frequently found metabolites, accounting for 41 compounds, followed by triterpenoids and phenylpropanoids.

3. Pharmacological Activity Studies

3.1. Antioxidant

Wang et al. [15] investigated the isolated flavonoids through three methods, including the DPPH assay, the Ferrozine assay, and the total antioxidant capacity assay kit ($ABTS^+$). The DPPH and Fe^{2+}-scavenging activities and total antioxidant capacity were tested, and the results indicated that pedalitin-3′-*O*-*β*-glucoside (**27**), luteolin-7-*O*-*β*-glucopyranoside (**13**), luteolin-7-*O*-*β*-*D*-glucoside ethyl ester (**32**), and luteolin (**19**) had strong antioxidant activities.

Yi et al. [16] assessed the free-radical-scavenging and antioxidant activities of the flavonoid constituents of *D. tanguticum* by using the DPPH assay. The results showed that the purified total flavonoids had a stronger antioxidant activity than the crude total flavonoid extract, while the antioxidant activities were slightly weaker than those of vitamin C (Vc).

The study conducted by Xu et al. [28] showed that the n-butanol fraction of *D. tanguticum* could effectively regulate superoxide dismutase (SOD), glutathione peroxidase (GPx), and catalase (CAT) activities, and meanwhile decrease the content of malondialdehyde (MDA) in the brain after cerebral ischemia. The results suggested that the n-butanol fraction of *D. tanguticum* had antioxidant activity and could alleviate the damage of reactive oxygen species (ROS) on the brain, which might account for its neuroprotective effect. Moreover, *D. tanguticum* was reported to protect against liver damage induced by high-altitude hypoxia, and the mechanism may be related to its ability to inhibit lipid peroxidation and enhance the antioxidant capacity of the body [29]. It should be noted that the antioxidant evidence summarized above is derived from in vitro chemical assays and animal models; no clinical data in humans are available.

3.2. Anti-Inflammatory Activity

Zeng et al. [8] isolated and identified 17 monomeric compounds, subsequently testing their effects on the growth inhibition of macrophage RAW264.7 and the inhibitory activity on the nitric oxide (NO) metabolism of these cells. The study revealed that all 17 monomeric compounds exhibited an inhibitory effect on the growth of macrophage RAW264.7; however, only two triterpenoids, oleanolic acid (**3**) and ursolic acid (**2**), demonstrated significant inhibitory activity, with their IC50 values indicating a certain level of

cytotoxicity. Furthermore, the compound pectolinarigenin (**22**) was found to inhibit NO production by RAW264.7 macrophages to a notable extent, while exhibiting minimal cytotoxicity. These findings were obtained in vitro in the RAW264.7 macrophage model.

3.3. Cardioprotective Effects

In the research performed by Wang et al. [15], the cardioprotective effects of isolated flavonoids against adriamycin-induced myocardial injury were examined in vitro on rat myocardial H9c2 cells. The flavonoid compound known as luteolin-7-*O*-*β*-glucopyranoside (**13**) was found to be the most effective. The following studies focused on finding the target molecules responsible for the cardioprotective effects of these flavonoids to further elucidate the antioxidant and anti-apoptotic properties of luteolin-7-*O*-*β*-glucopyranoside. In the study conducted by Liu et al. [21], the effects of *D. tanguticum* were explored on a rat model of acute myocardial ischemia induced by coronary artery ligation. The changes in ECG parameters, the size of the infarction, and serum cardiac myosin activity were analyzed. The aqueous extract of *D. tanguticum* was found to significantly protect the heart from acute myocardial ischemia induced by coronary artery ligation in rats. In another experiment performed by Wang et al. [25], the antioxidant activity and cardioprotective effects of luteolin-7-*O*-*β*-glucopyranoside (**13**) isolated from *D. tanguticum* were investigated. The findings revealed that this flavonoid glycoside effectively protected H9c2 cells from DOX-induced toxicity. The addition of it to the DOX-treated cultures significantly reduced levels of LDH and CK release, as well as prevented the increases in intracellular ROS and Ca^{2+} in DOX-treated H9c2 cells. The preliminary structure–activity relationship (SAR) analysis identified a set of structural features necessary for the cardioprotective effects of these flavonoids. The presence of a Δ(2, 3) double bond in the C ring, together with hydroxyl groups at the 3′ and 4′ positions in the B ring and a flavonoid backbone, appears to be important for the cardioprotective effects of these compounds. The cardioprotective evidence summarized above is based on in vitro experiments (H9c2 cardiomyocytes) and animal studies; clinical validation is currently lacking.

3.4. Antihyperglycemic Activity

In the study by Ma et al. [23], three novel phenylacetamide glycosides, dratanguticumide A (**83**), dratanguticumide B (**84**), and dratanguticumide C (**85**), were evaluated for their hypoglycemic activity. The evaluation was performed by determining the rate of glucose consumption in 3T3-L1 adipocytes using the glucose oxidase–peroxidase (GOD-POD) method. The results showed that all three compounds exhibited moderate hypoglycemic activity in 3T3-L1 adipocytes.

Gu et al. [30] established an experimental rat model of type II diabetes mellitus through tail vein injection of streptozotocin (50 mg/kg) combined with a high-fat, high-calorie diet. Blood glucose, blood lipid levels, serum insulin levels, and insulin receptor levels in hepatic cell membranes were subsequently measured following oral administration of *D. tanguticum* volatile oil by gavage. The results revealed that the high-dose *D. tanguticum* volatile oil group exhibited a substantial reduction in blood glucose levels, improved blood lipid profiles, restoration of serum insulin levels toward normal, and an increase in the number of insulin receptors on hepatic cell membranes. These data were obtained in vitro (3T3-L1 adipocytes) and in a streptozotocin-induced rat model, respectively; clinical evidence is not yet available.

3.5. Antimicrobial

Wang [31] reported that purified flavonoids from *D. tanguticum* exhibited stronger bacteriostatic activity against *Escherichia coli*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa* than the corresponding aqueous and alcoholic extracts, as well as honeysuckle granules.

Similarly, Yun [32] demonstrated that the extract of *D. tanguticum* showed notable bacteriostatic activity against *Staphylococcus aureus* and *Pseudomonas aeruginosa*, whereas no inhibitory activity was observed against *Escherichia coli* or *Enterobacter faecalis*. These observations derive from in vitro bacteriostatic assays.

3.6. Antiviral

Wang [31] investigated the antiviral activity of purified flavonoids from *D. tanguticum* and found that the flavonoid mixture exhibited considerable cytotoxicity at higher concentrations. However, at concentrations below 2 mg/mL, the flavonoids exhibited inhibitory effects against virus-infected cells, including direct antiviral activity and cytoprotective effects. These effects were not observed against HSV-2 at higher concentrations, whereas a concentration of 5 mg/mL was effective in directly inactivating the virus, possibly through inhibition of viral replication associated with its cytotoxic activity.

Furthermore, studies have shown that *D. tanguticum* extract can inhibit the attachment and entry of HSV-2 into host cells and exert direct antiviral effects. In a murine model of HSV-2 encephalitis, oral administration of the total extract of *D. tanguticum* significantly prolonged the mean survival time of infected mice and exhibited greater efficacy than the positive-control drug acyclovir [32].

A further study demonstrated that *D. tanguticum* extract reduced the attachment of HSV-2 to the cell surface and inhibited the replication of HSV-2 viral DNA. In HSV-2-infected mice, treatment with the extract significantly prolonged the mean survival time and reduced the mortality rate compared with the control group ($p < 0.05$) [33]. The antiviral evidence derives from in vitro assays and a mouse model; no clinical trials have been conducted.

3.7. Anti-Hypoxia

Li et al. [34] established a rat model of chronic hypoxia-induced myocardial injury and evaluated the protective effects of *D. tanguticum* using enzyme-linked immunosorbent assay (ELISA). The results demonstrated that *D. tanguticum* exerted a protective effect against chronic hypoxia-induced myocardial injury in rats.

In a separate study, Li et al. [35] used a hypobaric oxygen chamber to simulate continuous hypoxia at an altitude of 5000 m and established an animal model of hypoxic pulmonary hypertension. Pulmonary artery pressure, carotid artery pressure, the right ventricular hypertrophy index, and malondialdehyde (MDA) content, as well as the activities of superoxide dismutase (SOD) and glutathione peroxidase (GSH-Px) in lung tissues, were measured. In addition, the microstructure of the small pulmonary arteries was examined. The results showed that administration of *D. tanguticum* at high, medium, and low doses exerted a potential preventive effect against the development of hypoxic pulmonary hypertension.

Similarly, Li Yongfang et al. [36] investigated the preventive effects of *D. tanguticum* against hypoxic pulmonary hypertension and explored its underlying mechanism. The study suggested that *D. tanguticum* exerted its protective effects by reducing endothelin levels and promoting nitric oxide synthase expression.

In addition, Ye et al. [37] reported that *D. tanguticum* significantly increased erythrocyte activity and enhanced the body's tolerance to hypoxia and its capacity to scavenge free radicals. Hai et al. [38] employed several animal models of hypoxia to evaluate the anti-hypoxic effects of the aqueous extract and volatile oil of *D. tanguticum*. The aqueous extract exhibited comprehensive anti-hypoxic effects, including reduced overall oxygen consumption, increased resistance to confinement and decompression-induced hypoxia, and enhanced SOD activity in erythrocytes of hypoxic animals. It also reduced lipid peroxide accumulation and promoted the scavenging of oxygen free radicals. The volatile oil

exhibited protective effects against myocardial hypoxia induced by various experimental conditions and enhanced myocardial tolerance to hypoxia.

Hai et al. [39] further established a model of high-altitude hypoxia and found that *D. tanguticum* exerted inhibitory effects on hypoxia-induced alterations in blood rheology, reductions in platelet counts, and right ventricular hypertrophy. Furthermore, *D. tanguticum* significantly attenuated hypoxia-induced tissue damage in the lungs, liver, and kidneys of rats. Further studies demonstrated that the volatile oil and alcoholic extracts of *D. tanguticum* possess antioxidant properties and promote the synthesis of neurotrophic factors [40,41]. All anti-hypoxia evidence summarized above comes from animal models.

3.8. Antitumor Activity

Shen et al. [11] evaluated the anti-HBV activity of individual compounds using HBV-expressing hepatocellular carcinoma cells, with lamivudine serving as the positive control. The levels of HBsAg and HBeAg were measured, and therapeutic indices were calculated to assess the inhibitory effects. Among the tested compounds, (R,S)-*n*-butyl rosmarinate (**67**) exhibited potent anti-HBV activity, whereas benzoic acid (**103**) showed moderate activity.

In addition, Zheng [42] reported that the ethyl acetate extract of *D. tanguticum* exhibited stronger anti-hepatocellular carcinoma activity and lower cytotoxicity toward L-02 cells than the total extract. Further investigations demonstrated that the ethyl acetate extract exerted significant inhibitory effects against HepG2 cells in a clear dose- and time-dependent manner. These findings suggested that the ethyl acetate extract of *D. tanguticum* may exert anticancer effects, at least in part, by inducing apoptosis in HepG2 cells. These findings are limited to in vitro cell models.

3.9. Structure–Activity Relationship (SAR) Discussion

Based on the structural characteristics of the isolated compounds and their reported pharmacological activities, several preliminary structure–activity relationships (SARs) can be proposed for *D. tanguticum*.

Flavonoids constitute the most abundant class of compounds identified from *D. tanguticum*, with 41 compounds reported to date. Among these, luteolin and its derivatives, including compounds (**13**), (**19**), and (**27**), have demonstrated notable antioxidant and cardioprotective activities. In particular, luteolin-7-*O*-*β*-glucopyranoside (**13**) exhibited cardioprotective effects in three independent studies [19,27,31]. Structurally, luteolin derivatives possess a catechol moiety characterized by 3′,4′-dihydroxyl substitution on the B ring and a C2=C3 double bond in the C ring. These structural features are likely to contribute to their free-radical-scavenging capacity. The catechol moiety can facilitate electron donation and stabilization of radical species, while the C2=C3 double bond, together with the 4-oxo group, promotes electron delocalization throughout the flavonoid skeleton. Thus, the 3′,4′-dihydroxy substitution pattern and the C2=C3 double bond may represent important structural determinants of the antioxidant activity of luteolin derivatives, which may subsequently contribute to their cardioprotective effects.

4. Compound Preparations

D. tanguticum is an important "ministerial medicine" used in Tibetan medicinal prescriptions, with an occurrence rate of approximately 10% among Tibetan medicine formulations. It is reportedly used in the treatment of 125 major disease conditions and is combined with 307 commonly used Tibetan medicinal herbs, and is accordingly incorporated into a wide range of commonly used Tibetan medicinal preparations [43]. In this review, the term "compound preparations" refers to such fixed multi-herb Tibetan medicinal formulations (pills, powders, etc.) containing *D. tanguticum* as one of several ingredients, rather than

to single-herb extracts. To date, 30 Tibetan medicinal compound preparations containing *D. tanguticum* have been documented in the Drug Standard of the Ministry of Health of the People's Republic of China, Tibetan Medicine Book I (hereafter referred to as the Ministry Standard for Tibetan Medicines, Book I) and the National Compendium of Standards for Proprietary Chinese Medicines, as summarized in Table 8 [44–67].

Table 8. Compound preparations and their functions.

No.	Name	Source	Functional Indications	Reference
1	Ershiwuwei Yuganzi pills	Ministry Standard, Tibetan Medicine Vol. 1, p. 148	Cools blood and lowers blood pressure	[44,45]
2	Ershiwuwei Yuganzi Powders	Ministry Standard, Tibetan Medicine Vol. 1, p. 149	Cools blood and lowers blood pressure	[44,45]
3	Wuwei Ganlu Pills	Ministry Standard, Tibetan Medicine Vol. 1, p. 268	Soothes the liver and strengthens the stomach	[46,47]
4	Shiyiwei Ganlu Pills	Ministry Standard, Tibetan Medicine Vol. 1, p. 169	Nourishes the heart, calms the mind, and harmonizes Qi and blood	[48]
5	Wuwei Zhaxun Pills	Ministry Standard, Tibetan Medicine Vol. 1, p. 277	Clears liver heat, treats hepatitis	[49,50]
6	Shiyiwei Hanshuishi Powders	Ministry Standard, Tibetan Medicine Vol. 1, p. 175	Relieves pain and stomach cramps	–
7	Bawei Anning Powders	Ministry Standard, Tibetan Medicine Vol. 1, p. 237	Treats excessive menstrual bleeding and indigestion	[51]
8	Shiliu Puan Powder	Ministry Standard, Tibetan Medicine Vol. 1, p. 304	Strengthens stomach fire and eliminates phlegm-dampness	–
9	Qiwei Xiaozhong Pills	Ministry Standard, Tibetan Medicine Vol. 1, p. 225	Clears heat and reduces swelling	[52]
10	Bawei Saffron Liver Heat-Clearing Powders	Ministry Standard, Tibetan Medicine Vol. 1, p. 243	Clears liver heat	–
11	Mijue Qingliang Powder	Ministry Standard, Tibetan Medicine Vol. 1, p. 329	Clears heat, treats hepatitis, etc.	–
12	Bawei Jiangxiang Pills	Ministry Standard, Tibetan Medicine Vol. 1, p. 187	Treats hypertension, etc.	[53]
13	Shisanwei Qinglan Powders	Ministry Standard, Tibetan Medicine Vol. 1, p. 194	Treats gastric ulcers and gastritis	[54]
14	Ershiwuwei Datang Powders	Ministry Standard, Tibetan Medicine Vol. 1, p. 145	Relieves stomach and liver pain, improves appetite	[55]
15	Ershiwuwei Datang Pill	Ministry Standard, Tibetan Medicine Vol. 1, p. 144	Same as above	[56]
16	Shibawei Bezoar Powders	Ministry Standard, Tibetan Medicine Vol. 1, p. 181	Promotes blood circulation, removes stasis, treats liver and stomach discomfort	–
17	Ershiliuwei Tongjing Powders	Ministry Standard, Tibetan Medicine Vol. 1, p. 164	Stops bleeding, removes stasis, regulates menstruation, and promotes blood circulation	[57]
18	25 Ershiwuwei Meconopsis Pills	Ministry Standard, Tibetan Medicine Vol. 1, p. 160	Detoxifies and clears liver heat	[58]
19	Bawei Saffron Liver Heat-Clearing Powders	Ministry Standard, Tibetan Medicine Vol. 1, p. 243	Clears liver heat, used for various liver and gallbladder diseases	–
20	Ershibawei Areca Pills	Ministry Standard, Tibetan Medicine Vol. 1, p. 140	Warms the kidneys and promotes urination	[59,60]

Table 8. *Cont.*

No.	Name	Source	Functional Indications	Reference
21	Ershiyiwei Hanshuishi Powders	Ministry Standard, Tibetan Medicine Vol. 1, p. 139	Relieves stomach pain and treats dry stools	[61]
22	Qishiwei Songshi Pills	National Standard for Chinese Patent Medicines, Internal Medicine Liver and Gallbladder Section, p. 214	Soothes the liver, benefits the gallbladder, removes stasis, and relieves pain	[62]
23	Sanshiyiwei Songshi Pills	National Standard for Chinese Patent Medicines, Internal Medicine Liver and Gallbladder Section, p. 242	Treats acute and chronic hepatitis	–
24	Ershiwei Shugan Capsule	National Standard for Chinese Patent Medicines, Internal Medicine Liver and Gallbladder Section, p. 279	Clears heat, promotes diuresis, soothes the liver, and regulates the spleen	–
25	Tibetan Lipid-Lowering Capsule	National Standard for Chinese Patent Medicines, Internal Medicine Cardiovascular Section, p. 159	Treats hyperlipidemia	[63,64]
26	Lishukang Capsule	National Standard for Chinese Patent Medicines, Internal Medicine Qi, Blood, and Body Fluids Section, p. 65	Treats palpitations, shortness of breath, and loss of appetite	[65,66]
27	Bawei Saffron Liver Heat-Clearing Capsule	National Standard for Chinese Patent Medicines, Internal Medicine Liver and Gallbladder Section, p. 412	Treats liver and gallbladder diseases	–
28	Ershiliuwei Tongjing Capsule	National Standard for Chinese Patent Medicines, Surgery and Gynecology Section, p. 586	Promotes blood circulation, removes stasis, regulates menstruation, and relieves pain	[67]
29	Jieyu Ganshu Capsule	National Standard for Chinese Patent Medicines, Internal Medicine Liver and Gallbladder Section, p. 98	Soothes the liver, relieves depression, calms the mind, and stabilizes the spirit	
30	Ganchang Capsule	National Standard for Chinese Patent Medicines, Internal Medicine Liver and Gallbladder Section, p. 165	Treats loss of appetite and acute hepatitis	–

Note: "–" indicates no relevant research literature available.

Despite the extensive traditional use of *D. tanguticum* in compound formulations, systematic pharmacological and clinical research on these preparations remains limited, and information on many of them is not readily available in the published research literature. The 30 documented preparations are all Tibetan medicinal formulations, and their principal therapeutic functions can be broadly categorized into five groups: (1) lowering blood pressure and regulating blood lipid levels; (2) promoting liver and gallbladder health; (3) improving gastrointestinal function; (4) promoting blood circulation and regulating menstruation; and (5) clearing heat and alleviating edema.

As described above, *D. tanguticum* is incorporated into at least 30 Tibetan medicinal compound preparations; however, research on these formulations remains insufficient. To further elucidate the therapeutic value and potential applications of these preparations, three representative formulations were selected for detailed analysis in this review.

4.1. Ershiwuwei Yuganzi Pills

4.1.1. Rationale for Herb CombinationRationale for Herb Combination of Ershiwuwei Yuganzi Pills

According to the principles of Tibetan medicine, this formulation is traditionally intended to "cool the blood and lower blood pressure." *D. tanguticum* may contribute to these effects through its traditional roles in clearing heat and supporting liver and gallbladder function, while other components, such as *Phyllanthus emblica* (Yuganzi), may provide complementary antioxidant and anti-inflammatory effects [68]. The combination of these medicinal herbs may therefore exert synergistic, multi-target effects that contribute to the management of hypertension and hyperlipidemia.

4.1.2. Modern Pharmacological Validations Modern Pharmacological Validations of Ershiwuwei Yuganzi Pills

Studies have shown that this formulation exhibits antihypertensive, lipid-lowering, and antioxidant effects. It is commonly used in clinical practice for hypertension and hyperlipidemia, with preliminary clinical observations suggesting improvements in vascular endothelial function and reductions in oxidative stress [45,46].

4.2. Ershiyiwei Hanshuishi Powders

4.2.1. Rationale for Herb Combination Rationale for Herb Combination of Ershiyiwei Hanshuishi Powders

This formulation is primarily used for gastrointestinal disorders, including stomach pain and constipation. It combines *D. tanguticum* with Hanshuishi and other digestive-regulating medicinal herbs to clear heat, promote digestion, and alleviate gastrointestinal discomfort and pain [61].

4.2.2. Modern Pharmacological Validations Modern Pharmacological Validations of Ershiyiwei Hanshuishi Powders

The formulation has been reported to exhibit antacid, anti-ulcer, and prokinetic activities. It is clinically used for the management of gastritis and gastric ulcers, with evidence suggesting that it may reduce gastric acid secretion and protect the gastric mucosa [61].

4.3. Qishiwei Songshi Pills

4.3.1. Rationale for Herb CombinationRationale for Herb Combination of Qishiwei Songshi Pills

This formulation is a traditional Tibetan medicinal preparation used for the management of liver and gallbladder disorders. It combines *D. tanguticum* with mineral components such as turquoise and other medicinal herbs and is traditionally used to "soothe the liver, benefit the gallbladder, remove stasis, and relieve pain." Its therapeutic rationale is rooted in the Tibetan medicinal concept of clearing "liver heat," which may be broadly interpreted in modern biomedical terms as addressing inflammatory or hyperfunctional states. The formulation may also promote bile flow, thereby contributing to its potential hepatobiliary therapeutic effects [62].

4.3.2. Modern Pharmacological Validations Modern Pharmacological Validations of Qishiwei Songshi Pills

Pharmacological studies support its use in acute and chronic hepatitis, cholecystitis, and liver protection. It demonstrates anti-inflammatory, choleretic, and hepatoprotective activities. Small-scale clinical observations have reported improvements in liver function

markers and symptom relief in patients with hepatic disorders, but large-scale randomized controlled trials are lacking [62].

These three representative formulations illustrate the sophisticated integration of *D. tanguticum* within Tibetan compound preparations. Each formula is designed based on traditional principles of symptom pattern differentiation and herb synergy, and is supported mainly by preliminary pharmacological evidence; however, rigorous randomized controlled trials remain scarce. Future research should focus on elucidating the mechanisms of action, standardizing quality control, and conducting randomized controlled trials to further validate these traditional uses.

5. Conclusions

Dracocephalum tanguticum is an important traditional Tibetan medicinal herb with a long history of therapeutic use and considerable potential as a source of bioactive natural products. A comprehensive analysis of the available literature identified 113 compounds isolated from *D. tanguticum*, representing diverse chemical classes, including flavonoids, triterpenoids, phenylpropanoids, sterols, alkaloids, sesquiterpenoids, and other constituents. Among these, flavonoids constitute the largest group and have demonstrated a broad spectrum of biological activities, particularly antioxidant, cardioprotective, anti-inflammatory, antibacterial, antiviral, and antihyperglycemic effects. In addition, pharmacological investigations of *D. tanguticum* extracts and traditional compound preparations have provided preliminary evidence supporting its applications in cardiovascular, hepatic, gastrointestinal, metabolic, and hypoxia-related disorders. The occurrence of *D. tanguticum* in numerous Tibetan medicinal formulations further highlights its important role in traditional therapeutic practice.

Despite substantial progress in phytochemical and pharmacological research, the current evidence base remains fragmented, and several important aspects require further investigation. It must be emphasized that the pharmacological evidence currently available for *D. tanguticum* derives predominantly from in vitro assays and animal experiments, and that clinical studies in humans are essentially absent; consequently, the activities summarized above should be regarded as preliminary pharmacological indications rather than established therapeutic effects. Moreover, systematic investigations linking specific chemical constituents to their molecular targets and mechanisms of action remain limited, and comprehensive quality-control systems for *D. tanguticum* have yet to be fully established. In particular, standardized microscopic and thin-layer chromatographic identification methods, characteristic chromatographic fingerprints, and a multi-component quality-evaluation strategy are needed to ensure the authenticity, consistency, and quality of this medicinal plant. The identification and validation of appropriate quality markers should therefore be prioritized.

Future research should focus on the targeted isolation and characterization of key bioactive constituents, systematic evaluation of their structure–activity relationships, and investigation of potential synergistic or additive interactions among compounds and within traditional compound preparations [69]. Advanced pharmacological, molecular, and systems-biology approaches should be employed to elucidate the mechanisms underlying the reported effects of *D. tanguticum*, particularly its activities against hypertension, hepatic disorders, gastrointestinal diseases, metabolic disturbances, and hypoxia-related injury. Integrating phytochemical profiling with pharmacological and mechanistic studies will help establish clearer links between chemical composition and therapeutic efficacy. Furthermore, standardized extracts, validated analytical methods, pharmacokinetic studies, toxicity evaluations, and well-designed randomized controlled clinical trials are necessary to strengthen the evidence supporting its traditional applications.

Overall, *D. tanguticum* represents a promising medicinal resource with substantial chemical diversity and broad pharmacological potential. Integrating traditional Tibetan medicinal knowledge with modern phytochemical, pharmacological, and quality-control approaches may provide a rational scientific basis for its therapeutic applications and facilitate the development of standardized, evidence-based *D. tanguticum*-derived medicines and functional products.

Author Contributions: Conceptualization, X.L. and T.W.; methodology, X.L., T.W. and Y.W.; validation, H.Q. and A.K.; formal analysis, A.K., H.Q. and Y.W.; investigation, Y.W., Z.D. and T.W.; resources, Z.D., X.L. and T.W.; data curation, T.W., Y.W. and H.Q.; writing—original draft preparation, T.W. and X.L.; writing—review and editing, F.M., X.L. and T.W.; supervision, X.L. and F.M.; project administration, X.L.; funding acquisition, X.L. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the ZFYC Plan for Science and Technology Innovation Team (No. 2024-175), the General Projects of Science and Technology Department of Xizang Autonomous Region (XZ202501ZR0084), the Science and Technology Projects of Nyingchi City (LZZX2026-09), Studies on the chemical composition and pharmacological activity of Nepeta hemsleyana extracts (NYQNKY2024-08) and the Xizang Agricultural and Animal Husbandry University Postgraduate Innovation Program (YJS-2025-25).

Data Availability Statement: No new data were created or analyzed in this study. Data sharing is not applicable to this article.

Conflicts of Interest: The authors declare no conflicts of interest.

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