REVIEW ARTICLE

A C G publications

Rec. Nat. Prod. 17:5 (2023) 793-844

records of natural products

Traditional Use, Pharmacology and Toxicology of the Lignans in Genus *Kadsura*: A Systematic Review

Haonan Xu [#], Wei Wang [#], Xinzhuo Li, Yuze Li, Chong Deng, Yi Jiang, Xiaomei Song and Dongdong Zhang [*]

School of Pharmacy, Shaanxi University of Chinese Medicine, Xianyang 712046, China

(Received April 19, 2023; Revised June 20, 2023; Accepted June 22, 2023)

Abstract: The genus *Kadsura* is an important part of traditional Chinese medicine, it has the functions of promoting wind, eliminating dampness, activating blood circulation. Modern pharmacological studies have shown that lignans are one of the main components to possess these medicinal effects. This review aimed to provide a systematic summary on the traditional use, phytochemistry, pharmacology, toxicology and other aspects of lignans in genus *Kadsura*. In this paper, we collected the relevant literature on *Kadsura* lignans from 1973 to the present, and isolated more than **337** lignans from this genus, including dibenzocyclooctadienes, aryltetralins, tetrahydrofurans, diarylbutanes, 7,8-seco-lignans, bisepoxylignans, neolignans, seco-dibenzocyclooctadienes, sesquilignan and coumarin-containing lignan. Previous pharmacological studies have shown that lignans of the genus Kadsura have antitumor, anti-inflammatory, antibacterial, anti-HIV, anti-platelet aggregation, immunomodulatory and antioxidant effects. In clinical practice, it is commonly used to treat Alzheimer's disease, inflammation and insomnia. *Kadsura* is an important part of the field of Chinese medicine and is widely used in traditional medicine. However, further clarification of its active ingredients and mechanism of action and the establishment of a complete quality standard system are needed in order to provide a scientific basis for in-depth studies of this genus.

Keywords: *Kadsura*; traditional uses; lignans; pharmacology; toxicity.

1. Introduction

The genus *Kadsura* is one of the subgenera of the family Schisandraceae, which is mainly distributed in eastern and southeastern Asia, eight species and four endemic species are recorded in China [1]. It is a

[*]Corresponding authors: E-Mail: zhangnatprod@163.com

[#]These authors contributed equally to this work

The article was published by ACG Publications
http://www.acgpubs.org/journal/records-of-natural-products September-October 2023 EISSN:1307-6167
DOI: http://doi.org/10.25135/rnp.403.2304.2765
Available online: July 13, 2023

widely used Chinese herb among Chinese folklore and was first described in Shennong's Herbal Classic, where it was recorded to have the effects of moving qi and relieving pain, activating blood circulation and removing blood stasis, dispelling wind and dampness, and was used to treat headaches and hypertension [2].

In recent years, a great deal of research has been conducted on the phytochemical and biological activities of plants of the genus *Kadsura*. Several new compounds with unprecedented structures have been isolated, further enriching the range of natural products. The results showed that lignans are the main pharmacological substance base for exerting clinical efficacy. Therefore, the study of lignin monomer composition should draw attention. The in vitro antitumor activity evaluation test confirmed that biphenyl cyclooctene lignans extracted from K. *oblongifolia* have significant antitumor activity and can be used for the preparation of antitumor drugs, especially for lung, nasopharyngeal and colorectal cancers. In addition, this class of components has shown its excellent immunoprotected effects in immunomodulation and organ transplantation. Studies have shown that they possess a variety of beneficial biological activities, such as anti-HIV, anti-tumor, anti-hepatitis, antioxidant, anti-platelet aggregation activity and neuroprotective effects. Research on the development of the genus *Kadsura* does not stop here, as the development of wine, health products and cosmetics has been welcomed by many countries and regions, showing far-reaching market potential [3-5].

In order to assess the medicinal potential of lignans in the genus *Kadsura*, this article presents a systematic structural classification of lignans. Additionally, a comprehensive summary of the development of lignans, including their traditional usage, pharmacological activity, and toxicity evaluation, was presented. The aim of this analysis was to provide a thorough understanding of the current state of research and exploitation of lignans, as well as to offer insights into their future potential for use in the medical field.

2. Search Strategy

In this paper, a comprehensive study and analysis of previously published literature was carried out to investigate the traditional uses, phytochemical and pharmacological activities of lignans from the genus *Kadsura*. All literature on the genus *Kadsura* was collected by using databases such as Medline PubMed, Science Direct, Sci Finder, Baidu Scholar, Google Scholar and CNKI, and finally 175 references were selected for use in the article. The keywords searched included: genus *Kadsura*, *Kadsura* longipedunculata, *Kadsura* cocinea, patent reports, *Kadsura* uses and toxicity assessment. Some of the analysed studies were obtained by manually searching articles in the reference lists of the included studies. Chemical structures were drawn with Chem Draw Professional 20.0 software.

3. Botany, Description, and Distribution

Currently, about 8 species (four endemic) of the genus *Kadsura* have been reported in China, including *Kadsura ananosma*, *Kadsura coccinea* (Variety name *Kadsura coccinea* var. Sichuanaensis), *Kadsura heteroclita*, *Kadsura induta*, *Kadsura japonica*, *Kadsura longipedunculata*, *Kadsura oblongifolia* and *Kadsura renchangiana* [6]. Meanwhile, In the *Flora of China*, *Kadsura interior* and *Kadsura ploysperma* are clearly classified as *K. heteroclita*. The following are the main characteristics of this genus. Vines, woody, glabrous (except *K. induta*). Leaf blade elliptic, ovate, or obovate, papery to leathery, base cuneate (especially when young), broadly cuneate, truncate, or subcordate, margin denticulate to entire, apex acute to acuminate. Staminate flowers: stamens 13-80, distinct but basally connate or sometimes tightly aggregated into a sub globose mass. Pistillate flowers: carpels 17 to ca. 300, distinct; stigmatic crest forming subulate or laterally flattened "pseudostyle" or modified as sub peltate or irregular "pseudo stigma"; ovary with 1-5(-11) pendulous or ventrally attached ovules. Fruit aggregates of apocarps; receptacle ellipsoid or clavate; apocarps

ripening red or yellow, sub globose, obovoid, or elongate-obovoid. Seeds 1-5(-11) per apocarp, smooth. They mostly grow on mountain slopes, along streams or in dense forests at altitudes of 500-2000 m [7-11].

4. Traditional Use

Genus *Kadsura* is an herb widely used in ancient China, giving birth to many Chinese medical prescriptions due to its good effects. It is recorded in the *Chinese Materia Medica* and *Shennon's Herbal Classic*. It is written that it can be used to treat rheumatism, inflammation, traumatic injury and burns. Furthermore, it is recorded in *Zhejiang folk herbal medicine* that the leaves of *K. longipedunculata* can be used to treat knife wounds by pounding them and applying [12-13]. It is worth mentioning that *K. longipedunculata* is one of the "Shi ba zuan" of Yao medicines, which refers to it as "Xiao zuan". Meanwhile, *K. coccinea* (Da zuan), *K. heteroclite* (Da hong zuan), *K. oblongifolia* (Xiao hong zuan) and *K. renchangiana* (Tie zuan) also belong to the "Shi ba zuan" group. Because of its traditional and regional nature, it has gradually formed a Yao medicine with ethnic characteristics [14-16].

In modern times, plants of the genus *Kadsura* are also used in clinical treatment, mainly for digestive disorders, bone and joint diseases and for the treatment of various pains [17-18]. In this article, we have collected proprietary Chinese medicines or preparations of the genus *Kadsura*, including empirical prescriptions for folk use and in-hospital preparations (Table 1, Figure 8)

Table 1. Traditional uses of the genus *Kadsura*

Species	Local name	Part	Dosage form	Traditional clinical uses
K. longipedunculata	Xiao zuan, Hong mu xiang, Zi jin pi, Xiao xue teng, Tu mu xiang.	roots	Powder(orally)	chronic cough
			Decoction(orally)	Palpitations, night sweating, rheumatism, chronic gastritis, acute gastroenteritis, ascariasis
K. coccinea	Da zuan, Leng fan tuan, Guo shan long teng, Chou fan tuan, Xue teng.	roots and stems	Decoction(orally)	postpartum hemorrhage, chronic gastritis, stomachache, cirrhotic ascites, dysmenorrhea, amenorrhea
			Powder(orally)	acute gastroenteritis, gastric ulcer, gastrointestinal ulcer
			Vinum(orally)	labor Injuries
			Decoction, vinum(orally)	rheumatism
			Mash (External application)	traumatic injury
			Tablets(orally)	dysentery
			Injections	gastrointestinal discomfort

K. heteroclita	Da hong zuan, Di xue xiang, Da fan tuan, Hai feng teng.	roots and stems	Decoction(orally)	Irregular menstruation, chronic nephritis, prostatic hyperplasia, chronic prostatitis, iron deficiency anemia, edema, postpartum hemorrhage, neurasthenia, rheumatism, abdominal pain, traumatic injury
			Decoction, vinum(orally)	stroke, lumbar muscle strain
			Mash (external application)	fractures
K. jponica	Hong gu she, Mei nan ge.	fruits	Decoction (orally or external application)	rheumatism, traumatic injury
			Decoction (orally)	Irregular menstruation, stomachache, headache
K. oblongifolia	Xiao hong zuan, Fan tuan teng.	roots and stems	Decoction (orally)	rheumatoid arthritis, cold fever, stomachache, dysmenorrhea
			Decoction (orally or external application)	traumatic injury, fractures
K. anansoma		Whole herb	Decoction (orally)	Insomnia, palpitations, night sweating
K. renchangiana	Tie zuan.	stems	Decoction (orally or external application)	rheumatism, rheumatoid arthritis, stroke, traumatic injury
			Decoction (orally)	limb numbness
K. induta		stems	Decoction (orally)	chronic gastritis, stomachache, postpartum abdominal pain, dysmenorrhea
			Decoction (external application)	rheumatoid arthritis, traumatic injury

5. Lignans in Genus *Kadsura*

In recent years, scholars have isolated a variety of active ingredients from the genus *Kadsura*, and found that its fruits, rhizomes mainly contain lignans, triterpenes, volatile oils, polysaccharides and other

components. Among them, lignans are the main components, and 337 lignans have been isolated from this genus, according to its structure it is divided into dibenzocyclooctadienes, aryltetralins, dibenzylbutanes, monoepoxylignans, 7,8-seco-lignans, bisepoxylignans, neolignans, seco-dibenzocyclooctadienes, sesquilignan and coumarin-containing lignan. The specific compound names and structures are shown in Table 2 and Figures 1-7.

Table 2. lignans from *Kadsura* genus

No	Name	*From*	Part	Ref
		Dibenzocyclooctadienes		
1	schisandrin C	*K. Interior*	stems	[19]
2	kadsufolin A	*K. oblongifolia*	roots and stems	[20]
3	kadsufolin B	*K. oblongifolia*	roots and stems	[20]
4	kadsufolin C	*K. oblongifolia*	roots and stems	[20]
5	kadsufolin D	*K. oblongifolia*	roots and stems	[20]
6	polysperlignan A	*K. polysperma*	stems	[21]
7	polysperlignan B	*K. polysperma*	stems	[21]
8	polysperlignan C	*K. polysperma*	stems	[21]
9	polysperlignan D	*K. polysperma*	stems	[21]
10	polysperlignan E	*K. polysperma*	stems	[21]
11	polysperlignan F	*K. polysperma*	stems	[21]
12	polysperlignan G	*K. polysperma*	stems	[21]
13	polysperlignan H	*K. polysperma*	stems	[21]
14	kadsuphilin A	*K. polysperma*	stems	[21]
15	polysperlignan K	*K. polysperma*	stems	[21]
16	tiegusanin I	*K. polysperma*	stems	[21]
17	polysperlignan I	*K. polysperma*	stems	[21]
18	polysperlignan J	*K. polysperma*	stems	[21]
19	methyl schisantherin F	*K. polysperma*	stems	[21]
20	longipedunin A	*K.longipedunculata*	roots and stems	[22]
21	longipedunin B	*K.longipedunculata*	roots and stems	[22]
22	longipedunin C	*K.longipedunculata*	roots and stems	[22]
23	kadsurindutin A	*K. induta*	stems	[23]
24	kadsurindutin B	*K. induta*	stems	[23]
25	schisantherin L	*K. induta*	stems	[23]
26	schisantherin P	*K. induta*	stems	[23]
27	benzoylbinankadsurin A	*K.longipedunculata*	stems	[24]
28	isovaleroylbinankadsurin A	*K.longipedunculata*	stems	[24]
29	isobutyroylbinankadsurin A	*K.longipedunculata*	stems	[24]
30	kadlongilignan G	*K.longipedunculata*	roots	[25]
31	longipedlignan	*K.longipedunculata*	roots	[26]
32	longipedlignan B	*K.longipedunculata*	roots	[26]
33	longipedlignan C	*K.longipedunculata*	roots	[26]
34	longipedlignan D	*K.longipedunculata*	roots	[26]
35	longipedlignan E	*K.longipedunculata*	roots	[26]

36	kadsutherin E	*K. Interior*	stems	[27]
37	interiotherin C	*K. Interior*	stems	[19]
38	interiotherin A	*K. Interior*	stems	[29]
39	angeloylgomisin R	*K. Interior*	stems	[29]
40	interiotherin B	*K. Interior*	stems	[29]
41	schisantherin D	*K. Interior*	stems	[29]
42	ananosin A	*K. ananosma*	seeds	[30]
43	ananolignan A	*K. ananosma*	seeds	[30]
44	ananolignan B	*K. ananosma*	seeds	[30]
45	ananolignan C	*K. ananosma*	seeds	[30]
46	ananolignan D	*K. ananosma*	seeds	[30]
47	ananolignan E	*K. ananosma*	seeds	[30]
48	ananolignan F	*K. ananosma*	seeds	[30]
49	ananolignan G	*K. ananosma*	seeds	[30]
50	ananolignan H	*K. ananosma*	seeds	[30]
51	ananolignan I	*K. ananosma*	seeds	[30]
52	ananolignan J	*K. ananosma*	seeds	[30]
53	ananolignan K	*K. ananosma*	seeds	[30]
54	ananolignan L	*K. ananosma*	seeds	[30]
55	ananolignan M	*K. ananosma*	seeds	[30]
56	ananolignan N	*K. ananosma*	seeds	[30]
57	isogomisin O	*K. polysperma*	stems	[21]
58	kadsurin	*K. japonica*	stems	[28]
59	yunnankadsurin B	*K. polysperma*	stems	[21]
60	heilaohulignan C	*K. coccinea*	roots	[31]
61	heteroclitin S	*K. heteroclita*	stems	[33]
62	heilaohusu A	*K. coccinea*	roots	[34]
63	heilaohusu B	*K. coccinea*	roots	[34]
64	heilaohusu C	*K. coccinea*	roots	[34]
65	heilaohusu D	*K. coccinea*	roots	[34]
66	neglignan	*K. coccinea*	roots	[34]
67	kadsulignan W	*K. heteroclita*	stems	[35]
68	kadsurarin	*K. heteroclita*	stems	[35]
69	kadoblongifolin A	*K. oblongifolia*	stems	[36]
70	kadoblongifolin B	*K. oblongifolia*	stems	[36]
71	kadoblongifolin C	*K. oblongifolia*	stems	[36]
72	propinquanin C	*K. oblongifolia*	stems	[36]
73	schisantherin G	*K. oblongifolia*	stems	[36]
74	heteroclitin Q	*K. oblongifolia*	stems	[36]
75	schizanrin F	*K. oblongifolia*	stems	[37]
76	gomisin J	*K. Interior*	stems	[19]
77	gomisin C	*K. Interior*	stems	[19]
78	tigloylgomisin P	*K. heteroclita*	roots and stems	[38]
79	angeloylgomisin P	*K. heteroclita*	roots and stems	[38]

80	angeloylbinankadsurin	*K. japonica*	fruits	[39]
81	caproylbinankadsurin A	*K. japonica*	fruits	[39]
82	acetylbinankadsurin A	*K. japonica*	fruits	[39]
83	deacetyldeangeloyl-kadsurarin	*K.longipedunculata*	roots	[40]
84	angeloylbinankadsurin B	*K. japonica*	fruits	[41]
85	acetylbinankadsurin B	*K. japonica*	fruits	[41]
86	deangeloylschisantherin F	*K. japonica*	fruits	[41]
87	kadsuralignan J	*K. coccinea*	roots	[42]
88	binankadsurin A	*K. japonica*	fruits	[39]
89	schizandrin H	*K. coccinea*	rhizomes	[43]
90	kadsuralignan L	*K. coccinea*	rhizomes	[44]
91	kadsuralignan G	*K. coccinea*	rhizomes	[44]
92	acetylepigomisin R	*K. coccinea*	roots	[42]
93	heteroclitalignan A	*K. heteroclita*	stems	[46]
94	heteroclitalignan D	*K. heteroclita*	stems	[46]
95	heteroclitalignan B	*K. heteroclita*	stems	[46]
96	kadheterin A	*K. heteroclita*	stems	[47]
97	kadheterin B	*K. heteroclita*	stems	[47]
98	kadheterin C	*K. heteroclita*	stems	[47]
99	kadheterin D	*K. heteroclita*	stems	[47]
100	kadheterin E	*K. heteroclita*	stems	[47]
101	kadheterin F	*K. heteroclita*	stems	[47]
102	kadheterin G	*K. heteroclita*	stems	[47]
103	kadheterin H	*K. heteroclita*	stems	[47]
104	9-benzoyloxy-gomisin B	*K. heteroclita*	stems	[47]
105	kadsuphilol R	*K. heteroclita*	stems	[47]
106	kadsuphilol T	*K. heteroclita*	stems	[47]
107	kadsuphilin F	*K. heteroclita*	stems	[47]
108	heteroclitin A	*K. heteroclita*	stems	[48]
109	heteroclitin B	*K. heteroclita*	stems	[48]
110	heteroclitin C	*K. heteroclita*	stems	[48]
111	kadsuralignan I	*K. coccinea*	rhizomes	[49]
112	kadsuralignan K	*K. coccinea*	rhizomes	[49]
113	ananonin A	*K. ananosma*	seeds	[50]
114	ananonin B	*K. ananosma*	seeds	[50]
115	ananonin C	*K. ananosma*	seeds	[50]
116	ananonin D	*K. ananosma*	seeds	[50]
117	ananonin E	*K. ananosma*	seeds	[50]
118	ananonin F	*K. ananosma*	seeds	[50]
119	ananonin G	*K. ananosma*	seeds	[50]
120	ananonin H	*K. ananosma*	seeds	[50]
121	ananonin I	*K. ananosma*	seeds	[50]
122	ananonin J	*K. ananosma*	seeds	[50]
123	ananonin K	*K. ananosma*	seeds	[50]

124	ananonin L	*K. ananosma*	seeds	[50]
125	ananonin M	*K. ananosma*	seeds	[50]
126	ananonin N	*K. ananosma*	seeds	[50]
127	kadsuralignan B	*K. coccinea*	stems	[45]
128	kadsuralignan A	*K. coccinea*	stems	[45]
129	(±)-kadsutherin	*K. coccinea*	roots and stems	[51]
130	isokadsuranin	*K. coccinea*	roots and stems	[51]
131	deoxyschisandrin	*K. coccinea*	roots and stems	[51]
132	*R*-wuweizisu	*K. coccinea*	roots and stems	[51]
133	benzoylisogomisin O	*K. coccinea*	roots and stems	[51]
134	schisandrol B	*K. coccinea*	roots and stems	[51]
135	schisantherin M	*K. coccinea*	seeds	[52]
136	schisantherin N	*K. coccinea*	seeds	[52]
137	schisantherin O	*K. coccinea*	seeds	[52]
138	schisanhenol B	*K. coccinea*	seeds	[52]
139	acetylschisantherin L	*K. coccinea*	seeds	[52]
140	(-)-wuweizisu C	*K. coccinea*	seeds	[52]
141	gomisin R	*K. coccinea*	stems	[45]
142	schisantherin Q	*K. coccinea*	stems	[53]
143	gomisin B	*K. heteroclita*	roots and stems	[38]
144	heteroclitin P	*K. heteroclita*	stems	[47]
145	kadsurindutin H	*K. induta*	stems	[54]
146	schisantherin J	*K.longipedunculata*	seeds	[55]
147	renchangianin C	*K. renchangiana*	stems	[56]
148	renchangianin A	*K. renchangiana*	stems	[56]
149	renchangianin B	*K. renchangiana*	stems	[56]
150	renchangianin D	*K. renchangiana*	stems	[56]
151	gomisin G	*K. Interior*	stems	[19]
152	(±)-gomisin M_1	*K. heteroclita*	roots and stems	[38]
153	angeloylgomisin M_1	*K.longipedunculata*	stems	[57]
154	(+)-gomisin M_2	*K. coccinea*	roots and stems	[51]
155	kadsuranin	*K.longipedunculata*	stems	[57]
156	gomisin A	*K. heteroclita*	roots and stems	[38]
157	gomisin H	*K. coccinea*	roots and stems	[51]
158	angeloylgomisin H	*K. heteroclita*	roots and stems	[38]
159	schizandrin	*K. heteroclita*	roots and stems	[38]
160	(+)-deoxyschizandrin	*K. coccinea*	roots	[58]
161	schizanrin M	*K. japonica*	stems	[59]
162	schizanrin N	*K. japonica*	stems	[59]
163	schizanrin I	*K. japonica*	stems	[59]
164	schizanrin J	*K. japonica*	stems	[59]
165	schizanrin K	*K. japonica*	stems	[59]
166	schizanrin L	*K. japonica*	stems	[59]
167	heteroclitin E	*K. heteroclita*	stems	[61]

168	renchangianin E	*K. renchangiana*	stems	[67]
169	longipedunin D	*K.longipedunculata*	roots and stems	[68]
170	longipedunin E	*K.longipedunculata*	roots and stems	[68]
171	kadangustin L	*K. coccinea*	stems	[69]
172	deoxyschisandrin	*K. japonica*	roots and stems	[73]
173	heilaohuguosu A	*K. coccinea*	fruits	[70]
174	heilaohuguosu B	*K. coccinea*	fruits	[70]
175	heilaohuguosu C	*K. coccinea*	fruits	[70]
176	heilaohuguosu D	*K. coccinea*	fruits	[70]
177	heilaohuguosu E	*K. coccinea*	fruits	[70]
178	heilaohuguosu F	*K. coccinea*	fruits	[70]
179	heilaohuguosu G	*K. coccinea*	fruits	[70]
180	heilaohuguosu H	*K. coccinea*	fruits	[70]
181	heilaohuguosu I	*K. coccinea*	fruits	[70]
182	heilaohuguosu J	*K. coccinea*	fruits	[70]
183	heilaohuguosu K	*K. coccinea*	fruits	[70]
184	heilaohuguosu L	*K. coccinea*	fruits	[70]
185	heilaohuguosu M	*K. coccinea*	fruits	[70]
186	longipedunculatin D	*K. longipedunculata*	roots	[71]
187	longipedlignan K	*K. longipedunculata*	roots	[71]
188	kasuracin A	*K. coccinea*	leaves	[72]
189	angeloyl-binankadsurin A	*K. oblongifolia*	roots and stems	[73]
190	angeloyl-binankadsurin B	*K. oblongifolia*	roots and stems	[73]
191	acetyl-binankadsurin A	*K.longipedunculata*	roots and stems	[22]
192	xuetonlignan A	*K. heteroclita*	leaves	[80]
193	xuetonlignan B	*K. heteroclita*	leaves	[80]
194	xuetonlignan C	*K. heteroclita*	leaves	[80]
195	kadsindutalignan A	*K. induta*	stems and leaves	[81]
196	kadsindutalignan B	*K. induta*	stems and leaves	[81]
197	kadsindutalignan C	*K. induta*	stems and leaves	[81]
198	kadsulignan L	*K. induta*	stems	[23]
199	neokadsuranin	*K. induta*	stems	[23]
200	kadlongilignan E	*K.longipedunculata*	roots	[25]
201	kadlongilignan F	*K.longipedunculata*	roots	[25]
202	kadsutherin F	*K. Interior*	stems	[27]
203	kadsutherin G	*K. Interior*	stems	[27]
204	kadsutherin H	*K. Interior*	stems	[27]
205	oxokadsurane	*K. Interior*	stems	[27]
206	heteroclitin D	*K. Interior*	stems	[27]
207	interiotherin D	*K. Interior*	stems	[19]
208	isovaleroyl oxokadsurane	*K. coccinea*	roots	[32]
209	propoxyl oxokadsurane	*K. coccinea*	roots	[32]
210	acetoxyl oxokadsurane	*K. coccinea*	roots	[32]
211	benzoyl oxokadsurane	*K. coccinea*	roots	[32]

212	isovaleroyl oxokadsuranol	*K. coccinea*	roots	[32]
213	propoxyl oxokadsuranol	*K. coccinea*	roots	[32]
214	benzoyl oxokadsuranol	*K. coccinea*	roots	[32]
215	heteroclitin R	*K. heteroclita*	stems	[33]
216	taiwanschirin C	*K. japonica*	stems	[59]
217	gomisin D	*K. coccinea*	roots and stems	[51]
218	gomisin E	*K. coccinea*	roots and stems	[51]
219	kadsulignan A	*K.longipedunculata*	roots	[40]
220	kadsulignan B	*K.longipedunculata*	roots	[40]
221	kadsulignan M	*K. coccinea*	seeds	[60]
222	kadsulignan N	*K. coccinea*	seeds	[60]
223	kadsulignan K (heteroclitinG)	*K. heteroclita*	stems	[61]
224	kadsuralignan D	*K. heteroclita*	stems	[61]
225	heteroclitin I	*K. heteroclita*	stems	[62]
226	heteroclitin J	*K. heteroclita*	stems	[62]
227	heteroclitin K	*K. heteroclita*	stems	[62]
228	heteroclitin L	*K. heteroclita*	stems	[62]
229	kadsulignan C	*K.longipedunculata*	roots	[40]
230	kadsulignan D	*K.longipedunculata*	roots	[40]
231	heteroclitin H	*K. heteroclita*	stems	[63]
232	heteroclitin O	*K. heteroclita*	stems	[64]
233	interiorin	*K. Interior*	stems	[19]
234	interiorin B	*K. Interior*	vines	[65]
235	interiorin C	*K. Interior*	vines	[65]
236	interiorin D	*K. Interior*	vines	[65]
237	isointeriorin	*K. Interior*	vines	[65]
238	heteroclitalignan C	*K. heteroclita*	stems	[46]
239	heteroclitin F	*K. Interior*	stems	[19]
240	kadsulignan O	*K. oblongifolia*	stems	[66]
241	kadsulignan P	*K. oblongifolia*	stems	[66]
242	longipedlignan F	*K.longipedunculata*	roots	[26]
243	longipedlignan G	*K.longipedunculata*	roots	[26]
244	longipedlignan H	*K.longipedunculata*	roots	[26]
245	longipedlignan I	*K.longipedunculata*	roots	[26]
246	longipedlignan J	*K.longipedunculata*	roots	[26]
247	kadsulignan E	*K. coccinea*	rhizomes	[49]
248	kadsulignan F	*K. coccinea*	rhizomes	[49]
249	kadsulignan G	*K. oblongifolia*	stems	[66]
250	heteroctitin H	*K. heteroclita*	stems	[68]
251	heilaohuguosu N	*K. coccinea*	fruits	[70]
252	propinquain I	*K. coccinea*	fruits	[70]
253	longipedunculatin A	*K. longipedunculata*	roots	[71]
254	longipedunculatin B	*K. longipedunculata*	roots	[71]
255	longipedunculatin C	*K. longipedunculata*	roots	[71]

256	longipedlignan L	*K. longipedunculata*	roots	[71]
257	longipedlignan M	*K. longipedunculata*	roots	[71]
258	longipedlignan N	*K. longipedunculata*	roots	[71]
259	longipedlignan O	*K. longipedunculata*	roots	[71]
260	longipedlignan P	*K. longipedunculata*	roots	[71]
261	kadsufolin E	*K. oblongifolia*	roots and stems	[73]
262	isointeriotherin D	*K. japonica*	roots and stems	[73]
		Aryltetralins		
263	heilaohusu E	*K. coccinea*	roots	[34]
264	isolariciresinol	*K. heteroclita*	stems	[35]
265	isolariciresinol 9-*O*-*β*-*D*-xylo-pyranoside	*K. heteroclita*	stems	[35]
266	kadsuralignan C	*K. coccinea*	stems	[45]
267	kadsuralignan H	*K. coccinea*	rhizomes	[49]
268	kadsurindutin C	*K. induta*	stems	[54]
269	ent-isolariciresinol	*K.longipedunculata*	roots and stems	[68]
270	arisantetralone A	*K.longipedunculata*	roots and stems	[68]
271	arisantetralone B	*K.longipedunculata*	roots and stems	[68]
272	arisantetralone C	*K.longipedunculata*	roots and stems	[68]
273	arisantetralone D	*K.longipedunculata*	roots and stems	[68]
274	aviculin	*K.longipedunculata*	roots and stems	[68]
275	schizandriside	*K.longipedunculata*	roots and stems	[68]
276	heilaohuguosu O	*K. coccinea*	fruits	[70]
277	heilaohuguosu P	*K. coccinea*	fruits	[70]
278	heilaohuguosu Q	*K. coccinea*	fruits	[70]
279	heilaohuguosu R	*K. coccinea*	fruits	[70]
280	otobaphenol	*K.longipedunculata*	roots and stems	[74]
		Dibenzylbutane lignans		
281	meso-dihydroguaiaretic acid	*K. coccinea*	roots	[58]
282	(+)-anwulignan	*K.longipedunculata*	roots and stems	[68]
283	dihydroguaiaretic acid	*K.longipedunculata*	roots and stems	[68]
284	monomethyl dihydroguaiaretic acid	*K.longipedunculata*	roots and stems	[68]
285	saururenin	*K.longipedunculata*	roots and stems	[68]
286	4-[4-(3,4-dimethoxyphenyl)-2,3-dimethy1-butyl]-2-methoxy-phenol	*K.longipedunculata*	roots and stems	[68]
287	dihydrocubebin	*K. heteroclita*	stems	[68]
288	isoanwulignan	*K.longipedunculata*	roots and stems	[74]
289	kadcoccilignan	*K. coccinea*	stems	[69]
290	longipedlignan R	*K. longipedunculata*	roots	[71]
291	longipedlignan Q	*K. longipedunculata*	roots	[71]
292	3-methoxyl-4-hydroxyl-3',4'-methenedioxyl lignan	*K. japonica*	roots and stems	[73]

293	(*R*)-tran-3,4-dipiperonyl-tetrahydro-furan	*K. japonica*	roots and stems	[73]
294	(±)-dihydro-cubebin	*K. japonica*	roots and stems	[73]
295	kadsufolin F	*K. oblongifolia*	roots and stems	[73]
296	sauriol B	*K. coccinea*	roots and stems	[73]
297	lengfantuanjing I	*K. coccinea*	roots and stems	[75]
298	kadsurindutin D	*K. induta*	fruits	[76]
299	kadsurindutin E	*K. induta*	fruits	[76]
300	kadsurindutin F	*K. induta*	fruits	[76]
301	kadsurindutin G	*K. induta*	fruits	[76]
	Monoepoxylignans			
302	6-hydroxyhinokinin 6-*O*-*D*-glucopyranoside	*K. heteroclita*	stems	[35]
303	(+)-laricre-sinol	*K. heteroclita*	stems	[35]
304	D-epigalbbacine	*K. heteroclita*	stems	[35]
305	(-)-hinokininok	*K. heteroclita*	stems	[68]
306	zuonin A	*K.longipedunculata*	roots and stems	[68]
307	heilaohuguosu S	*K. coccinea*	fruits	[70]
308	chicanine	*K. japonica*	roots and stems	[73]
309	grandisin	*K.longipedunculata*	roots and stems	[74]
310	fragransin B	*K.longipedunculata*	roots and stems	[74]
311	zuihonin A	*K.longipedunculata*	roots and stems	[74]
312	kadlongirin A	*K.longipedunculata*	roots and stems	[74]
313	kadlongirin B	*K.longipedunculata*	roots and stems	[74]
314	3-methoxy-3'4'-(methylenedioxy)-9,9'-epoxylignan-4,7'-diol	*K.longipedunculata*	stems	[77]
	7,8-seco-lignans			
315	evofolin B	*K. heteroclita*	stems	[35]
316	8,4'-oxyneolignan	*K. heteroclita*	stems	[35]
317	3',4'-dimethoxybenzoic acid-(3',4'-dimethoxyphenyl)-2-methyl-3-oxobutyl ester	*K. longipedunculata*	roots	[71]
318	schisandlignan B	*K. longipedunculata*	roots	[71]
319	schisandlignan C	*K. longipedunculata*	roots	[71]
320	schisandlignan D	*K. longipedunculata*	roots	[71]
	Bisepoxylignans			
321	(+)-1-hydroxy-2,6-*bis*-*epi*-pinoresinol	*K. heteroclita*	stems	[35]
322	pinoresinol	*K. heteroclita*	stems	[68]
323	okbalanophonin B	*K. heteroclita*	stems	[68]

		Neolignans		
324	vladirol F	*K.longipedunculata*	roots and stems	[68]
325	(7*S*,8*R*)-4,7,9,9'-tetrahydroxy-3,3'-dimethoxy-8-*O*-4'-neolignan	*K.longipedunculata*	roots and stems	[68]
326	dehydrodiisoeugenol	*K. heteroclita*	stems	[68]
327	(7'*R*,8'*S*)-3,4-methylenedioxy-3',4'-dimethoxy-7,8-seco-7,7'-epoxylignan-dione	*K.longipedunculata*	roots and stems	[68]
328	machilolin A	*K.longipedunculata*	roots and stems	[68]
329	licarin A	*K. oblongifolia*	roots and stems	[73]
330	(-)-dihydrodehydrodiconiferyl alcohol-9-*O*-*β*-*D*-glucopyranoside	*K. heteroclita*	stems	[78]
331	xuetonlignan D	*K. heteroclita*	leaves	[80]
		Seco-dibenzocyclooctadienes		
332	kadlongilignan A	*K.longipedunculata*	roots	[79]
333	kadlongilignan B	*K.longipedunculata*	roots	[79]
334	kadlongilignan C	*K.longipedunculata*	roots	[79]
335	kadlongilignan D	*K.longipedunculata*	roots	[79]
		Sesquilignan		
336	pinobatol	*K.longipedunculata*	roots and stems	[82]
Coumarin-containing lignan				
337	coumarinlignan	*K. heteroclita*	stems	[83]

5.1. Dibenzocyclooctadienes

Scholars have isolated a large number of dibenzocyclooctadienes from the genus *Kadsura*. A summary analysis of the components of this group shows that these lignans have two aromatic protons at C4 and C11 of the biphenyl ring, and positions 1~3 and 12~14 of the benzene ring on both sides of the structure are mainly substituted with hydroxyl, methylenedioxy or methoxy groups. In addition, a series of new spirobenzofuranoid-dibenzo cyclooctadiene-type lignans were identified Table 3 and Figure 1.

Table 3. Dibenzocyclooctadiene lignans from the genus *Kadsura*

No.	Name	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	Ref	Skeleton
1	schisandrin C	OCH_2O		OMe	OMe	OCH_2O			*α*-Me	*α*-Me		[19]	A
2	kadsufolin A	OMe	OMe	OMe	OMe	OMe	OMe		*α*-Me	*α*-Me	OAng	[20]	A
3	kadsufolin B	OMe	OMe	OMe	OMe	OMe	OMe		*α*-Me	*α*-Me	OAc	[20]	A
4	kadsufolin C	OCH_2O		OMe	OMe	OMe	OH		*α*-Me	*α*-Me	*t*-OCin	[20]	B
5	kadsufolin D	OCH_2O		OMe	OMe	OMe	OH		*α*-Me	*α*-Me	OBz	[20]	B
6	polysperlignan A	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAng	*α*-Me	*α*-Me	*α*-OAng	[21]	A
7	polysperlignan B	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAc	*α*-Me	*α*-Me	*α*-OTig	[21]	A
8	polysperlignan C	OCH_2O		OMe	OMe	OMe	OMe	*β*-OBz	*α*-Me	*α*-Me	*α*-OTig	[21]	A
9	polysperlignan D	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAng	*α*-Me	*α*-Me	*α*-OTig	[21]	A
10	polysperlignan E	OCH_2O		OMe	OMe	OMe	OMe	*t*-OCin	*α*-Me	*α*-Me	*α*-OAng	[21]	A
11	polysperlignan F	OCH_2O		OMe	OMe	OMe	OMe		*α*-Me	*α*-Me	*c*-OCin	[21]	A
12	polysperlignan G	OCH_2O		OMe	OAng	OMe	OMe	*β*-OAng	*α*-Me	*α*-Me	*α*-OH	[21]	A
13	polysperlignan H	OCH_2O		OMe	OAng	OMe	OMe	*β*-OTig	*α*-Me	*α*-Me	*α*-OH	[21]	A
14	kadsuphilin A	OCH_2O		OMe	OMe	OMe	OMe		*α*-Me	*α*-Me	*t*-OCin	[21]	A
15	polysperlignan K	OCH_2O		OMe	OAc	OMe	OMe		*α*-Me	*α*-Me	*β*-OH	[21]	B
16	tiegusanin I	OCH_2O		OMe	OMe	OMe	OMe	*α*-OAng	*β*-Me	*α*-Me	*α*-OProp	[21]	A
17	polysperlignan I	OMe	OMe	OMe	OAng	OMe	OMe	*β*-OAng	*α*-Me	*α*-Me	*α*-OH	[21]	A
18	polysperlignan J	OMe	OMe	OMe	OAng	OMe	OMe	*β*-OTig	*α*-Me	*α*-Me	*α*-OH	[21]	A
19	methyl schisantherin F	OMe	OMe	OMe	OAng	OMe	OMe		*α*-Me	*α*-Me	*α*-OH	[21]	A
20	longipedunin A	OCH_2O		OMe	OH	OMe	OMe		*α*-Me	*α*-Me	*t*-OCin	[22]	A
21	longipedunin B	OCH_2O		OMe	OH	OMe	OMe		*α*-Me	*α*-Me	*α*-OProp	[22]	A
22	longipedunin C	OCH_2O		OMe	OH	OMe	OMe		*α*-Me	*α*-Me	*α*-OBz	[22]	B
23	kadsurindutin A	OCH_2O		OMe	OMe	OCH_2O		*β*-OAng	*β*-Me, α-OH	*α*-Me	*α*-OBz	[23]	A
24	kadsurindutin B	OCH_2O		OMe	OMe	OCH_2O		*β*-OAng	*β*-Me, α-OH	*α*-Me	*α*-OAc	[23]	A

25	schisantherin L	OCH_2O		OMe	OMe	OCH_2O		*β*-OAng	*α*-Me	*α*-Me	*α*-OH	[23]	A
26	schisantherin P	OCH_2O		OMe	OMe	OCH_2O		*β*-OH	*α*-Me	*α*-Me	*α*-OH	[23]	A
27	benzoylbinankadsurin A	OMe	OMe	OH	OMe	OCH_2O		*β*-OBz	*β*-Me	*β*-Me		[24]	A
28	isovaleroylbinankadsurin A	OMe	OMe	OH	OMe	OCH_2O		*β*-OAng	*β*-Me	*β*-Me		[24]	A
29	isobutyroylbinankadsurin A	OMe	OMe	OH	OMe	OCH_2O		*β*-OProp	*β*-Me	*β*-Me		[24]	A
30	kadlongilignan G	OH	OMe		OMe	OMe	OH	*α*-OH	*α*-Me	*α*-Me		[25]	A
31	longipedlignan A	OCH_2O		OMe	OH	OMe	OMe		*β*-Me, *α*-OH	*α*-Me	*α*-OBz	[26]	A
32	longipedlignan B	OCH_2O		OMe	OH	OMe	OMe		*α*-Me, *β*-OH	*α*-Me	*α*-OBz	[26]	A
33	longipedlignan C	OCH_2O		OMe	OH	OMe	OMe		*β*-Me, *α*-OH	*α*-Me	*t*-OCin	[26]	A
34	longipedlignan D	OCH_2O		OMe	OH	OMe	OMe		*α*-Me, *β*-OH	*α*-Me	*t*-OCin	[26]	A
35	longipedlignan E	OCH_2O		OMe	OH	OMe	OMe		*β*-Me, *α*-OH	*α*-Me	*α*-OAng	[26]	A
36	kadsutherin E	OCH_2O		OH	OH	OMe	OMe		*α*-Me	*α*-Me	*α*-OBz	[27]	A
37	interiotherin C	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAng	*α*-Me	*α*-Me	*α*-OAc	[19]	A
38	interiotherin A	OCH_2O		OMe	OMe	OCH_2O		*β*-OBz	*α*-Me	*α*-Me		[29]	A
39	angeloylgomisin R	OCH_2O		OMe	OMe	OCH_2O		*β*-OAng	*α*-Me	*α*-Me		[29]	A
40	interiotherin B	OCH_2O		OMe	OMe	OCH_2O		*β*-OAng	*β*-Me, *α*-OH	*α*-Me		[29]	B
41	schisantherin D	OCH_2O		OMe	OMe	OCH_2O		*β*-OBz	*β*-Me, *α*-OH	*α*-Me		[29]	B
42	ananosin A	OCH_2O		OMe	OMe	OMe	OMe	*β*-OTig	*α*-Me	*α*-Me	*α*-OH	[30]	A
43	ananolignan A	OCH_2O		OMe	OMe	OMe	OMe		*α*-Me	*α*-Me	*α*-OAc	[30]	B
44	ananolignan B	OCH_2O		OMe	OMe	OMe	OMe	O	*β*-Me	*α*-Me	*β*-OAc	[30]	B
45	ananolignan C	OCH_2O		OMe	OMe	OMe	OMe	*α*-OH	*α*-Me	*α*-Me	*α*-OH	[30]	A
46	ananolignan D	OCH_2O		OMe	OMe	OMe	OMe	*α*-OH	*α*-Me	*α*-Me	*α*-OAc	[30]	A
47	ananolignan E	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAc	*α*-Me	*α*-Me	*α*-OH	[30]	A
48	ananolignan F	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAc	*α*-Me	*α*-Me	*α*-OAc	[30]	A
49	ananolignan G	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAc	*α*-Me	*α*-Me	*α*-OProp	[30]	A

50	ananolignan H	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAc	*α*-Me	*α*-Me	*α*-OIsobut	[30]	A
51	ananolignan I	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAc	*α*-Me	*α*-Me	*α*-OBut	[30]	A
52	ananolignan J	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAc	*α*-Me	*α*-Me	*α*-OIsoval	[30]	A
53	ananolignan K	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAc	*α*-Me	*α*-Me	*α*-OBz	[30]	A
54	ananolignan L	OCH_2O		OMe	OMe	OMe	OMe	*β*-OTig	*α*-Me	*α*-Me	*α*-OAc	[30]	A
55	ananolignan M	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAng	*α*-Me	*α*-Me	*α*-OIsobut	[30]	A
56	ananolignan N	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAng	*α*-Me	*α*-Me	*α*-OBut	[30]	A
57	isogomisin O	OCH_2O		OMe	OMe	OMe	OMe		*α*-Me	*α*-Me	*α*-OH	[21]	A
58	kadsurin	OCH_2O		OMe	OMe	OMe	OMe		*α*-Me	*α*-Me	*α*-OAc	[28]	A
59	yunnankadsurin B	OCH_2O		OMe	OMe	OMe	OMe		*β*-Me	*β*-Me	*α*-OH	[21]	A
60	heilaohulignan C	OCH_2O		OMe	OH	OMe	OMe		*α*-Me	*β*-Me	*α*-OAng	[31]	A
61	heteroclitin S	OMe	OMe	OH	OMe	OCH2O		O	*α*-Me	*α*-Me	*α*-OAng	[33]	A
62	heilaohusu A	OCH_2O			OMe	OMe	OMe	*α*-OAng	*α*-Me	*α*-Me	*β*-OH	[34]	B
63	heilaohusu B	OCH_2O			OMe	OMe	OMe	*α*-OIsoval	*α*-Me	*α*-Me	*β*-OH	[34]	B
64	heilaohusu C	OCH_2O		OMe	OH	OMe	OMe		*α*-Me	*α*-Me, *β*-OAng	O	[34]	A
65	heilaohusu D	OH	OMe	OMe	OMe	OMe	OMe	*β*-OBz	*α*-Me, *β*-OH	*β*-Me	*α*-OAc	[34]	A
66	neglignan	OCH_2O		OH	OMe	OMe	OMe		*α*-Me	*α*-Me	*α*-OIsobut	[34]	A
67	kadsulignan W	OCH_2O		OMe	OMe	OMe	OMe	*t*-OCin	*β*-Me, *α*-OH	*α*-Me	*α*-OAc	[35]	A
68	kadsurarin	OCH_2O		OMe	OMe	OMe	OMe	*α*-OAng	*β*-Me, *α*-OH	*α*-Me	*α*-OAc	[35]	A
69	kadoblongifolin A	OCH_2O		OMe	OH	OMe	OMe		*β*-Me	*α*-Me, *β*-OH	O	[36]	A
70	kadoblongifolin B	OCH2O		OMe	OMe	OMe	OH		*β*-Me	*α*-Me, *β*-OH	O	[36]	A
71	kadoblongifolin C	OCH_2O		OMe	OMe	OMe	OMe		*β*-Me	*α*-Me, *β*-OH	O	[36]	A
72	propinquanin C	OCH_2O		OH	OMe	OMe	OMe	*β*-OAng	*β*-Me, *α*-OH	*α*-Me	*α*-OProp	[36]	A
73	schisantherin G	OCH_2O		OH	OMe	OMe	OMe	*β*-OAng	*β*-Me, *α*-OH	*α*-Me	*α*-OAc	[36]	A
74	heteroclitin Q	OCH_2O		OMe	OH	OMe	OMe	*β*-OBz	*β*-Me, *α*-OH	*α*-Me	*α*-OAc	[36]	A
75	schizanrin F	OCH_2O		OMe	OMe	OMe	OMe	*β*-OBz	*β*-Me, *α*-OH	*α*-Me	*α*-OAc	[37]	A

76	gomisin J	OH	OMe	OMe	OMe	OMe	OH		*α*-Me	*α*-Me		[19]	A
77	gomisin C	OCH_2O		OMe	OMe	OMe	OMe	*β*-OBz	*β*-Me, *α*-OH	*α*-Me		[19]	A
78	tigloylgomisin P	OCH_2O		OMe	OMe	OMe	OMe	*β*-OTig	*β*-Me, *α*-OH	*α*-Me		[38]	A
79	angeloylgomisin P	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAng	*β*-Me, *α*-OH	*α*-Me		[38]	A
80	angeloylbinankadsurin	OCH_2O		OMe	OH	OMe	OMe		*α*-Me	*α*-Me	*α*-OAng	[39]	A
81	caproylbinankadsurin A	OCH_2O		OMe	OH	OMe	OMe		*α*-Me	*α*-Me	*α*-OAc	[39]	A
82	acetylbinankadsurin A	OCH_2O		OMe	OH	OMe	OMe		*α*-Me	*α*-Me	*α*-OA	[39]	A
83	deacetyldeangeloyl-kadsurarin	OCH_2O		OMe	OH	OMe	OMe	*β*-OH	*β*-Me, *α*-OH	*α*-Me	*α*-OH	[40]	A
84	angeloylbinankadsurin B	OMe	OMe	OMe	OH	OMe	OMe		*α*-Me	*α*-Me	*α*-OAng	[41]	A
85	acetylbinankadsurin B	OMe	OMe	OMe	OH	OMe	OMe		*α*-Me	*α*-Me	*α*-OAc	[41]	A
86	deangeloylschisantherin F	OH	OMe	OMe	OH	OMe	OMe		*α*-Me	*α*-Me	*α*-OH	[41]	A
87	kadsuralignan J	OCH_2O		OMe	*β*-OTig	OMe	OMe		*α*-Me	*α*-Me	*α*-OH	[42]	A
88	binankadsurin A	OCH_2O		OMe	OH	OMe	OMe		*α*-Me	*α*-Me	*α*-OH	[39]	A
89	schizandrin H	OMe	OMe	OMe	OMe	OMe	OMe	*β*-OBz	*β*-Me, *α*-OH	*α*-Me	*α*-OAc	[43]	A
90	kadsuralignan L	OH	OMe	OMe	*β*-OAng	OMe	OMe		*α*-Me	*α*-Me	*α*-OH	[44]	A
91	kadsuralignan G	OCH_2O		OMe	OH	OMe	OMe		*α*-Me	*α*-Me	*α*-b	[44]	A
92	acetylepigomisin R	OCH_2O		OMe	OMe	OCH_2O		*α*-OAc	*α*-Me	*α*-Me		[42]	A
93	heteroclitalignan A	OCH_2O		OH	OMe	OMe	OMe	*β*-OAc	*β*-Me, *α*-OH	*α*-Me	*α*-OBz	[46]	A
94	heteroclitalignan D	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAc	*β*-Me, *α*-OH	*α*-Me	*α*-OBz	[46]	A
95	heteroclitalignan B	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAng	*β*-Me, *α*-OH	*α*-Me	*α*-OProp	[46]	A
96	kadheterin A	OCH_2O		OMe	OH	OMe	OMe	*β*-OAng	CH_2	*α*-Me	*α*-OAng	[47]	A
97	kadheterin B	OCH_2O		OMe	OH	OMe	OMe	*β*-OBz	OXirane	*α*-Me	*α*-OAng	[47]	A
98	kadheterin C	OCH_2O		OMe	OH	OMe	OMe	*β*-OAng	*α*-Me, *β*-OH	*α*-Me	*α*-OAng	[47]	A
99	kadheterin D	OCH_2O		OMe	OH	OMe	OMe	*β*-OBz	*α*-Me, *β*-OH	*α*-Me	*α*-OAng	[47]	A
100	kadheterin E	OCH_2O		OMe	OH	OMe	OMe	*β*-OAng	*α*-Me, *β*-OH	*α*-Me	*α*-OBz	[47]	A

101	kadheterin F	OCH_2O		OMe	OH	OMe	OMe	*β*-OBz	*β*-Me, *α*-OH	*α*-Me	*α*-OBz	[47]	A
102	kadheterin G	OCH_2O		OMe	OH	OMe	OMe	*β*-OIsobut	*β*-Me, *α*-OH	*α*-Me	*α*-OAng	[47]	A
103	kadheterin H	OCH_2O		OMe	OH	OMe	OMe	*β*-OAng	*β*-Me, *α*-OH	*α*-Me	*α*-OIsoval	[47]	A
104	9-benzoyloxy-gomisin B	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAng	*β*-Me, *α*-OH	*α*-Me	*α*-OBz	[47]	A
105	kadsuphilol R	OCH_2O		OMe	OH	OMe	OMe	*β*-OAng	*β*-Me, *α*-OH	*α*-Me	*α*-OAng	[47]	A
106	kadsuphilol T	OCH_2O		OMe	OH	OMe	OMe	*β*-OBz	*β*-Me, *α*-OH	*α*-Me	*α*-OAng	[47]	A
107	kadsuphilin F	OCH_2O		OMe	OH	OMe	OMe		*α*-Me	*α*-Me, *β*-OH	*α*-OBz	[47]	A
108	heteroclitin A	OCH_2O		OMe	OMe	OMe	OMe		*α*-Me	*α*-Me	*α*-OIsobut	[48]	A
109	heteroclitin B	OCH_2O		OMe	OMe	OMe	OMe		*α*-Me	*α*-Me	*α*-OAng	[48]	A
110	heteroclitin C	OCH_2O		OMe	OMe	OMe	OMe		*α*-Me	*α*-Me	*α*-OTig	[48]	A
111	kadsuralignan I	OCH_2O		OMe	*β*-OAng	OMe	OMe		*α*-Me	*α*-Me	*α*-OH	[49]	A
112	kadsuralignan K	OCH_2O		OMe	*β*-OBz	OMe	OMe		*α*-Me	*α*-Me	*α*-OH	[49]	A
113	ananonin A	OCH_2O		OMe	OMe	OMe	OMe	*β*-OBz	*α*-Me	*α*-Me	*α*-OH	[50]	A
114	ananonin B	OCH_2O		OMe	OMe	OMe	OMe	*β*-OBz	*α*-Me	*α*-Me	*α*-OAc	[50]	A
115	ananonin C	OCH_2O		OMe	OMe	OMe	OMe	*β*-OBz	*α*-Me	*α*-Me	*α*-OProp	[50]	A
116	ananonin D	OCH_2O		OMe	OMe	OMe	OMe	*β*-OBz	*α*-Me	*α*-Me	*α*-OBut	[50]	A
117	ananonin E	OCH_2O		OMe	OMe	OMe	OMe	*β*-OBz	*α*-Me	*α*-Me	*α*-OIsobut	[50]	A
118	ananonin F	OCH_2O		OMe	OMe	OMe	OMe	*β*-OBz	*α*-Me	*α*-Me	*α*-OIsoval	[50]	A
119	ananonin G	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAng	*α*-Me	*α*-Me	*α*-OIsoval	[50]	A
120	ananonin H	OCH_2O		OH	OMe	OMe	OMe	*β*-OAng	*α*-Me	*α*-Me	*α*-OAc	[50]	A
121	ananonin I	OCH_2O		OH	OMe	OMe	OMe	*β*-OAng	*α*-Me	*α*-Me	*α*-OProp	[50]	A
122	ananonin J	OCH_2O		OH	OMe	OMe	OMe	*β*-OAng	*α*-Me	*α*-Me	*α*-OIsoval	[50]	A
123	ananonin K	OH	OMe	OMe	OMe	OMe	OMe	*β*-OAc	*α*-Me	*α*-Me	*α*-OAc	[50]	A
124	ananonin L	OH	OMe	OMe	OMe	OMe	OMe	*β*-OAng	*α*-Me	*α*-Me	*α*-OAc	[50]	A
125	ananonin M	OH	OMe	OMe	OMe	OMe	OMe	*β*-OBz	*α*-Me	*α*-Me	*α*-OH	[50]	A
126	ananonin N	OH	OMe	OMe	OMe	OMe	OMe	*β*-OBz	*α*-Me	*α*-Me	*α*-OAc	[50]	A
127	kadsuralignan B	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAc	*β*-Me, *α*-OH	*α*-Me	*α*-OAc	[45]	A

128	kadsuralignan A	OCH_2O		OMe	OMe	OMe	OH		*β*-Me	*α*-Me	*α*-OH	[45]	A
129	(±)-kadsutherin	OCH_2O		*β*-OAng	OMe	OMe	OMe		*α*-Me	*α*-Me		[51]	B
130	isokadsuranin	OCH_2O		OMe	OMe	OMe	OMe		*α*-Me	*α*-Me		[51]	A
131	deoxyschisandrin	OMe	OMe	OMe	OMe	OMe	OMe		*α*-Me	*α*-Me		[51]	B
132	*R*-wuweizisu	OCH_2O		OMe	OMe	OCH_2O			*α*-Me	*α*-Me		[51]	B
133	benzoylisogomisin O	OMe	OMe	OMe	OMe	OCH_2O		*β*-OBz	*α*-Me	*α*-Me		[51]	A
134	schisandrol B	OCH_2O		OMe	OMe	OMe	OMe		*α*-Me, *β*-OH	*α*-Me		[51]	B
135	schisantherin M	OCH_2O		OMe	OMe	OCH_2O		*β*-OAng	*α*-Me	*α*-Me	*α*-OTig	[52]	A
136	schisantherin N	OCH_2O		OMe	OMe	OCH_2O		*β*-OAng	*α*-Me	*α*-Me	*α*-OAng	[52]	A
137	schisantherin O	OCH_2O		OMe	OH	OMe	OMe		*α*-Me	*α*-Me	*α*-OAc	[52]	B
138	schisanhenol B	OCH_2O		OMe	OH	OMe	OMe		*α*-Me	*α*-Me		[52]	B
139	acetylschisantherin L	OCH_2O		OMe	OMe	OCH_2O		*β*-OAng	*α*-Me	*α*-Me	*α*-OAc	[52]	A
140	(-)-wuweizisu C	OCH_2O		OMe	OMe	OCH_2O			*α*-Me	*α*-Me		[52]	A
141	gomisin R	OCH_2O		OMe	OMe	OCH_2O		*β*-OH	*β*-Me	*α*-Me		[45]	A
142	schisantherin Q	OCH_2O		OMe	OMe	OCH_2O		O	*β*-Me	*α*-Me	*β*-OH	[53]	A
143	gomisin B	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAng	*β*-Me, *α*-OH	*α*-Me		[38]	A
144	heteroclitin P	OCH_2O		OMe	OH	OMe	OMe	*β*-OAng	*β*-Me, *α*-OH	*α*-Me	*α*-OBz	[47]	A
145	kadsurindutin H	OCH_2O		OMe	OMe	OCH_2O		O	*β*-Me	*α*-Me	*α*-OH	[54]	A
146	schisantherin J	OCH_2O		OMe	OMe	OMe	OMe	*β*-OBz	*β*-Me, *α*-OH	*α*-Me	*α*-OAng	[55]	A
147	renchangianin C	OMe	OMe	OH	OH	OMe	OMe	*t*-OCin	*α*-Me	*α*-Me	*α*-OAng	[56]	A
148	renchangianin A	OMe	OMe	OH	OH	OMe	OMe	*β*-OBz	*β*-Me, *α*-OH	*α*-Me	*α*-OAc	[56]	A
149	renchangianin B	OMe	OMe	OH	OH	OMe	OMe	*β*-OBz	*β*-Me, *α*-OH	*α*-Me	*α*-OAng	[56]	A
150	renchangianin D	OH	OMe	OMe	OH	OMe	OMe	*β*-OBz	Oxirane	*α*-Me	*α*-OAng	[56]	A
151	gomisin G	OMe	OMe	OMe	OMe	OCH_2O		*β*-OBz	*β*-Me, *α*-OH	*α*-Me		[19]	A
152	(±)-gomisin M_1	OMe	OMe	OH	OMe	OCH_2O			*α*-Me	*α*-Me		[38]	A
153	angeloylgomisin M_1	OMe	OMe	*β*-OAng	OMe	OCH_2O			*α*-Me	*α*-Me		[57]	B
154	(+) gomisin M_2	OMe	OMe	OMe	OH	OCH_2O			*α*-Me	*α*-Me		[51]	B

155	kadsuranin	OMe	OMe	OMe	OMe	OCH_2O			*α*-Me	*α*-Me		[57]	B
156	gomisin A	OCH_2O		OMe	OMe	OMe	OMe		*α*-Me, *β*-OH	*α*-Me		[38]	B
157	gomisin H	OMe	OMe	OH	OMe	OMe	OMe		*β*-Me, *α*-OH	*α*-Me		[51]	A
158	angeloylgomisin H	OMe	OMe	*β*-OAng	OMe	OMe	OMe		*α*-Me	*α*-Me		[38]	B
159	schizandrin	OMe	OMe	OMe	OMe	OMe	OMe		*α*-Me, *β*-OH	*α*-Me		[38]	B
160	(+)-deoxyschizandrin	OMe	OMe	OMe	OMe	OMe	OMe		*α*-Me	*α*-Me		[58]	B
161	schizanrin M	OCH_2O		OMe	OMe	OMe	OH	O	*α*-Me	*α*-Me		[59]	A
162	schizanrin N	OMe	OMe	OMe	OH	OCH_2O		O	*α*-Me	*α*-Me		[59]	A
163	schizanrin I	OCH_2O		OH	OMe	OMe	OMe	*β*-OBz	*β*-Me, *α*-OH	*α*-Me	*α*-OBz	[59]	A
164	schizanrin J	OCH_2O		OH	OMe	OMe	OMe	*β*-OAng	*β*-Me, *α*-OH	*α*-Me	*α*-OAng	[59]	A
165	schizanrin K	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAng	*β*-Me, *α*-OH	*α*-Me	O	[59]	A
166	schizanrin L	OMe	OMe	OMe	OMe	OMe	OMe		*α*-Me	*α*-Me	*α*-OBz	[59]	A
167	heteroclitin E	OCH_2O		OMe	OMe	OMe	OMe		*α*-Me	*α*-Me	*α*-OTig	[61]	A
168	renchangianin E	OH	OMe	OMe	OH	OMe	OMe	*β*-OBz	*β*-Me, *α*-OH	*α*-Me	*α*-OBz	[67]	A
169	longipedunin D	OH	OMe	OMe	OH	OMe	OMe	*β*-OBz	*β*-Me, *α*-OH	*α*-Me	*α*-OAc	[68]	A
170	longipedunin E	OH	OMe	OMe	OMe	OH	OMe	*β*-OBz	O	*α*-Me	*α*-OAng	[68]	A
171	kadangustin L	OCH_2O		OMe	OMe	OMe	OMe	*β*-OH	*α*-Me	*α*-Me	*α*-OH	[69]	A
172	deoxyschisandrin	OMe	OMe	OMe	OMe	OMe	OMe		*α*-Me	*α*-Me		[73]	B
173	heilaohuguosu A	OCH_2O		OMe	OMe	OMe	OMe		*β*-Me, *β*-OH	*α*-Me	*α*-OAng	[70]	A
174	heilaohuguosu B	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAng	*β*-Me, *α*-OH	*α*-Me	*α*-OH	[70]	A
175	heilaohuguosu C	OCH_2O		OMe	OH	OMe	OMe	*β*-OAng	*β*-Me	*α*-Me	*α*-OAc	[70]	A
176	heilaohuguosu D	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAng	*β*-Me	*α*-Me	*α*-methacrylate	[70]	A
177	heilaohuguosu E	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAng	*β*-Me	*α*-Me	*α*-OH	[70]	A
178	heilaohuguosu F	OCH_2O		OMe	OMe	OMe	OMe		*β*-Me	*α*-Me	*α*-OIsobut	[70]	A
179	heilaohuguosu G	OCH_2O		OMe	OMe	OMe	OMe		*β*-Me	*α*-Me	*α*-OBz	[70]	A
180	heilaohuguosu H	OMe	OMe	OMe	OCap	OMe	OMe	*α*-OAc	*α*-Me	*α*-Me	*α*-OH	[70]	A

181	heilaohuguosu I	OMe	OMe	OMe	OAng	OMe	OMe	*β*-OAc	*α*-Me	*β*-Me	*α*-OH	[70]	A
182	heilaohuguosu J	OMe	OMe	OMe	OH	OMe	OMe	*β*-OMe	*α*-Me	*α*-Me	*α*-OAc	[70]	A
183	heilaohuguosu K	OMe	OMe	OMe	OMe	OMe	OMe	*β*-OMe	*α*-Me	*α*-Me	*α*-OH	[70]	A
184	heilaohuguosu L	OMe	OMe	OMe	OMe	OMe	OMe	*β*-OAc	*α*-Me	*α*-Me	*α*-OH	[70]	A
185	heilaohuguosu M	OCH_2O		OMe	OH	OMe	OMe	*α*-OH	*α*-Me	*α*-Me		[70]	B
186	longipedunculatin D	OCH_2O		OMe	OH	OMe	OGlc		*α*-Me	*α*-Me	*α*-OH	[71]	A
187	longipedlignan K	OH	OMe	OMe	OMe	OMe	OH		*α*-Me	*α*-Me	*α*-OBz	[71]	B
188	kasuracin A	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAng	O	*α*-Me	*α*-OAc	[72]	A
189	angeloyl-binankadsurin A	OCH_2O		OMe	OH	OMe	OMe		*α*-Me	*α*-Me	*α*-OAng	[73]	A
190	angeloyl-binankadsurin B	OMe	OMe	OMe	OH	OMe	OMe		*α*-Me	*α*-Me	*α*-OAng	[73]	A
191	acetyl-binankadsurin A	OCH_2O		OMe	OH	OMe	OMe		*α*-Me	*α*-Me	*α*-OAc	[22]	A
192	xuetonlignan A	OCH_2O		OMe	OMe	OMe	OMe	*t*-Cin	*β*-Me, *α*-OH	*α*-Me	*α*-OMe	[80]	A
193	xuetonlignan B	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAc	*β*-Me, *α*-OH	*α*-Me	*α*-OMe	[80]	A
194	xuetonlignan C	OCH_2O		OMe	OH	OMe	OMe	*β*-OAng	*β*-Me, *α*-OH	*α*-Me	*α*-OH	[80]	A
195	kadsindutalignan A	OCH_2O		OMe	OMe	OMe	OMe	*β*-OAc	*β*-Me, *α*-OH	*α*-Me	*α*-OH	[81]	A
196	kadsindutalignan B	OCH_2O		OMe	OMe	OMe	OMe	*β*-OBz	*β*-Me, *α*-OH	*α*-Me	*α*-OAc	[81]	A
197	kadsindutalignan C	OH	OMe	OMe	OMe	OMe	OH		*α*-Me	*α*-Me	*α*-OH	[81]	A

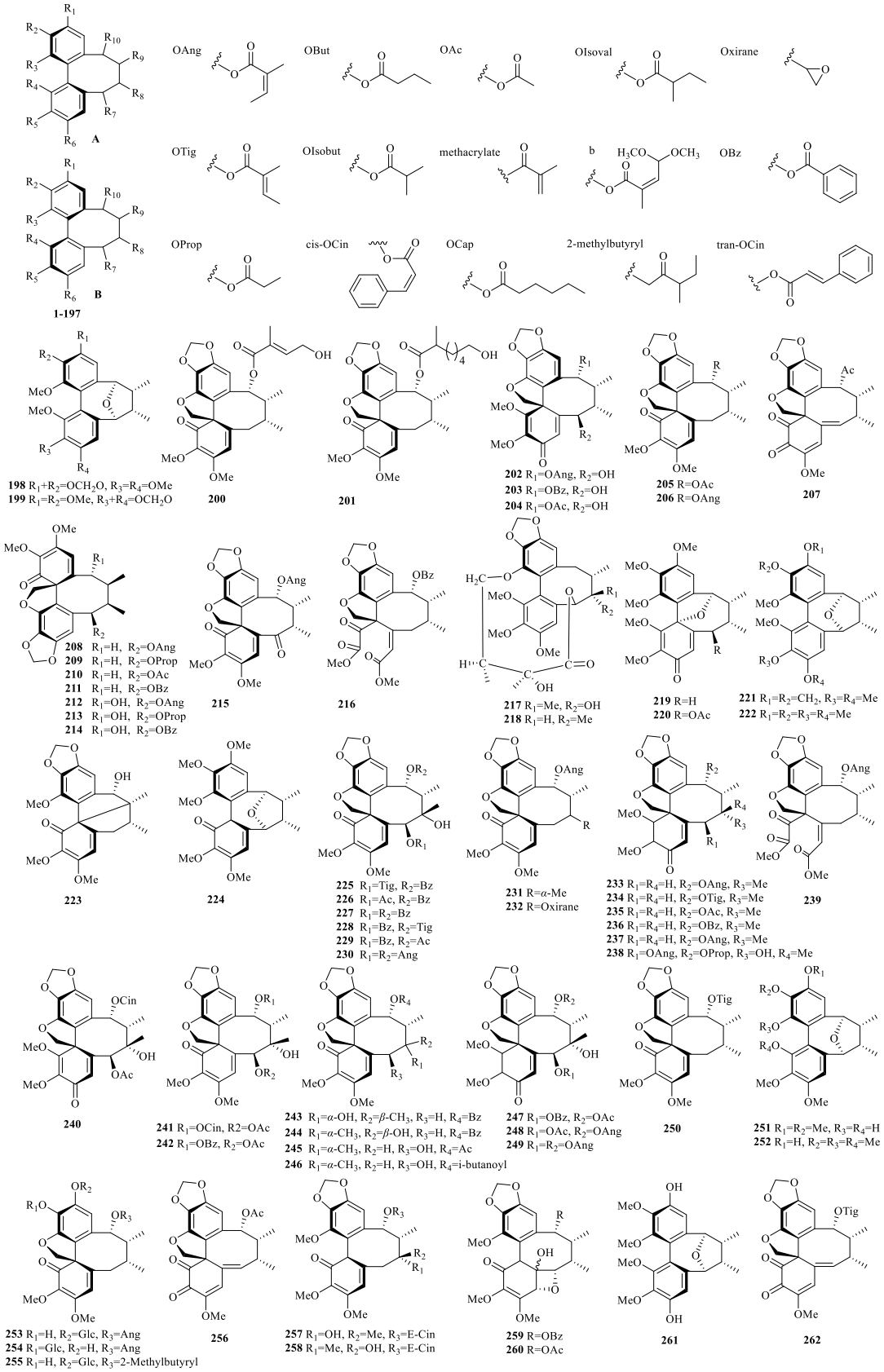

Figure 1. Structure of dibenzocyclooctadienes lignans in the genus *Kadsura*

5.2. Aryltetralins

Aryltetralins are formed by the cyclization of the C6 position in one phenylpropanoid unit with the C7 position of another phenylpropanoid. The common characteristic absorbing groups of this class of lignin are hydroxyl and carbonyl groups, etc. (Figure 2).

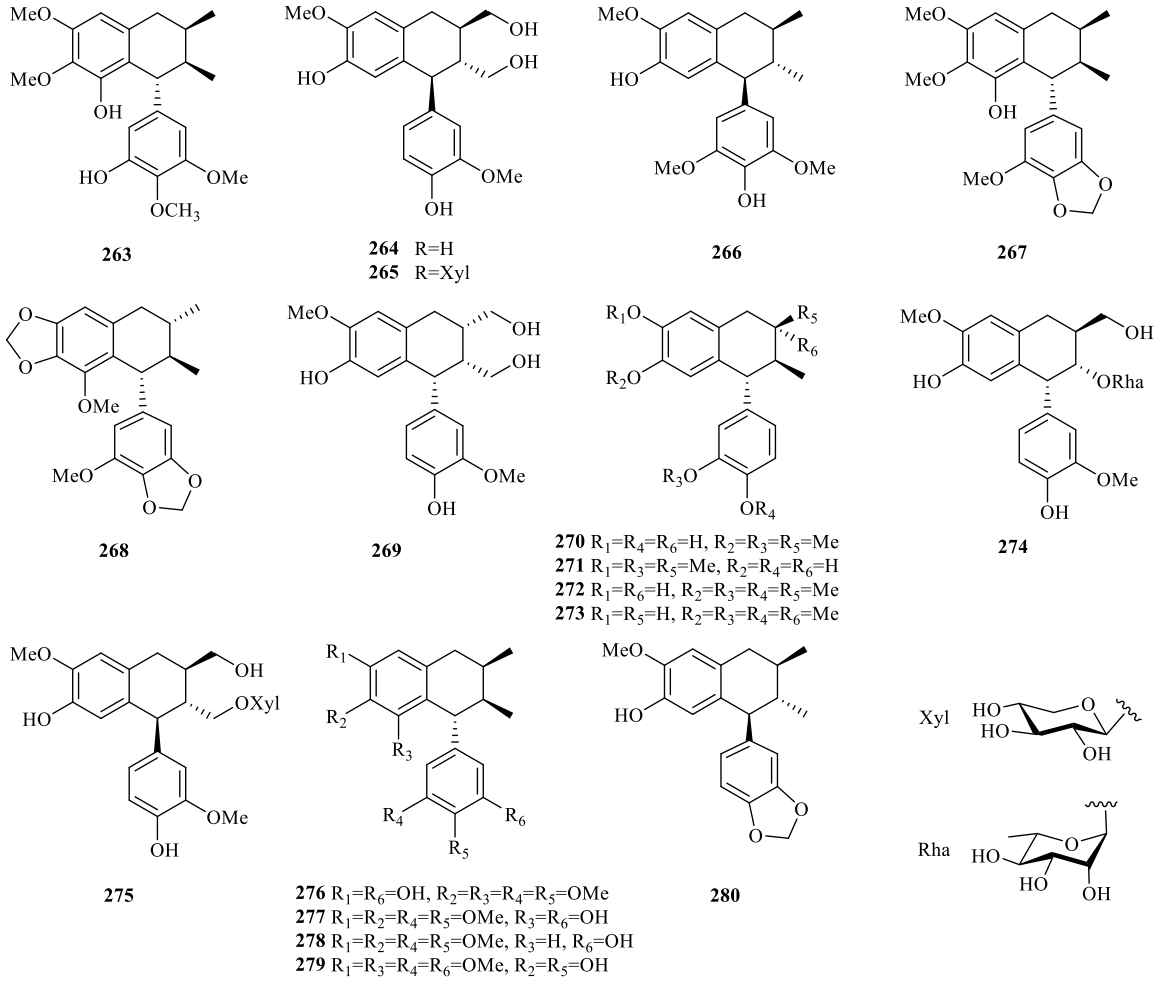

Figure 2. Structure of aryltetralins lignans in the genus *Kadsura*

5.3. Dibenzylbutanes

The conformation of this group of compounds (**86~97**) is feature by a borated methyl group or an exocyclic double bond at C-12, which are currently isolated only from plants such as *K. induta, K. coccinea* and *K. polysperma*, the specific structures of which are shown in Figure 3.

This group is characterized by the presence of tetrahydrofuran structures based on simple lignan, with 7-O-7', 9-O-9' or 7-O-9' types of structure being more common and the structures often having symmetry (Figure 3).

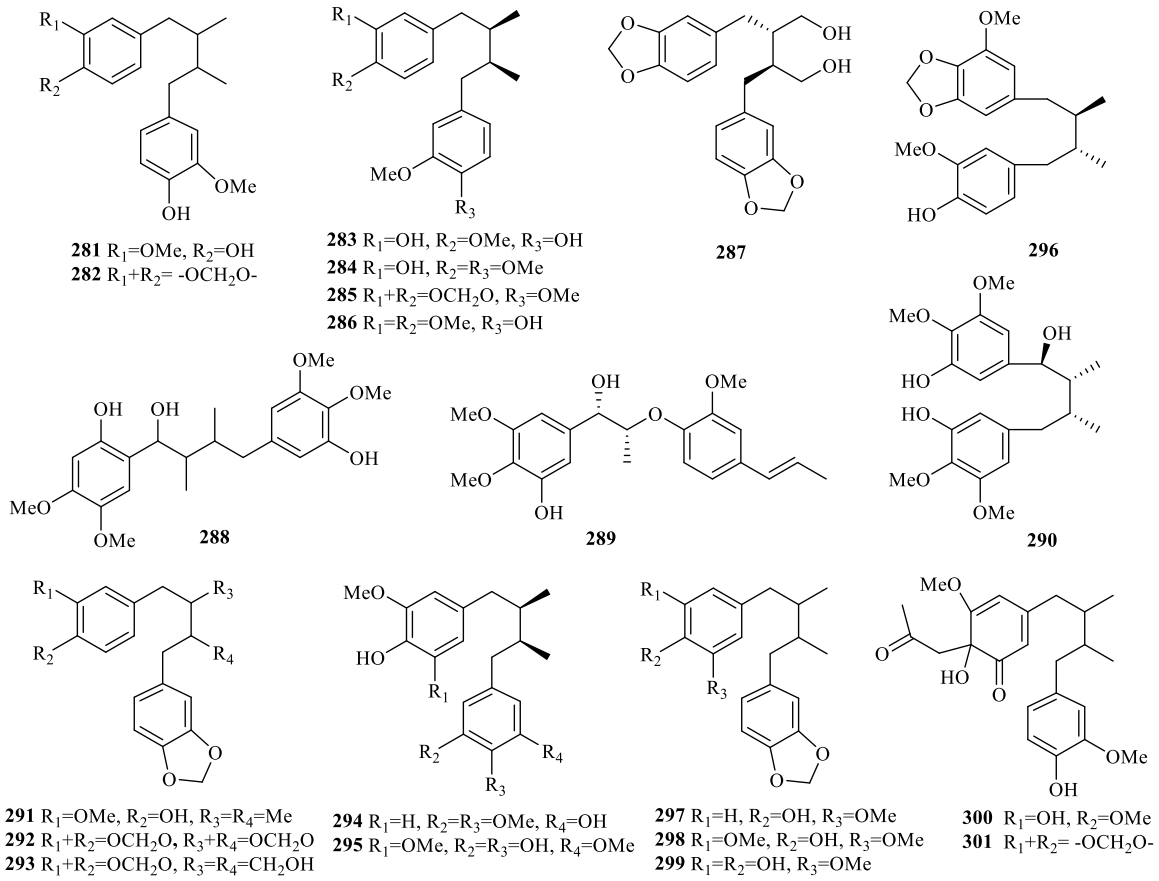

Figure 3. Structure of dibenzylbutanes lignans in the genus *Kadsura*

5.4. Monoepoxylignans

The compounds in this group (**98**~**124**) are formed by breaking C-13 and C-14 in the structure of lanostane-type triterpenoids and forming a new ring between C-12 and C-14, generated *via* Wagner-Milwyn rearrangement, as shown in Figure 4.

Monoepoxylignans is formed by linking two molecules of phenylpropanoid (Figure 4). In addition, this type of lignan is also a biogenic precursor for a number of other types of lignan.

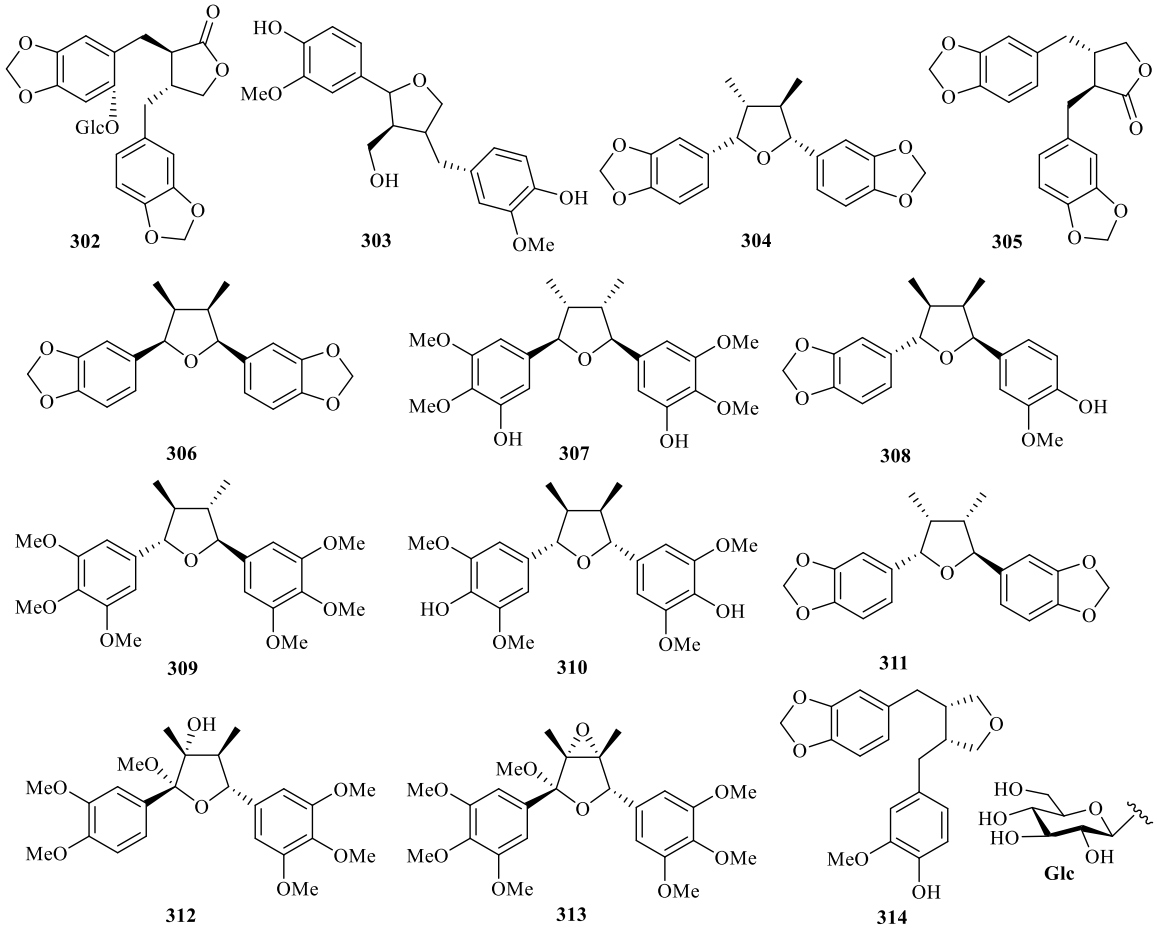

Figure 4. Structure of monoepoxylignans in the genus *Kadsura*

5.5. 7,8-seco-lignans

This group of compounds is derived from the oxidative cleavage of the C7, C8 bond of the aryl tetrahydrofuran lignan. See Table 1 and Figure 5 for specific structures and names.

5.6. Bisepoxylignans

The bisepoxylignans are also formed by the interconnection of two groups of phenylpropanoids, in most cases with a skeleton of four chiral carbon spin isomers (Figure 5). Due to the symmetry of the structure, the hydrogen and carbon spectra often show overlapping signals.

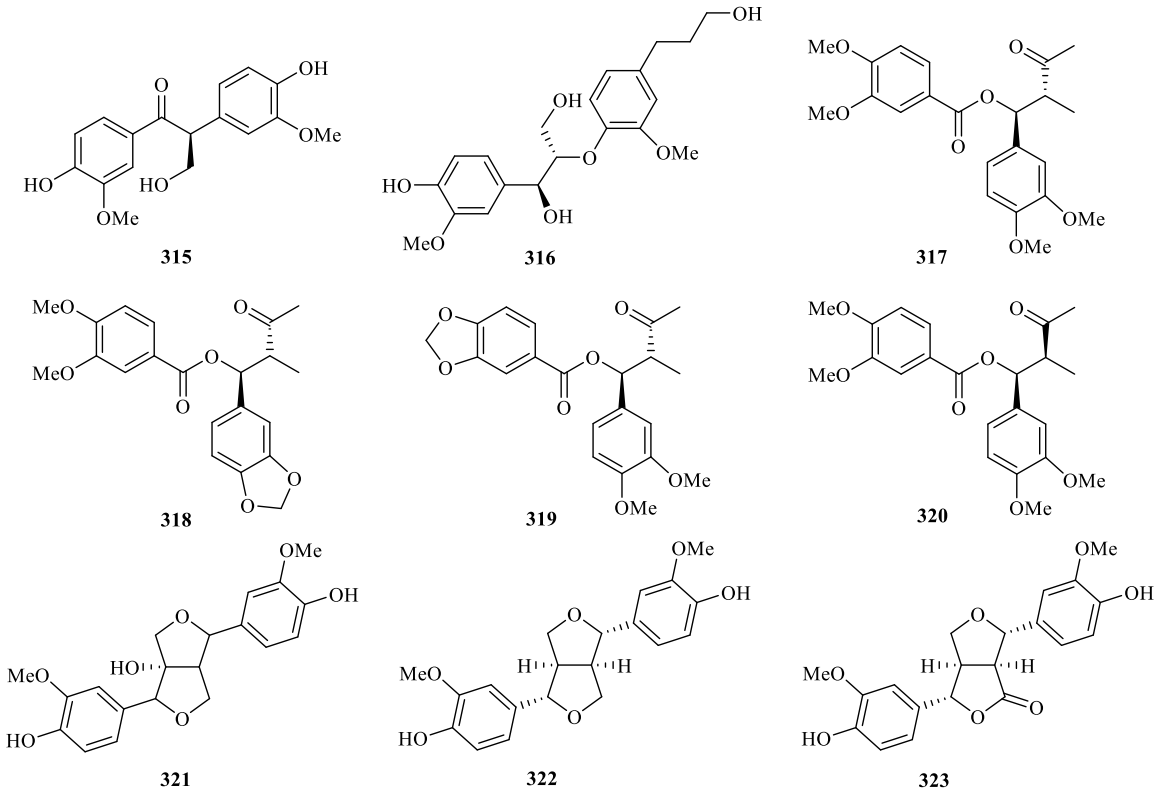

Figure 5. Structure of 7,8-seco-lignans and bisepoxylignans in the genus *Kadsura*

5.7. Neolignans

It is formed from two phenylpropanoids linked by side chains, in addition, neolignans can also be C6-C3 monomers consisting of two monomers linked as oxygen bonds via an oxyether bond (Figure 6).

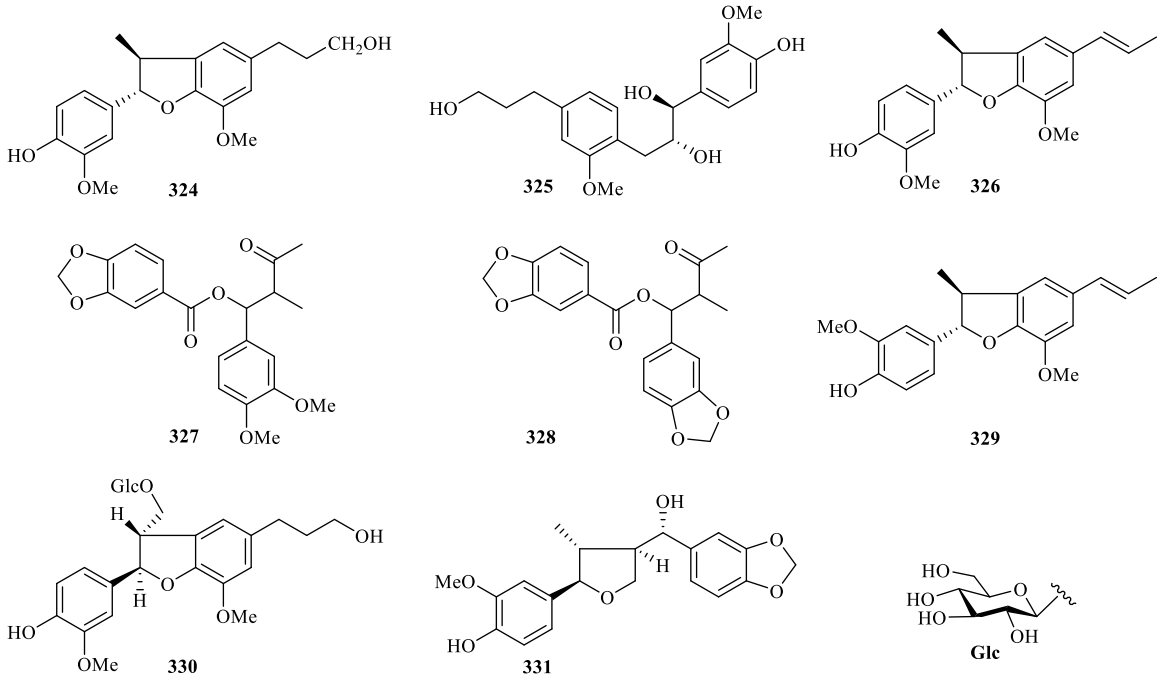

Figure 6. Structure of neolignans in the genus *Kadsura*

5.8. Seco-dibenzocyclooctadienes

Qi et al. [79] isolated four structurally novel seco-dibenzocycloctadiene lignans from the roots of *K. longipedunculata* and elucidated their structures by wave spectroscopy techniques (Figure 7).

5.9. Sesquilignan

Guo et al. [82] isolated a sesquilignan (pinobatol) with a spirodienone structure from *K. longipedunculata* (Figure 7), and it was reported that only one sesquilignan with a helical skeleton has been reported to date.

5.10. Coumarin-containing lignan

Compound 337 with a unique coumarin-contain lignan skeleton which was isolated from stems of K. heteroclita (Figure 7).

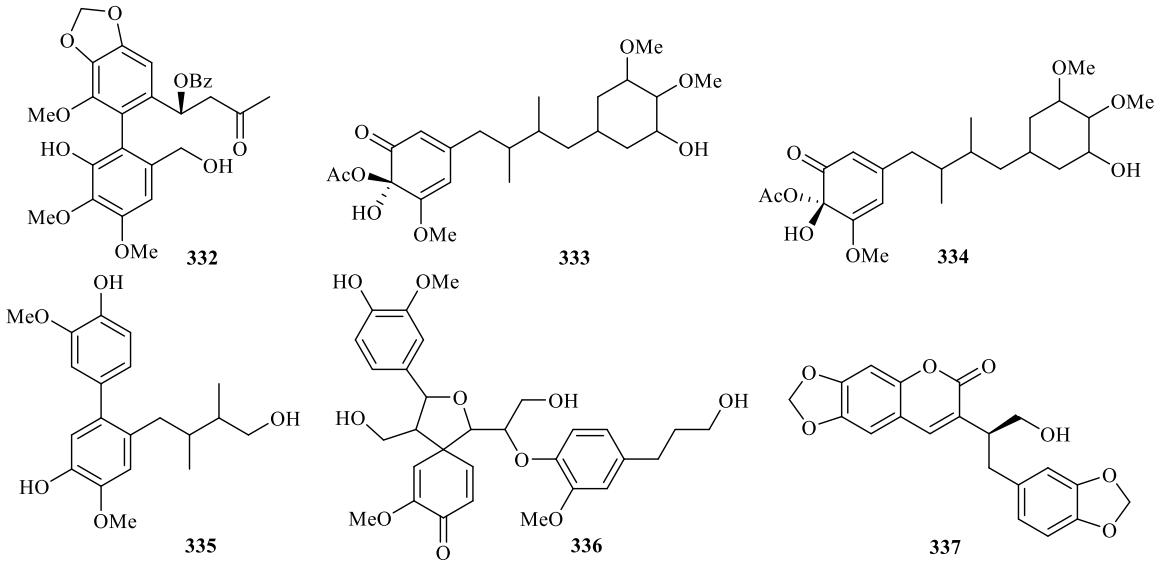

Figure 7. Structure of dibenzocyclooctadienes, sesquilignans and coumarin-containing lignan in the genus *Kadsura*

6. Pharmacological activities

6.1. Hepatoprotective and Anti-inflammation Activity

Oh et al. [84] found that gomisin J, gomisin N and schisandrin C were able to reduce nitric oxide (NO) production in LPS-stimulated Raw 264.7 cells. All three lignans had a low cytotoxic effect on Raw 264.7 cells. Pretreatment of Raw 264.7 cells with gomisin J, gomisin N and schisandrin C reduced mRNA expression and secretion of pro-inflammatory cytokines. These inhibitory effects were induced by blocking p38 mitogen-activated protein kinase (MAPK), extracellular signal-regulated kinase 1 and 2 (ERK 1/2), and c-Jun N-terminal kinase (JNK) phosphorylation for the prevention of inflammation. The researchers isolated two new dibenzocyclooctane lignans kadsurindutin A and B, and known lignans schisantherin L, schisantherin P, kadsulignan L and neokadsuranin from *K. induta* stems and tested these six compounds for the anti-HBV activity of these six compounds was tested in vitro. The compounds

kadsurindutin A, kadsulignan L and neokadsuranin were found to have in vitro antiviral effects against hepatitis B virus. The compounds kadsulignan L and neokadsuranin (concentration 0.1 mg/ml) are known to have some antiviral activity with inhibition of HBsAg and HBeAg of 32.6 and 36.5%, 14.5 and 20.2%, respectively. Compound kadsurindutin A at 0.2 mg/ml concentration showed HBsAg and HBeAg effects of 35.4 and 15.4%, respectively [25]. The compounds longipedlignan F and schiarisanrin B were found to have moderate hepatoprotective activity against N-acetaminophen-induced HepG2 cells using the hepatoprotective drug dicyclanol as a positive control. Cell survival was 52.2% and 50.2% at a concentration of 10 μM (49.0% with dicyclomine), respectively [26]. In addition, longipedlignan M was found to have similar hepatoprotective activity, with a cell survival rate of 50.8% at a concentration of 10 μM [71].

The potential anti-RA activity of four compounds, heilaohusus A-D, isolated from *K. coccinea*, was measured on RA-FLS cells. It was found that heilaohusu A had potential anti-RA activity on RA-FLS cells with an IC50 value of 14.57 μM [34]. Jia et al. [70] examined the cellular activity of the isolated compounds heilaohuguosus A-N and showed that heilaohuguosu A and heilaohuguosu L had good hepatoprotective activity against APAP-induced HepG-2 cells, with 10 μM cell survival rates of 53.5 ± 1.7% and 55.2 ± 1.2%, respectively (positive control, dicyclomine, 52.1±1.3%). Huang et al. [73] found that only angeloyl-binankadsurin A, angeloyl-binankadsurin B and acetyl-binankadsurin A had anti-HBV activity during the screening of anti-HBV active substances. Among them, angeloyl-binankadsurin A showed the strongest activity with 51.85% inhibition of HBeAg and an IC50 of 48.0 ug/mL. By comparing their structural features, the hydroxyl group at the 1 position may be the key group for the anti-HBV activity of these compounds. Liu et al. [86] reported the effects of *K. longipedunculata* on serum indices in mice with acute liver injury caused by D-GalN. The results pointed out that ALT and AST activities were significantly lower in the *K. longipedunculat* high-dose group compared with the model group, indicating that the drug group had a protective effect on D-GalN-induced liver injury. Moreover, it was also found that all dose groups of *K. heteroclita* alcohol extract reduced AST and ALT activity in rat serum, alleviated CCI4-induced liver histopathological changes, and significantly increased GSH content in liver homogenate while reducing liver coefficients, indicating its protective effect on CCI4-induced acute liver injury, and it is speculated that its anti-liver injury mechanism may be related to enhancing the ability of rats to scavenge free radicals [87].

6.2. Anticancer Activity

Huang et al. [20] isolated four new dibenzocyclooctadiene lignans from *K. oblongifolia* and performed in vitro toxicity assays on these four compounds to evaluate the cytotoxic activity against tumors including A549, DU145, KB and HCT-8. Kadsufolin D exhibited strong cytotoxic activity against A549 and HCT-8 The GI50 values were 5.1 mg/ml and 5.7 mg/ml, respectively, while kadsufolin A showed only weak cytotoxic activity against these cell lines, with GI50 values ranging from (10.55-20.0) mg/ml. Wang and co-workers investigated a series of lignans from *K. interior*, initially using short-term in vitro experiments on EBV-EA activation, to observe the inhibitory effect of these compounds on TPA-induced EBV-EA activation and the associated viability of Raji cells. The results showed that all compounds had an inhibitory effect on EBV-EA activation but no cytotoxic effect on Raji cells. The experimental data suggest that neokadsuranin and schisandrin C may be potentially valuable antitumor promoters [19].

Shehla et al. [35] performed a systematic isolation of *K. heteroclita* and evaluated the cytotoxic

effects of these compounds. It was learned that only (+)-1-hydroxy-2,6-*bis*-*epi*-pinoresinol was cytotoxic against human gastric cancer cells (BGC-823) and human cervical cancer cell line (HeLa) with IC50 values of 11.0 and 23.8 μM, respectively, compared to the positive control paclitaxel. It was shown that Heilaohulignan C prevented the development of BGC-823 cells in vitro and induced apoptosis through the P53 and mitochondrial apoptotic pathways, while Bax was upregulated and cleaved caspase-3 and p53, thus blocking the p53 and mitochondrial apoptotic pathways. In addition, the movement of BGC-823 cells was prevented. Indicates that the compound has a potential natural compound for the treatment of human gastric cancer [88-89]. In vitro studies have shown that schizandrin A exhibits some inhibitory effects on a variety of tumor cells, and it is speculated that the mechanism may be related to the inhibition of heat shock factor 1 activation, inhibition of NF-κB, PI3K/AKT pathway [90]. Zhang et al. [91] found that schisandrin B could inhibit the growth and metastasis of liver cancer, gallbladder cancer, melanoma, prostate cancer and glioma by regulating the Trfa/TAK1, MAPK and Wnt/β-catenin signaling pathways, blocking cell cycle, inducing apoptosis, preventing tumor cell invasion and metastasis, inhibiting tumor angiogenesis and promoting oxygen free radical scavenging. Furthermore, schisandrin B inhibits the expression of drug resistance-associated proteins, reduces drug efflux and enhances the sensitivity of anti-tumor drugs [92]. In vitro studies have shown that heteroclitin D can promote apoptosis and inhibit the growth of gastric cancer cells, as well as effectively down-regulate the levels of chemokines such as chemokine IL-8 and intercellular adhesion factor ICAM-1 in the serum of gastric cancer nude mice [93-94]. Xu et al [95] performed in vitro cellular assays on compounds isolated from *K. heteroclita* and showed that longipedlactones A and F significantly inhibited the proliferation of human hepatocellular carcinoma HepG2 cells and Bel-7402 cells.

Chen et al. [19] isolated 14 lignans from the vine stems of *K. interior* and screened them for their ability to inhibit Epstein-Barr virus early antigens, with neokadsuranin and schisandrin C showing stronger antitumour-promoting effects. The results suggest that such lignans may be used as antitumour promoters. Tan et al. [96] studied the inhibitory effect of ethanolic extract of *K. longipedunculata* on four tumor cells (human colorectal cancer cells LOVO, human breast cancer cells MCF-7, human liver cancer cells HepG2, mouse melanoma cells B16). The inhibition rate increased with increasing concentration of the drug, and the inhibitory effect was dose dependent. Liu et al. [97] screened the compounds isolated from *K. oblongifolia* for antitumor activity, among which schizanrin B showed significant inhibitory activity against colorectal cancer HCT-15 and oral epithelial cancer KB-3-1 tumor strains.

6.3. Anti-HIV

Chen et al. [98] evaluated lignans isolated from *K. interior* for anti-HIV viral activity. The results showed that interiotherin A and schisantherin D had a strong inhibitory effect on HIV [29]. Subsequently, in further experiments, gomisin G was also found to have strong anti-HIV activity, which is a highly valuable anti-HIV natural product and lead compound. Pu et al. [99] found that kadsurin and heteroclitin F showed weak anti-HIV activity and interiorin and interiorin B showed moderate anti-HIV activity by anti-HIV assay analysis. Sun et al. [100] screened the anti-HIV activity of longipedunins A-C and the data showed that longipedunin A had stronger inhibitory activity against HIV-1 protease than the other compounds. A study has shown that lignans from *K.coccinea* have an inhibitory effect on the reverse transcription of HIV-1 [101]. In addition, some scholars have applied HIV protease (HIVPR) to screen them for preliminary anti-HIV activity and

found that *K. longipedunculata* showed some anti-HIV activity [102]. Liu et al. [103] showed that kadsulignan M had significant anti-HIV activity.

6.4. Antioxidant Activity

Modern pharmacological studies have found that some lignans have significant protective effects on tissue models of oxidative stress injury both in vivo and in vitro. The researchers investigated the antioxidant capacity of anthocyanins and polyphenols extracted from *K. coccinea* fruit using the DPPH method. The results showed that the total polyphenol extract from the peel of the fruit had better antioxidant capacity compared to the pigment extract and the pulp polyphenol extract [104]. Lin et al. [105] found that the antioxidant capacity of ethanolic extracts from different parts of *K. longipedunculata* was in the following order: old roots, young roots, old stems, young stems and leaves. The morphology showed a decreasing trend from bottom to top. Scholars found that the combination of *K. coccinea* extract with cyclodextrins enhanced its antioxidant effect and also enhanced its thermal stability [106]. During the study of *K. interior*, gomisin J was found to have a significant anti-lipid peroxidation effect. It was reported that gomisin J had a significant inhibitory effect on calcium overload and other induced lipid peroxidation in liver mitochondria and oxidative modification of LDL induced by copper ions and endothelial cells, as well as a scavenging effect on superoxide anion radicals [107]. In addition, experiments by Gu et al. [108] showed that gomisin J has a stronger scavenging effect on hydroxyl radicals. Studies have reported that the active ingredients of *K. heteroclita* (Da Hong Zuan) significantly reduced the production of lipid peroxidation products in mouse liver, restored superoxide dismutase (SOD) activity and induced oxygen radical scavenging by liver enzymes [109].

Wu et al. [110-111] explored the scavenging ability and antioxidant effect of different solvent extracts of *K. longipedunculata* on oxygen radicals and found that its ethanolic extract had the strongest scavenging ability on DPPH, and it was hypothesized that the stronger the extract solvent polarity, the higher the scavenging rate on DPPH. The heteroclitins F-G extracted from *K. heteroclita* significantly restored SOD activity and induced oxygen radical scavenging by liver enzymes [112]. Ai et al. [113] used modern pharmacological methods to study the pharmacological activity of *K. coccinea* and found that its active ingredients significantly reduced the production of lipid peroxidation products such as thio barbituric reactive substances in the liver of mice and induced liver enzymes to scavenge oxygen free radicals. Additionally, Yan et al. [114] examined the free radical scavenging effect of compounds in *K. coccinea* in vitro. The results revealed that the ethyl acetate extracted part of its ethanolic extract had in vitro antioxidant effects. The ethanolic extract of *K. longipedunculata* significantly inhibited the degree of autoxidation and hydrogen peroxide-induced erythrocyte hemolysis in rat liver homogenates in vitro and showed significant antioxidant activity [115].

6.5. Anti-platelet Aggregation

Jiang et al. [116-117] investigated the effects of heteroclitin D and (+)-anwulignan on platelet aggregation and improvement of blood microcirculation. The study showed that as the concentration of heteroclitin D increased, its inhibitory effect on ADP-induced platelet aggregation became more pronounced and the inhibitory effect was comparable to that of aspirin. It also has the effect of shortening the time to maximum platelet aggregation induced by ADP. (+)-anwulignan had an inhibitory effect on ADP and PAF-induced platelet aggregation but had no significant effect on the

time to aggregation. It was found that tigloylgomisin B, angeloylgomisin P and R-(+)-gomisin M1 all had competitive antagonistic effects on platelet activating factors [38]. Li et al. [118] studied the effects of gomisin J and heteroclitin D on vasoconstriction caused by hyperkalemic depolarization contractions, CaCl2 and norepinephrine through pharmacological experiments. The data show that both of them act similarly to verapamil, inhibiting the vasoconstriction caused by high potassium depolarization, CaCl2 and norepinephrine, and have a stronger inhibitory effect on CaCl2-induced vasoconstriction. Studies have shown that aqueous extracts of the Yao medicine Da Zuan (*K. coccinea*) have a significant inhibitory effect on thrombosis in mice. Compared with the model group, the aqueous extract of *K. coccinea* significantly prolonged the bleeding time of tail breakage and reduced the extent of carrageenan-induced black tail in mice [119-120]. In addition, isovaleroylbinankadsurin A and acetylbinankadsurin A have also been reported to have an inhibitory effect on platelet aggregation [121].

6.6. Cardiovascular Protective Effect

It was found that isovaleroylbinankadsurin A could directly agonize the glucocorticoid receptor, activate the RISK signaling pathway, inhibit oxidative stress and apoptosis, and improve myocardial ischemia-reperfusion injury [122]. Ye et al. [123] investigated the vasodilatory activity of gomisin J through pharmacological experiments and found that gomisin J could inhibit angiotensin II-induced hypertension in mice. In Furthermore, Park et al. [124] speculated that the vasodilating effect of gomisin J might be through the promotion of endothelial nitric oxide synthase activation and AKT phosphorylation to promote NO (nitric oxide) production. Zhou et al. [125] found Schizandrin A to be effective against cerebral ischemia-reperfusion injury. Xu et al. [126] treated *K. interior* and found that its ethanolic extract significantly increased hematocrit, hemoglobin and red blood cell levels, as well as serum levels of interleukin 3 and macrophage-stimulating factor, demonstrating its good homotonic efficacy. According to the literature, *K. coccinea* seeds contain 17 amino acids required by the human body, as well as three functional amino acids, namely glutamic acid, arginine and proline, and therefore have cardiovascular disease prevention and immunomodulatory effects [127]. Schisandrin B and schisandrin C can regulate keap/Nrf2, AMPK signaling and ATR, TGF-β/Smad signaling pathways. Reduce oxidative stress and apoptosis, improve Ang-II-induced myocardial remodeling and prevent oxidative damage in the heart in mice [128-130].

6.7. Antibacterial Activity

In the course of their study on K. coccinea, Duan et al. [131] found that neglectalignan D, yunnankadsurin B and arisantetralone B inhibited Staphylococcus aureus, with arisantetralone B also exhibiting an inhibitory effect on Escherichia coli. Shi and Li [132] studied the antibacterial activity of *K. coccinea* fruit peel and found that it had strong antibacterial activity against Salmonella typhi and strong stability of the inhibitory component. Research shows that, both the ethanolic extract and the aqueous extract of *K. longipedunculata* inhibited Escherichia coli, Staphylococcus aureus and Salmonella typhi. The antibacterial effect of the ethanolic extract was slightly stronger than that of the aqueous extract [133]. In subsequent experiments, the ethanol extract of *K. longipedunculata* was found to have the strongest inhibitory effect on Salmonella when the pH was acidic or normal and had good thermal stability [134]. Another study showed that the inhibitory activity of *K. longipedunculata* extracts treated with Fe3+ and Fe2+ was significantly

increased [135]. Furthermore, Zhao et al. [136] found that *K. longipedunculata* extracts showed stronger antibacterial activity under weakly acidic conditions. According to Aldo and Miyazawa's experiments, t extracts of *K. longipedunculata* showed good inhibitory effects on Mycobacterium tuberculosis H37Rv and Salmonella typhi [137-138].

6.8. Lipid-regulating and Anti-diabetic Effects

Pharmacological studies have shown that *K. coccinea* fruit can significantly reduce cholesterol levels in mice and delay the synthesis or accelerate the breakdown of blood lipids in mice [139]. Gomisin M1 has been reported to be effective in scavenging DPPH, ABTs free radicals and inhibiting the synthesis of glycosylation end products, thereby reducing the risk of cardiovascular disease in patients [140]. Hsu et al. [141] showed that schiarisanrin A and schiarisanrin B have insulin-promoting effects and that the mechanism may be related to the inhibition of apoptosis in rat pancreatic BRIN-BD11 cells and that there is a dose-dependent protective effect.

6.9. Immunomodulation

The results of Li et al. [142] showed that anwulignan has immunomodulatory functions, inhibiting the inflammatory response and increasing the levels of immunoglobulins IgG, IgM and lgA in mice by regulating the Nrf2/HO^{-1} signaling pathway. It also regulates the expression of calpain I and Bax in splenocytes and reduces lymphocyte death. Liu et al. [143] conducted a preliminary study on the anti-immune liver fibrosis of *K. coccinea* alcohol extract and its mechanism of action. The results showed that the serum levels of PCIII, IV-C, LN and HA were significantly increased in rats, suggesting that it has the effect of reducing the degree of liver fibrosis in rats. It also significantly increased the serum TGF-β1 and TNF-α levels in rats and had a regulatory effect on cytokines. Wang et al. [144] reported that the fruits of *K. japonica* have a wide range of immunomodulatory effects and can significantly promote the proliferation of T lymphocytes and the production of ND antibodies in normal chickens, enhancing the body's immune function and keeping the body's antibody level at a high level.

6.10. Neuroprotective Effects

Reports indicate that *K. heteroclita* extract promotes the growth and development of hippocampal neurons and has some anti-aging effects on neuronal cells. The coumarinlignan extract from *K. heteroclita* has also been reported to have a neuroprotective effect [145-146]. Zhou et al. [147] showed that schisandrin could reduce neurological deficits caused by ischemic brain injury in mice by modulating the expression of small soluble α-synuclein in the presynaptic membrane of the central nervous system. It can also prevent cognitive impairment caused by ischemia-reperfusion injury in the central nervous system and improve the learning and memory ability [148-149]. Yang et al. [30] demonstrated that ananolignan F and ananolignan L, isolated from *K. ananosma*, had significant neuroprotective effects through in vitro experiments. It was reported that polysperlignans A、B、D and F showed significant neuroprotective effects in these in vitro assays[21].

6.11. Insecticidal Effect

Jiang [150] found that the lignans (-)-machilusin and schisantherin D had strong insecticidal activity against plutella xylostella with a 99% mortality rate of the pest, which warrants further study. During the screening process for insecticidal herbs, *K. longipedunculata* and *K. heteroclita*

were found to have strong insecticidal activity and the potential to be natural insecticides [151-152]. In addition, schisandrol A and schisandrin B have also been reported to have insecticidal effects [153].

6.12. Others

The ethanol extract of *K. longipedunculata* effectively inhibited gastric mucosal damage induced by hydrochloric acid-ethanol solution and cold-water immersion in rats and reduced diarrhea symptoms [151]. In another study, its ethanolic extract showed better protection against pyloric ligation ulcer model in rats [154]. Anwulignan has a fatigue-relieving effect by regulating Nrf2 and p38/MAPK-PGC-1α signaling pathways, preventing apoptosis, improving biochemical indicators related to fatigue and increasing endurance in mice [155]. The pharmacological effects of the monomeric compounds of this genus are detailed in Table 4.

Table 4. Pharmacological Activities of *Kadsura*

Pharmacological Action	Effective Fraction/ Compounds	Model	Dose or Critical Assessment	Target or Possible Mechanism	Ref
Hepatoprotective and Anti-inflammation	gomisin J gomisin N schisandrin C	Raw 264.7 cells	low activity positive control (dexamethasone)	Inhibiting NO	[84]
	kadsulignan L neokadsuranin kadsurindutins A	in vitro/HepG2 cells	inhibited HBsAg secretion by more than 32.6%	CYP2E1, CPY1A2 and CYP3A11↓	[25]
	gomisin G	APAP-induced toxicity in HepG2 cells	Inhibition of 76.3%	Regulation of YAP1, Bcl-2, Bax and other proteins expression	[26]
	longipedlignan F		Inhibition of 52.2%		
	schiarisanrin B		Inhibition of 50.2% positive control bicyclol (49.0%)		
	longipedlignan M		Inhibition of 52.2%	Regulation of YAP1, Bcl-2, Bax expression	[71]
	heilaohusu A	RA-FLS cell line	14.57 μM	SSH1L/Cofilin-1 signaling pathway	[34]
	angeloy-lbinankadsurin A		11.70 μM (positive control indomethacin IC_{50}=4.10)		
	heilaohuguosu A	APAP-induced toxicity in HepG2 cells	Inhibition of 53.5±1.7%	Reduces ALT, AST levels and inhibits ROS	[70]
	heilaohuguosu L		Inhibition of 55.2±1.2% positive control bicyclol (52.1±1.3%, 10 μM)		
	gomisin C		3.77 μmol/L		[156]

	kadsurin heterolitin D interiorin angeloyl-binankadsurina A	Rat liver microsomes	6.18 μmol/L 20.67 μmol/L 16.43 μmol/L 23.07 μmol/L	Inhibits CYP3A1/2 activity	
	gomisin O	Raw 264.7 cells	0.5, 2.5, 12.5mg/L (Significant activity)	TNF-α, IL-6, IL-1β	[157]
	deoxyschisandrin	LPS-induced RAW264.7 cells	50 μmol/L	TLR4/NF-κB, MAPK, NLRP3	[158]
	(+)-anwulignan	RAW 264.7 cells	IC_{50} = 1.00 μM	COX-2	[159]
	kadsuralignan C	LPS-induced RAW264.7 cells	IC_{50} = 21.2 μM IC_{50} = 19.6 μM	Inhibiting NO	[160]
	meso-dihydroguaiaretic acid	RAW264.7 murine macrophage cell lines	1 mg/kg	LXR-α	[161]
	Isovaleroylbinan-kadsurin A binankadsurin A acetylepigomisin R	Hydrogen peroxide-induced hepatocyte injury	EC_{50} = 26.1 EC_{50} = 26.1 EC_{50} = 79.3	lactate dehydrogenase (LDH)	[70]
Anti-cancer	heteroclitin D	SGC-7901 cells	1.25, 2.5, 5, 10mg/L	Caspase3, Bax, P53, Bcl-2	[162]
	heilaohusu C neglignan G angeloylbinankadsurin A	HepG-2, HCT-116, BGC-823 and Hela cell line	13.04 to 21.93 μm	Regulation of bcl-2, bax protein	[34]
	gomisin M2	MCF10A cell line MDA-MB-231 cell line HCC1806 cell line Hela cell line	IC_{50} = 85 μM IC_{50} = 60 μM IC_{50} = 57 μM IC_{50} = 30.0 μM	Wnt/β-catenin	[89]
	meso-dihydroguaiaretic acid	HepG 2 cell line MCF-7 cell line H358 cell line	IC_{50} = 15.1 μM IC_{50} = 16.9 μM IC_{50} = 10.1 μM	Src/EGFR/intergrin β3	[161]

	anwulignan	A549, H1299, H1650 and H1975 cells	Not mentioned	JAK1/STAT3, cyclin D1/3	[162]
	neokadsuranin schisandrin C	Raji cells	Survival rate 92.6 ± 0.4% Survival rate 92.1 ± 0.4%	EBV-EA activation	[19]
	heilaohusu C	BGC-823 cell line HCT-116 cell line HeLa cell line	IC_{50} = 16 ± 0.38 μM IC_{50} = 16.59 ± 0.51 μM IC_{50} = 22 ± 0.65 μM	p53 apoptotic pathway BAX, Bcl-2	[88]
	schisandrin A	HCC827/GR and HCC827 cells	IC_{50} = 0.558, 14.62	IKKβ/NF-κB signal pathway, IKKβ and IκB phosphorylation	[90]
	schisandrin B	SW116 cells	apoptosis rate of 14.5-39.8%	BAX, Bcl-2	[164]
Anti-oxidative	gomisin J	SD rats	IC_{50} = 0.95(0.14～6.54) μmol/L	Fe^{2+}-Vit C, ADP/NADPH	[107]
	isolariciresinol (+)-1-hydroxy-2,6-bis-epi-pinoresinol (+)-laricresinol evofolin B pinobatol	human whole blood neutrophils	IC_{50} = 36.38 μM IC_{50} = 34.41 μM IC_{50} = 35.97 μM IC_{50} = 33.65 μM	ROS	[35]
	Matairesinol 4′-O-glucoside (-)-secoisolariciresinol-O-a-L-rhamnopyranoside (-)-secoisolariciresinol 9-O-α-L-arabinopyranoside (-)-Catechin isorhamnetin-3-O-β-D-glucoside	UMR106 cells	IC_{50} = 3.84-14.43 μg/ml	against ABTS free radicals	[165]
Anti-HIV	longipedunin A longipedunin B longipedunin C	T cell line	Inhibition rate of 47.3%-77.8%	Inhibition of HIV-1 protease	[100]
	kadsuranin gomisin J schisandrin C	H9 T cell line	EC_{50} = 0.006~1.5 μg/mL	HIV-1 RT, RNaseH	[98]

	gomisin G (+)-deoxyschizandrin interiorin interiorin B	C8166 cells	EC_{50} = 1.6, 1.4 lg/mL	αα'ββ'-dienone	[99]
Anti-platelet aggregation	heteroclitin D schisanhenol	New Zealand white rabbits (ADP- and PAF-induced platelet aggregation)	(ADP-) Inhibition of 36.35%, 19.57% (PAF-) Inhibition of 17.55%, 18.44%	TXA-2, blocking L-type calcium channels	[116]
	isovaleroyl-binankadsurin A acetyl-binankadsurin A	diabetic rabbits	Inhibition of 16.64%, 21.96%	Inhibition of platelet aggregation	[121]
Cardiovascular protection	Isovaleroylbinan-kadsurin A	H9c2 cells	mitochondrial dysfunction increased from 12.4% to 80.3%	Bcl-2, BAX	[122]
	gomisin J	Male C57BL/6 mice	the vasodilatory effect of GJ was 99 ± 12 μM	NO, eNOS, ROS	[123]
	schizandrin A	C57BL/6J mice	50 or 100 mg/kg	AMPK/Nrf2 pathway, Bcl-2, BAX	[125]
	schisandrin B	male sprague dawley rats	25 and 50 mg/kg	NO, cyclooxygenase-2, IL-1β, IL-6, tumor necrosis factor α	[129]
	schisandrin C	C57BL/6 mice	48.59 ± 2.301%	Nrf2, ROS, HO-1, NQO-1	[130]
	meso-dihydroguaiaretic acid	PDGF-BB	186.07 ± 111.7~3864.17 ± 346.5 at 1~20 μM	ERK1/2, p38, JNK, PDGFR β	[166]
Antibacterial	neglectalignan D yunnankadsurin B arisantetralone B	Staphylococcus aureus and escherichia coli	antibacterial ring diameter of 7.83 ± 0.13 to 10.25 ± 0.11 mm	Disruption of bacterial cell membranes	[131]
	meso-dihydroguaiaretic acid schisandrin	Salmonella typhimurium	ID_{50} = 0.08 μmol/ml	TA1535/ pSK1002	[137]
	schisandrin B	Escherichia coli, Aspergillus niger	minimum inhibitory concentration: E. coli (0.0625 g/mL ~ 0.125 g/mL), A. niger (0.125 g/mL ~ 0.25 g/mL)	Free radical scavenging effect	[167]

Anti-diabetic	tigloylgomisin P	Inhibitory activity of AGEs formation.	1.08 mg/mL	MOD↓, SOD ↑	[140]
	benzoyliso gomisin O		7.42 mg/mL		
	schiarisanrin A schiarisanrin B	BRIN-BD11 cells	20μg/mL	SAPK/JNK, p38MAPK and STAT-1α, Ca^{2+}	[141]
immunomodulatory activity	anwulignan	Clean-grade healthy male ICR mice	4 mg/kg	Nrf2/HO-1 pathway, IgG, IgM and lgA, Calpain I and Bax	[142]
	Alcohol extract from *K. coccinea*	SD male rats	1.68, 0.84, 0.42 g·kg-1	PCIII, IV-C, LN, HA, TGF-β1 and TNF-α, IFN-γ, TGF-β1	[143]
	gomisin M2	Male ICR mice	0.1 ~ 10 mg/kg	Lyn and Fyn pathways, Ca2+	[169]
	schizandrin	Mice (5-week Balb/c)	10 mg/kg	caspase-1, RIP-2, IgE, IgG1, TNF-α and IL-1β	[170]
Neuroprotective	extract of *K. heteroclita*	wistar rats	0.2 ~ 8 mg/ml	NGF, TBA-RS, SOD	[146]
	schisandrin	APP/PS1 double transgenic dementia mice	10 mg·kg-1. d-1	SYP, α-syn	[147]
	polysperlignan A polysperlignan B polysperlignan D polysperlignan F	PC12 cells	test concentration (1 and 10μM)	Against H2O2- or Aβ25-35-induced neurotoxicity	[21]
	heteroclitin D schiarisanrin A schiarisanrin B	LPS-induced BV-2 cells	IC_{50} = 18.6±1.0, 9.6±0.5, 26.4±3.2	Inhibiting NO	[105]
	schisandrol A	Myzus persicae Sulzer	LC_{50} = 295.62 mg/L	Regulation of intracellular Ca^{2+} levels	[153]
	schisandrin B	Plutella xylostella Linnaeus	LC_{50} = 586.22 mg/L		
Anti-ulcer	*k. longipedunculata* ethanol extract	Wistar female rats	100 mg/kg	Regulates levels of relevant inflammatory factors	[154]

Anti-fatigue	anwulignan	mice	4 mg/kg	LD, LDH, CK, Pi, MDA, TBARS, ROS, NRF-2, Bcl-2, LG, MG, SOD, CAT, GSH-Px and p38MAPK-PGC-1α pathway	[155]

7. Toxicity

Jin et al. [173] explored the toxicity studies of periwinkle on zebrafish embryo development. The results found that meso-dihydroguaiaretic acid (1 μg/mL) treated group exhibited severe pericardial oedema and yolk sac oedema, while embryos in the kadsulignan O and kadsufolin A (100 μg/mL) treated groups exhibited mild pericardial oedema, yolk sac oedema and slowed heart rate. Indicating that all three compounds were toxic to both embryonic development and cardiac development in zebrafish, and speculating that the target organ of toxicity may be the heart. Li et al. [139] investigated the acute toxicity test of *K. coccinea* fruit by taking the maximum gavage volume (40 ml/kg) for 30 days. During the experimental period, the mice showed normal activity, feeding, good growth and development, and no significant changes in their blood biochemical parameters and organism ratio. The above characteristics indicate that *K. coccinea* has no obvious toxic effects and is a safe fruit for consumption. Furthermore, Xia et al. [174] evaluated the toxicity of *K. coccinea* roots and stems using zebrafish as a model. *K. coccinea* alcohol extracts were found to cause hepatocyte damage and liver dysfunction in zebrafish larvae, in addition to inducing developmental hepatotoxicity. These results suggest that alcohol extracts of *K. coccinea* and stems are the main toxic extracts in zebrafish embryos and larvae. Deng et al. [175] used rats as a model to explore the pharmacological and toxicological safety of the extracts of *K. heteroclita*. The rats were divided into three groups and administered once daily at low, medium and high (1, 3 and 6 mg/kg) doses to observe the physiological changes during administration. The results showed that the high dose group showed coarse liver cell granules during the administration period, which returned to normal after discontinuation of the drug; the medium and low dose groups did not show any abnormalities during the experiment. In addition, there was no mortality in the rats of all dosing groups during the test period. This indicates that the extract is safe at medium and low doses, while the high dose needs to be further studied.

8. Discussion and Prospects

The genus *Ksdsura* has a history of thousands of years of development in China, with the earliest recorded use dating back to *Shennong's Classic of Materia Medica* and has the effect of dispels wind and dampness and moving Qi and blood. Due to its wide distribution, it has formed a variety of uses with ethnic characteristics, such as Dong and Yao medicine (*K. coccinea*), Wa, Hani and Yao medicine (*K. heteroclita*), etc. Today, modern techniques and methods have revealed that the genus *Ksdsura* contains more than 337 structurally diverse lignans, of which biphenyl cyclooctene-type lignans are considered to be the main bioactive components of the genus, See figure 9 for the percentage of major components. Pharmacological studies have confirmed its anti-inflammatory, hepatoprotective, neuroprotective, anti-HIV and anti-platelet aggregation pharmacological activities. Compared to the previous reviews, this paper further adds and refines

the information about the species, pharmacological activities and related applications of lignans from the genus *Kadsura*. Although some results have been achieved in the current understanding of the genus *Kadsura*, there are still some questions that deserve to be explored.

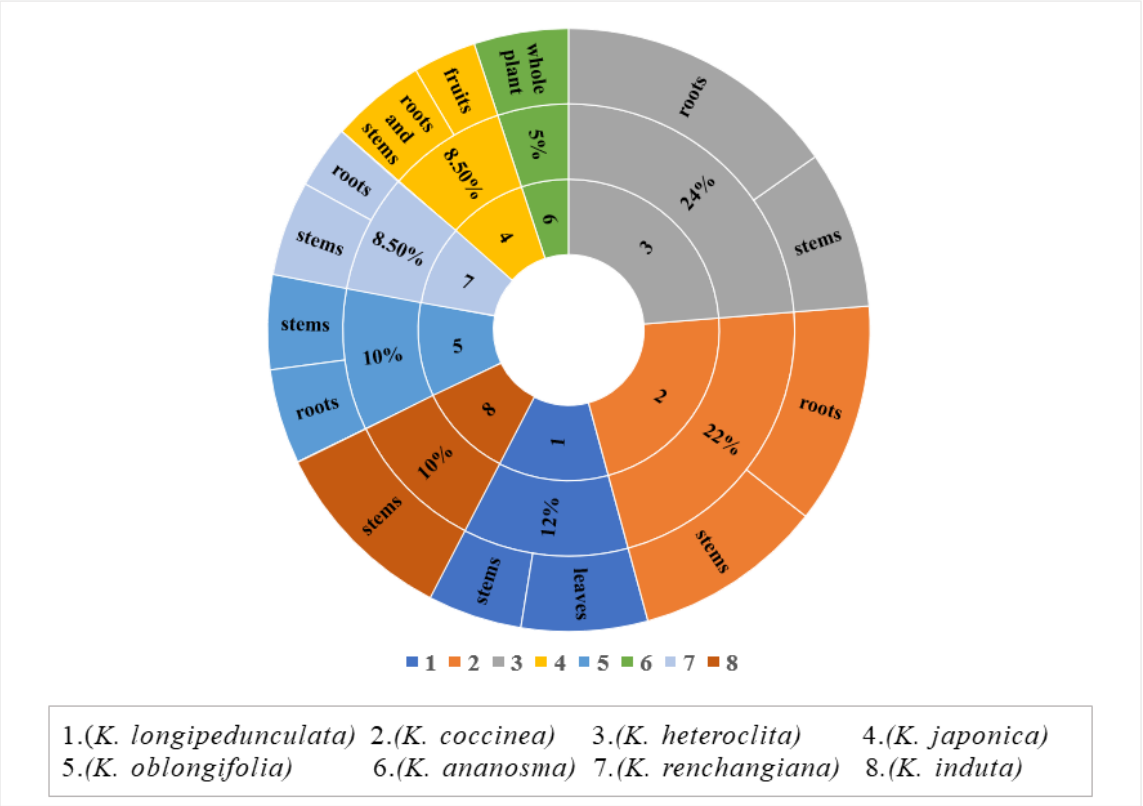

Figure 8. Traditionally used plant parts of genus *Kadsura*

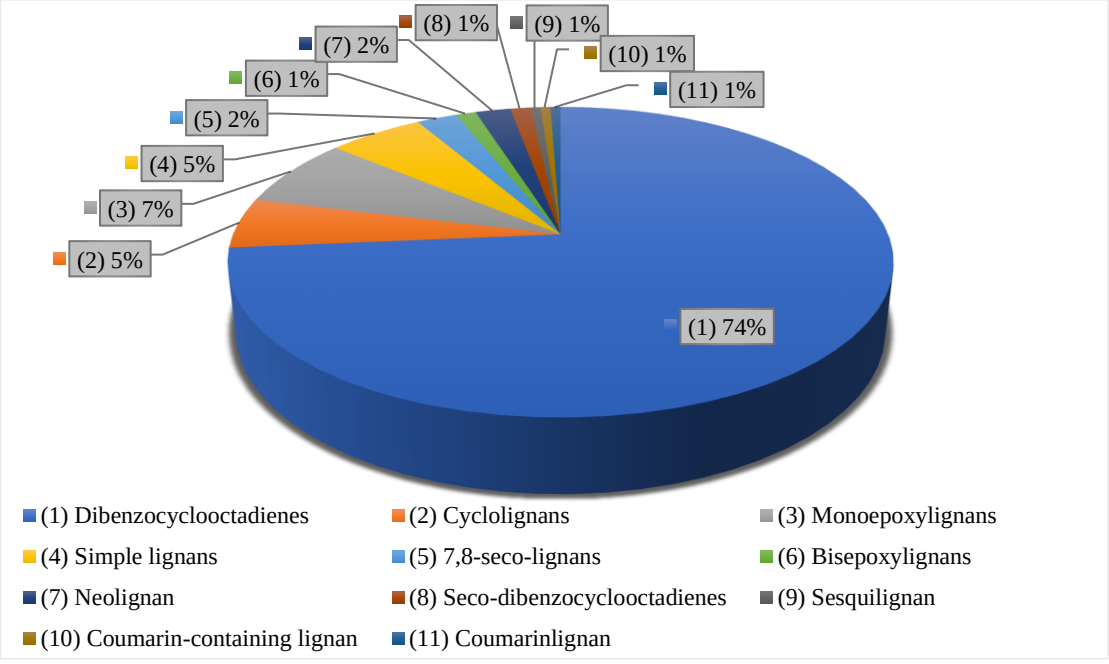

Figure 9. Percentage of various types of lignans in the genus *Kadsura*

First, the genus *Kadsura* is abundant and widespread, but most of the studies to date have reported *K. coccinea* and *K. longipedunculata* (Figures 10 and 11), while there are few other species. According to the literature, all plants in the genus *Kadsura* have medicinal value. In addition, *K. coccinea* and *K. japonica* can be used as fruit and have cough suppressant effects, and *K. longipedunculata* and *K. oblongifolia* can be used for ornamental purposes. The next step is to explore this genus in its entirety and to give full play to its value for exploitation. Secondly, the genus *Kadsura* can also be used clinically to treat rheumatic diseases, bone and joint diseases and various kinds of pain, and has achieved certain therapeutic effects. However, there is compatibility in the use of Chinese medicine for clinical applications, so the therapeutic mechanism of the genus in combination with other drugs should be studied in depth. At the meantime, the development of new clinical therapies should also receive attention. Third, to date, the genus has been identified as having more than 337 lignan-like constituents, and due to its diverse biological activities, considerable progress has been made in pharmacology (Figure 12), with anti-inflammatory, hepatoprotective and antitumor aspects in particular being the most extensively studied. Although there is a large body of literature reporting progress in the study of their pharmacological effects, there is still a lack of research on their mechanisms of action and targets. In the future, the mechanism and targets can be studied from compounded herbal formulations or with the help of network pharmacology. Fourthly, genus *Kadsura* has a long history of folk medicine use in China and has formed a variety of ethnic-specific medicine use, however, there are differences in each medicine use and dosage, and there is a lack of uniform standards. Moreover, only a small number of toxicity assessment experiments have been conducted, and a large number of experiments are needed to fill this gap.

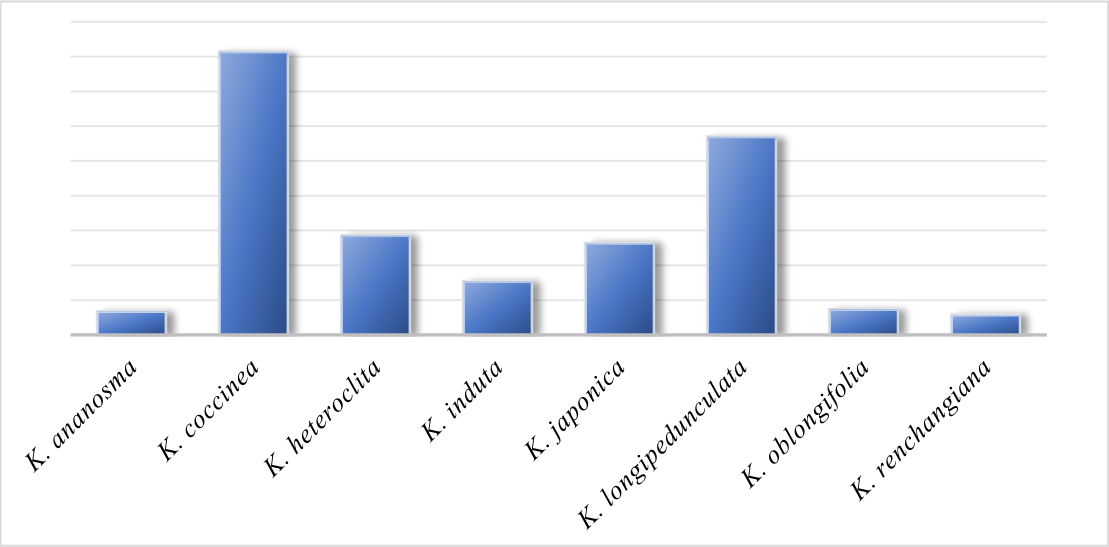

Figure 10. Percentage of all published reports on the chemistry and biology of species of the genus *Kadsura*

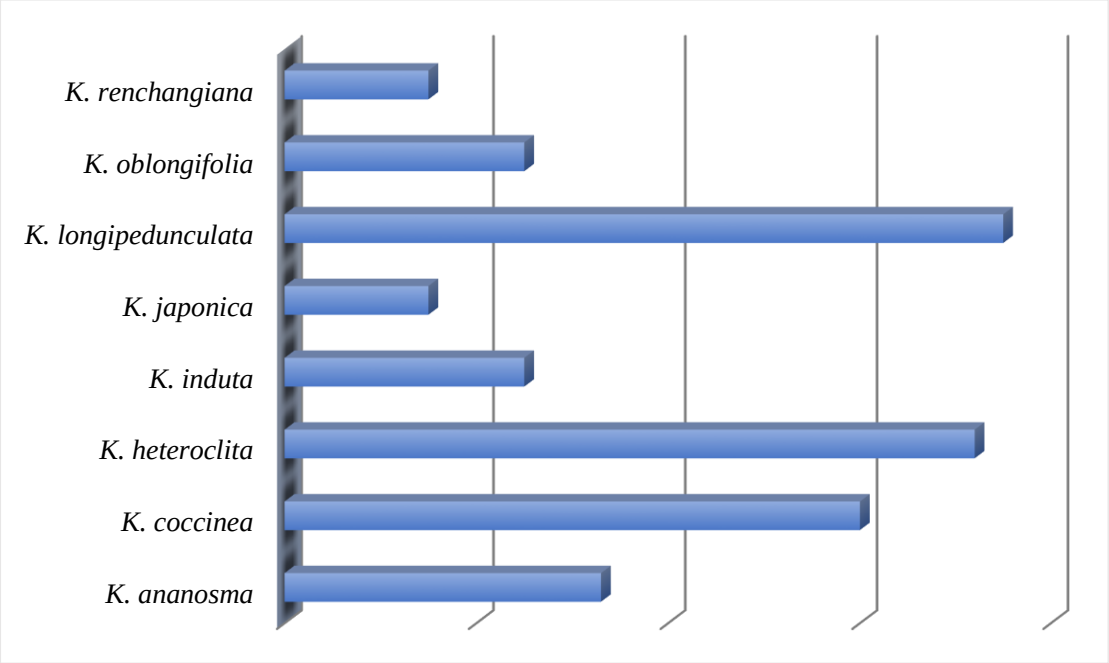

Figure 11. Percentage of lignan contained in each species in the genus *Kadsura*

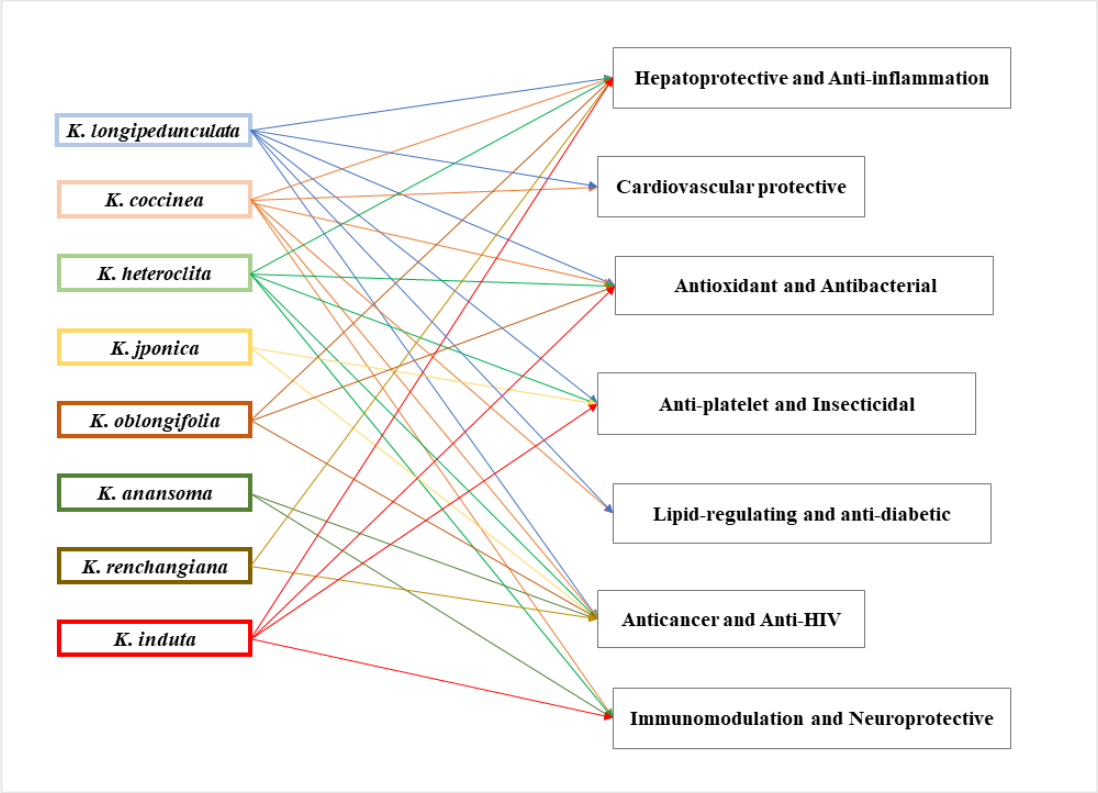

Figure 12. The pharmacological activity in different species of the genus *Kadsura*

On balance, the genus *Kadsura* is still lacking in comprehensive research and development, so this paper collates the existing studies and suggests a few noteworthy directions for development, in the hope of providing a valuable reference for subsequent exploration.

Author contributions

All the authors have accepted responsibility for the entire content of this submitted manuscript and approved submission.

Funding

This work was supported by the National Natural Science Foundation of China (82174111, 82104368), Shaanxi Provincial Science and Technology Department Project (2021JQ-744), Shaanxi University of Chinese Medicine Postgraduate Innovation Program (2021CX06) and Sci-Tech Innovation Talent System Construction Program of Shaanxi University of Chinese Medicine (2023-CXTD-05).

Competing Interests

The authors declare that there is no conflict of interest.

ORCID
Haonan Xu: 0000-0001-8873-0320
Wei Wang: 0000-0002-4699-0498
Xinzhuo Li: 0009-0004-7368-4201
Yuze Li: 0000-0001-7571-3214
Chong Deng: 0009-0000-7116-2128
Yi Jiang: 0000-0003-1200-1441
Xiaomei Song: 0000-0003-1906-1578
Dongdong Zhang: 0000-0003-0956-1261

References

[1] B. L. Deng, B. X. Xie and C. Zhang (2008). Germplasm resources of *Kadsura* and their utilization in China, *J. Cent. South. Univ*. **28**, 90-94.
[2] L. J. Xu, H. T. Liu, Y. Peng and P. G. Xiao (2008). A preliminary pharmacophylogenetic investigation in Schisandraceae, *J. Syst. Evol*. **5**, 692-723.
[3] X. Wei, H. L. Liang, H. Tang, Y. S. Jiang and F. Y. Jiang (2006). Distribution and utilization of *Kadsura* in Guangxi, *J. Southern. Agric*. **2**, 117-119.
[4] D. F. Chen (2007). Bioactive constituents of *Kadsura* medicinal plants, *Chin. J. Nat. Med*. **1**, 15-19.
[5] H. J. Guo, D. Y. Qi, X. W. Li, B. G. Zhang, H. T. Liu and P. G. Xiao (2015). Progress of traditional application of Schisandraceae plants and the systematic research on them, *World. Chin. Med*. **10**, 1133-1138.
[6] L. D. Duan, Q. Lin and Q. Yuan (2004). Floral morphology of *Kadsura* in relation to its systematic significance, *Bull. Bot. Res*. **1**, 87-92+130-133.
[7] C. R. Sun (2002). Micromorphological features of the seed surface of Schisandraceae and their systematic significance, *J. Syst. Evol*. **2**, 97-109.
[8] H. Y. Bi, Q. Lin, C. J. Liu and J. C. Zhao (2002). Seed morphology of *Kadsura* Juss. (Schisandraceae) in relation to its taxonomic significance, *J. Syst. Evol*. **6**, 501-510.

[9] Z. R. Yang, Q. Lin, X. Y. Wen, Q. W. Zeng and X. C. Zou (2009). Characters of the leaf epidermis in *Kadsura* (Schisandraceae), *Bull. Bot. Res*. **29**, 147-163.

[10] Z. R. Yang and Q. Lin (2007). Comparative wood anatomy of Schisandraceae and its systematic significance, *J. Syst. Evol*. **2**, 191-206.

[11] C. R. Sun (2000). Pollen morphology of the Schisandraceae and its systematic significance, *J. Syst. Evol*. **5**, 437-445+497-499.

[12] X. Zheng, E. W. Hao, Y. Li and X. T. Hou (2016). Research progress of diamond medications of Schisandraceae, *Asian. Pac. J. Trop. Biomed*. **12**, 24-27.

[13] L. Tan, Y. Cheng, D. D. Mo, R. L. Li, X. L. Zhou and B. L. Tang (2017). Exploration into the anti-rheumatoid arthritis mechanism of ethyl acetate extract from *Kadsura longipedunculata* finet et gagnep, *Chin. Pharm. J*. **52**, 637-642.

[14] X. C. Qu, Q. M. Hu, Y. F. Huang and L. P. Dou (2019). Comparative identification between *Kadsura coccinea* and *Kadsura heteroclite*, *Strait. Pharm. J*. **31**, 67-70.

[15] M. Zhang, J. Y. Zhou, W. Wei, E. W. Hao, J. G. Deng and X. T. Hou (2019). Research progress on chemical constituents and pharmacological effects of Yao medicine *Kadsura heteroclita*. *Zhong. Cao. Yao*. **50**, 3493-3502.

[16] Z. L. Jin, C. J. Li, X. Y. Zhang and B. X. Jia (2020). Research progress on pharmacological effects and clinical applications of *Kadsura coccinea*, *Chin. J. Ethnomed. Ethnopharm*. **29**, 50-54.

[17] B. L. Tang, L. Tan, D. D. Mo, X. L. Zhou, X. L. Hou and Y. Cheng (2022). Research progress of traditional Yao drug Zuan herbs against rheumatoid arthritis, *Guangxi. Med. J*. **44**, 101-104.

[18] J. S. Liu, Y. D. Qi, H. W. Lai, J. Zhang, X. G. Jia, H. T. Liu and P. G. Xiao (2014). Genus *Kadsura*, a good source with considerable characteristic chemical constituents and potential bioactivities, *Phytomedicine*. **21**, 1092-1097.

[19] D. F. Chen, S. X. Zhang, M. Kozuka, Q. Z. Sun, J. Feng and Q. Wang (2002). Interiotherins C and D, two new lignans from *Kadsura interior* and antitumor-promoting effects of related neolignans on epstein-barr virus activation, *J. Nat. Prod*. **65**, 1242-1245.

[20] Z. Huang, Y. Lu, Y. Liu, K. F. Bastow, K. Lee and D. Chen (2011). Kadsufolins A - D and related cytotoxic lignans from *Kadsura oblongifolia*, *Helv. Chim. Acta*. **94**, 519-527.

[21] K. Dong, J. X. Pu, H. Y. Zhang, X. Du, X. N. Li and J. Zou (2012). Dibenzocyclooctadiene lignans from *Kadsura polysperma* and their anti-neurodegenerative activities, *J. Nat. Prod*. **75**, 249-256.

[22] Q. Z. Sun, D. F. Chen, P. L. Ding, C. M. Ma, H. Kakuda, N. Nakamura and M. Hattori (2006). Three new lignans, longipedunins A-C, from *Kadsura longipedunculata* and their inhibitory activity against HIV-1 protease, *Chem. Pharm. Bull*. **54**, 129-132.

[23] W. Ma, X. Ma, H. Huang, P. Zhou and D. Chen (2007). Dibenzocyclooctane lignans from the stems of *Kadsura induta* and their antiviral effect on hepatitis B virus, *Chem. Biodivers*. **4**, 966-972.

[24] L. N. Li, H. Xue and X. Li (1991). Three new dibenzocyclooctadiene lignans from *Kadsura longipedunculata*, *Plant. Med*. **57**, 169-171.

[25] S. Y. Shao, X. Z. Qi, H. Sun and S. Li (2020). Hepatoprotective lignans and triterpenoids from the roots of *Kadsura longipedunculata*, *Fitoterapia*. **142**, 104487.

[26] J. Liu, P. Pandey, X. Wang, X. Qi, J. Chen and H. Sun (2018). Hepatoprotective dibenzocyclooctadiene and tetrahydrobenzocyclooctabenzofuranone lignans from *Kadsura longipedunculata*, *J. Nat. Prod*. **81**, 846-857.

[27] J. S. Liu, J. Zhang, Y. D. Qi, X. G. Jia, B. G. Zhang and H. T. Liu (2018). Four new lignans from *Kadsura interior* and their bioactivity, *Molecules*. **23**, 1279.

[28] Y. P. Chen, R. Liu, H. Y. Hsu, S. Yamamura, Y. Shizuri and Y. Hirata (1973). The structures and conformations of two new lignans, kadsurin and kadsurarin, *Tetrahedron. Lett*. **14**, 4257-4260.

[29] D. F. Chen, S. X. Zhang, K. Chen, B. N. Zhou, P. Wang and L. M. Cosentino (1996). Two new lignans, interiotherins A and B, as anti-HIV principles from *Kadsura interior*, *J. Nat. Prod*. **59**, 1066-1068.

[30] J. H. Yang, H. Y. Zhang, J. Wen, X. Du, J. H. Chen and H. B. Zhang (2011). Dibenzocyclooctadiene lignans with anti-neurodegenerative potential from *Kadsura ananosma*, *J. Nat. Prod*. **74**, 1028-1035.

[31] M. Daniyal, Y. Liu, Y. Yang, F. Xiao, J. Fan and H. Yu (2021). Anti-gastric cancer activity and mechanism of natural compound "Heilaohulignan C" isolated from *Kadsura coccinea*, *Phytother. Res*. **35**, 3977-3987.

[32] L. N. Li and H. Xue (1990). Dibenzocyclooctadiene lignans possessing a spirobenzofuranoid skeleton from *Kadsura coccinea*, *Phytochemistry*. **29**, 2730-2732.

[33] M. Chen, Y. P. Luo, Y. L. Zou, L. H. Lang and D. F. Chen (2014). Heteroclitins R-S: new dibenzocylooctadiene lignans from *Kadsura heteroclite*, *Chin. J. Nat. Medicines*. **12**, 689-692.

[34] Y. Yang, Y. Liu, M. Daniyal, H. Yu, Q. Xie and B. Li (2019). New lignans from roots of *Kadsura coccinea*, *Fitoterapia*. **139**, 104368.

[35] N. Shehla, B. Li, J. Zhao, L. Cao, Y. Jian and I. A. Khan (2020). New dibenzocyclooctadiene lignan from stems of *Kadsura heteroclite*, *Nat. Prod. Res*. **36**, 1-10.

[36] H. T. Liu, L. J. Xu, Y. Peng, J. S. Yang, X. W. Yang and P. G. Xiao (2010). Complete assignments of ^{1}H and ^{13}C NMR data for new dibenzocyclooctadiene lignans from *Kadsura oblongifolia*, *Magn. Reson. Chem*. **47**, 609-612.

[37] M. D. Wu, R. L. Huang, L. M. Kuo, C. C. Hung, C. W. Ong and Y. H. Kuo (2003). The anti-HBsAg (human type B hepatitis, surface antigen) and anti-HBeAg (human type B hepatitis, e antigen) C_{18} dibenzocyclooctadiene lignans from *Kadsura matsudai* and *Schizandra arisanensis*, *Chem. Pharm. Bull*. **51**, 1233-1236.

[38] G. Q. Han, P. Dai, R. Xue, B. R. Arison, D. C. Lankin and S. B. Hwang (1992). Dibenzocyclooctadiene lignans with platelet-activating factor (PAF) antagonist activity from *Kadsura heteroclite*, *J. Chin. Pharm. Sci*. **1**, 20-27.

[39] N. Ookawa, Y. Ikeya, H. Taguchi and I. Yosioka (1981). "The Constituents of *Kadsura Japonica* DUNAL. I. The structures of three new lignans, acetyl-, ngeloyl- and caproyl-binankadsurin A", *Chem. Pharm. Bull*. **29**, 123-127.

[40] J. S. Liu, M. F. Huang and H. X. Zhou (1991). Kadsulignan C and D, two novel lignans from *Kadsura longipedunculata*, *Can. J. Chem*. **69**, 1403-1407.

[41] N. Ookawa (1995). Dibenzocyclooctadiene lignans from *Kadsura japonica*, *Phytochemistry*. **39**, 1187-1191.

[42] N. Ban, B. Thanh, P. Kiem, C. Minh, N. Cuong and N. Nhiem (2009). Dibenzocyclooctadiene lignans and lanostane derivatives from the roots of *Kadsura coccinea* and their protective effects on primary rat hepatocyte injury induced byt-butyl hydroperoxide, *Plant. Med*. **75**, 1253-1257.

[43] K. Shinomiya, H. Li, S. Kitanaka and Y. Ito (2009). Countercurrent chromatographic separation of lipophilic ascorbic acid derivatives and extract from *Kadsura coccinea* using hydrophobic organic-aqueous two-phase solvent systems, *J. Liq. Chromatogr. Relat. Technol*. **32**, 2361-2371.

[44] W. Hu, L. Li, Q. Wang, Y. Ye, J. Fan and H. X. Li (2012). Dibenzocyclooctadiene lignans from *Kadsura coccinea*, *J. Asian. Nat. Prod. Res*. **14**, 364-369.

[45] H. R. Li, Y. L. Feng, Z. G. Yang, J. Wang, A. Daikonya and S. Kitanaka (2006). New lignans from *Kadsura coccinea* and their nitric oxide inhibitory, *Chem. Pharm. Bull*. **54**, 1022-1025.

[46] W. Wang, J. Liu, R. Liu, Z. Xu, M. Yang and W. Wang (2006). Four new lignans from the stems of *Kadsura heteroclite*, *Plant. Med*. **72**, 284-288.

[47] Y. Q. Luo, M. Liu, J. Wen, W. G. Wang, K. Hu and X. N. Li (2017). Dibenzocyclooctadiene lignans from *Kadsura heteroclite*, *Fitoterapia*. **119**, 150-157.

[48] D. F. Chen, G. J. Xu, X. W. Yang, M. Hattori, Y. Tezuka and T. Kikuchi (1992). Dibenzocyclooctadiene lignans from *Kadsura heteroclite*, *Phytochemistry*. **31**, 629-632.

[49] H. Li, L. Wang, Z. Yang and S. Kitanaka (2007). Kadsuralignans H-K from *Kadsura coccinea* and their nitric oxide production inhibitory effects. *J. Nat. Prod*. **70**, 1999-2002.

[50] J. H. Yang, H. Y. Zhang, X. Du, W. Wang, W. L. Xiao and J. Wen (2011). New dibenzocyclooctadiene lignans from the *Kadsura ananosma*, *Tetrahedron*. **67**, 4498-4504.

[51] L. N. Li, H. Xue and R. Tan (1985). Dibenzocyclooctadiene lignans from roots and stems of *Kadsura coccinea*, *Plant. Med*. **51**, 297-300.

[52] J. S. Liu and L. Li (1993). Schisantherins L-O and acetylschisantherin L from *Kadsura coccinea*, *Phytochemistry*. **32**, 1293-1296.

[53] J. S. Liu and L. Li (1995). Schisantherins P and Q, two lignans from *Kadsura coccinea*, *Phytochemistry*. **38**, 1009-1011.

[54] W. H. Ma, X. L. Ma, Y. Lu and D. F. Chen (2009). Lignans and triterpenoids from the stems of *Kadsura induta*, *Helv. Chim. Acta*. **92**, 709-715.

[55] J. S. Liu and Y. P. Pan (1991). Isolation and structures of schisantherin J and schisanlactone F, *Acta. Chim. Sin*. **49**, 308-312.

[56] M. Chen, Z. X. Liao and D. F. Chen (2004). Four new dibenzocyclooctene lignans from *Kadsura renchangiana*, *Helv. Chim. Acta*. **87**, 1368-1376.

[57] R. Tan, L. N. Li and Q. C. Fang (1984). Studies on the chemical constituents of *Kadsura longipedunculata*: isolation and structure elucidation of five new lignans, *Planta. Med*. **50**, 414-417.

[58] N. Wang, Z. L. Li, X. Q. Liu and H. M. Hua (2012). Chemical constituents from the roots of *Kadsura coccinea*, *Chin. J. Med. Chem*. **22**, 305-308.

[59] Y. H. Kuo, M. D. Wu, R. L. Huang, L. M. Kuo, Y. W. Hsu and C. C. Liaw (2005). Antihepatitis activity (anti-HBsAg and anti-HBeAg) of C_{19} homolignans and six novel C_{18} dibenzocyclooctadiene lignans from *Kadsura japonica*, *Planta. Med*. **71**, 646-653.

[60] J. S. Liu and L. Li (1995). Kadsulignans L-N, three dibenzocyclooctadiene lignans from *Kadsura coccinea*, *Phytochemistry*. **38**, 241-245.

[61] X. W. Yang, H. Miyashiro, M. Hattori, T. Namba, Y. Tezuka and T. Kikuchi (1992). Isolation of novel lignans, heteroclitins F and G, from the stems of *Kadsura heteroclita* and anti-lipid peroxidative actions of heteroclitins A-G and related compounds in the in vitro rat liver homogenate system, *Chem. Pharm. Bull*. **40**, 1510-1516.

[62] L. J. Xu, Y. Peng, S. B. Chen, S. L. Chen and P. G. Xiao (2007). Four new lignans from *Kadsura heteroclite*, *Heterocycles*. **71**, 941-947.

[63] M. Chen, Z. W. Jia and D. F. Chen (2006). Heteroclitin H, a new lignan from *Kadsura heteroclite*, *J. Asian. Nat. Prod. Res*. **8**, 643-648

[64] L. J. Xu, H. T. Liu, Y. Peng, S. B. Chen, S. L. Chen and P. G. Xiao (2008). Heteroclitins N-Q, new compounds from stems of *Kadsura heteroclita* (Roxb.) Craib, *Helv. Chim. Acta*. **91**, 220-226.

[65] Z. H. Ding and S. D. Luo (1990). Study on new lignans from *Kadsura interior* A. C. Smith, *Acta. Chim. Sin*. **11**, 1075-1079.

[66] H. Liu, B. Zhang, Y. Peng, Y. Qi, L. Xu and X. Yang (2011). New spirobenzofuranoid dibenzocyclooctadiene lignans from *Kadsura oblongifolia*, *Fitoterapia*. **82**, 731–734.

[67] S. Liu, Y. P. Luo, Y. J. Hu, L. Q. Deng, S. Y. Zhou and Z. H. Liao (2014). Renchangianin E: a new dibenzocyclooctadiene lignan from *Kadsura renchangiana*, *Acta. Pharm. Sin*. **49**, 1438-1441.

[68] Y. J. Guo (2016). Study on the resources chemistry of two medicinal plants of genus *Kadsura*, *Peking. Union. Med. Coll*. **1**, 1-108.

[69] X. M. Gao, J. X. Pu, Y. Zhao, L.B. Yang and H. D. Sun (2012). Lignans from *Kadsura angustifolia* and *Kadsura coccinea*, *J. Asian. Nat. Prod. Res*. **14**, 129-134.

[70] Y. Z. Jia, Y. P. Yang, S. W. Cheng, L. Cao, Q. L. Xie and M. Y. Wang (2021). Heilaohuguosus A-S from the fruits of *Kadsura coccinea* and their hepatoprotective activity, *Phytochemistry*. **184**, 112678.

[71] J. Liu, P. Pandey, X. Wang, K. Adams, X. Qi and J. Chen (2019). Hepatoprotective Tetrahydro-benzocyclooctabenzofuranone lignans from *Kadsura longipedunculata*, *J. Nat. Prod*. **82**, 2842-2851.

[72] H. T. Le, T. H. Tran, T. T. Le, V. T. Nguyen, T. A. Nguyen and H. M. Nguyen (2021). A new phenylethyl glycoside and a new dibenzocyclooctadiene lignan from the leaves of *Kadsura coccinea* (Lem.) A. C. Smith, *Phytochemistry. Lett*. **45**, 57-62.

[73] Z. H. Huang (2010). The chemical constituents of three *Kadsura* medicinal plants and their bioactivities, *Fudan. Univ.* **1**, 1-190.

[74] J. Pu, X. Gao, C. Lei, W. Xiao, R. Wang and L. Yang (2008). Three new compounds from *Kadsura longipedunculata*, *Chem. Pharm. Bull*. **56**, 1143-1146.

[75] X. J. Liu and B. K. Wang (1989). Isolation and structures of lengfantuanjing I, *Chin. Trad. Herb. Drugs*. **20**, 2-3.

[76] W. H. Ma (2007). Antiviral chemical constituents of *Kadsura induta* and *Schisandra wilsoniana*, *Fudan. Univ*. **1**, 1-241.

[77] J. X. Pu, W. L. Xiao, H. M. Li, S. X. Huang, S. H. Li and H. D. Sun (2007). Three new compounds from *Kadsura longipedunculata*, *Helv. Chim. Acta*. **90**, 723-729.

[78] Y. P. Luo, S. J. Wang, J. F. Zhao, X. D. Yang and L. Li (2009). Study on the chemical constituents of *Kadsura heteroclite*, *J. Yunnan. Univ*. **31**, 406-409.

[79] X. Qi, J. Liu, J. Chen, Q. Hou and S. Li (2020). New seco-dibenzocyclooctadiene lignans with nitric oxide production inhibitory activity from the roots of *Kadsura longipedunculata*, *Chin. Chem. Lett*. **31**, 423-426. •

[80] M. Wang, S. Jiang, N. Hussain, S. Zafar, Q. Xie and F. Huang (2022). Anti-RAFLS triterpenoids and hepatoprotective lignans from the leaves of Tujia ethnomedicine *Kadsura heteroclita* (Xuetong), *Front. Chem*. **10**, 878811.

[81] T. H. Thi, H. D. Thang, T. H. Anh, C. N. Thanh, D. T. Tuan and H. N. Ba (2022). Kadsindutalignans A-C: three new dibenzocyclooctadiene lignans from *Kasura induta* A.C. Smith. and their nitric oxide production inhibitory activities, *Nat. Prod. Res*. **18**, 1-8.

[82] Y. J. Guo, H. J. Guo, J. S. Liu, X. W. Li, Y. D. Qi, B. G. Zhang and H. T. Liu (2015). Advances in studies on chemical constituents in *Kadsura longipedunculata* and their pharmacological activities, *Mod. Chin. Med*. **17**, 1350-1358.

[83] W. Su, J. Zhao, M. Yang, H. W. Yan, T. Pang and S. H. Chen (2015). A coumarin lignanoid from the stems of *Kadsura heteroclite*, *Bioorg. Med. Chem. Lett*. **25**, 1506-1508.

[84] S. Y. Oh, Y. H. Kim, D. S. Bae, B. H. Um, C. H. Pan and C. Y. Kim (2010). Anti-inflammatory effects of gomisin N, gomisin J, and schisandrin C isolated from the fruit of *Schisandra chinensis*, *Biosci. Biotechnol. Biochem*. **74**, 285-291.

[85] W. H. Ma, Y. Lu, H. Huang, P. Zhou and D. F. Chen (2010). Schisanwilsonins A-G and related anti-HBV lignans from the fruits of S*chisandra wilsoniana*, *Bioorg. Med. Chem. Lett*. **19**, 4958-4962.

[86] Y. Liu, Y. Liu, L. Wang, J. H. Lu and L. Tan (2016). Study on anti-hepatitis B virus activity and protective effects of Nanwuweizi (*Kadsura Longipedunculata*) on acute hepatic injury, *Guiding. J. Trad. Chin. Med. Pharm*. **22**, 40-42.

[87] F. Y. Shen, H. Y. Ge and R. Zeng (2013). Protective effects of alcohol extract of *Kadsura heteroclita* on acute hepatic injury induced by carbon tetrachioride in Rats, *Chin. J. Exp. Trad. Med. Formulae*. **19**, 232-235.

[88] M. Daniyal, Y. B. Liu, Y. P. Yang, F. Xiao, J. L. Fan and H. H. Yu (2021). Anti-gastric cancer activity and mechanism of natural compound "Heilaohulignan C" isolated from *Kadsura coccinea*, *Phyto. Res*. **35**, 3977-3987.

[89] Y. G. Yang, E. Hao, X. L. Pan, D. C. Tan, Z. C. Du and J. L. Xie (2019). Gomisin M_2 from Baizuan suppresses breast cancer stem cell proliferation in a zebrafish xenograft model, *Aging*. **11**, 8347–8361.

[90] H. Xian, W. Feng and J. Zhang (2019). Schizandrin A enhances the efficacy of gefitinib by suppressing IKKβ/NF-κB signaling in non-small cell lung cancer, *Eur. J. Pharm*. **15**, 10-19.

[91] Y. M. Zhang, X. N. Wang, Y. Z. Pang and G. Fang (2021). Research progress on antitumor effect of schisandrin B, *Guiding. J. Trad. Chin. Med. Pharm*. **27**, 180-184.

[92] H. Lu, Z. B. Su, Z. Pan, L. Y. Zheng, R. Fu and T. J. Meng (2020). Research progress of schisandrin B on anti-tumor effect, *Chin. Trad. Pat. Med*. **42**, 1847-1850.

[93] F. Zhang (2016). Pharmacokinetics of heteroclitin D and inhibitory effect on gastric cancer, *Jilin. Univ*. **1**, 1-90.

[94] L. Huang, L. Chen and Z. Zhang (2004). Pathological observations of fructus Schisandrae polysaccharide on anti-tumor effects in S_{180}-bearing mice, *Zhong. Yao. Cai*. **27**, 202-3.

[95] L. J. Xu, Z. G. Peng, H. S. Chen, J. Wang and P. G. Xiao (2010). Bioative triterpenoids from *Kadsura heteroclite*, *Chem. Biodivers*. **7**, 2289-2295.

[96] L. Tan, X. M. Gong, Y. Cheng, D. D. Mo and B. L. Tang (2020). Effect of ethanol extract from Yao medicine *Kadsura longipedunculata* Finet et Gagnep. on proliferation of four types of tumor cells, *Guangxi. Med. J*. **42**, 1683-1686.

[97] K. L. Liu, R. H. Tian, X. L. Shen and Y. J. Hu (2013). Chemical constituents of *Kadsura oblongifolia* and their in-vitro anticancer activities, *J. Guangzhou. Univ. Trad. Chin. Med*. **30**, 843-848.

[98] D. F. Chen, S. X. Zhang, L. Xie, J. X. Xie, K. Chen and Y. Kashiwadab (1997). Anti-AIDS agents XXVl. Structure-activity correlations of gomisin-G-related anti-HIV lignans from *Kadsura interior* and of related synthetic analogs, *Bioorg. Med. Chem. Lett*. **5**, 1715-1723.

[99] J. X. Pu, L. M. Yang, W. L. Xiao, R. T. Li, C. Lei and X. M. Gao (2008). Compounds from *Kadsura heteroclita* and related anti-HIV activity, *Phytochemistry*. **69**, 1266-1272.

[100] Q. Z. Sun, D. F. Chen, P. L. Ding, C. M. Ma, H. Kakuda and N. Nakamura (2006). Three new lignans, longipedunins A-C, from *Kadsura longipedunculata* and their inhibitory activity against HIV-1 protease, *Chem. Pharm. Bull*. **54**, 129-32.

[101] Y. Yang, C. L. Zhang, Z. Wang and X. F. Pan (2003). Advances in lignans with anti-HIV properties, *Prog. Chem*. **4**, 327-331.

[102] Q. Z. Sun (2001). Studies on the anti-HIV active ingredients of the *Kadsura longipedunculata*, *Fudan. Uinv*. **1**, 1-95.

[103] J. S. Liu and L. Liang (1995). Kadsulignans L-N, three dibenzocyclooctadiene lignans from *Kadsura coccinea*, *Phytochemistry*. **38**, 241-245.

[104] J. Sun, J. Y. Yao, S. X. Huang, X. Long, J. B. Wang and G. G. Elena (2009). Anti-oxidant activity of polyphenol and anthocyanin extracts from fruits of *Kadsura coccinea* (Lem.) A.C. Smith, *Food. Chem*. **117**, 276-281.

[105] X. P. Lin, J. Han, B. Peng, L. Li and L. H. Qiu (2018). Antibacterial and antioxidation activities of root, stem and leaf ethanol extract of *Kadsura longipedunculata*, *J. Ningde. Normal. Univ*. **30**, 402-406.

[106] K. D. Su, Y. M. Li, X. L. Huang, L. Zhao, Q. R. Li and M. Li (2018). Complexion of *Kadsura coccinea* extract with cyclodextrin: characterization, thermal stability, antioxidative properties in vitro and the protective effects on kidney damage, *J. Incl. Phenom. Macro. Chem*. **91**, 3-4.

[107] X. L. Jin, Z. Gu, T. X. Hu, M. H. Jiang and D. F. Chen (2000). Effects of lignan gomisin J from *kadsura interior* on liver mitochondria lipid peroxidation and on the superoxide anion radical, *Chin. Pharm. Bull*. **1**, 26-28.

[108] Z. Gu, D. F. Chen, T. X. Hu and M. H. Jiang (1999). Effects of gomisin J on oxygen free radicals, *Fudan. Univ. J. Med. Sci*. **5**, 56-58.

[109] X. W. Yang, M. Hattori, T. Namba, D. F. Chen and G. J. Xu (1992). Anti-lipid peroxidative effect of an extract of the stems of *Kadsura heteroclita* and its major constituent, kadsurin, in mice, *Chem. Pharm. Bull*. **40**, 406.

[110] S. H. Wu and X. Yu (2012). Antioxidation of *Kadsura longipedunculata* extract, *J. Zhongkai. Univ. Agri. Eng*. **25**, 23-25.

[111] S. H. Wu, C. S. Zhao and X. Yu (2012). Study on DPPH. and OH. scavenging activity of extracts from *Kadsura longipedunculata* fruit, *Guangdong. Agri. Sci*. **39**, 134-136.

[112] J. C. Xia (2012). Advances in the study of the chemical composition and activity of *Kadsura longipedunculata*, *Sci. Tech. Innovation*. **2**, 10.

[113] J. Ai and Y. S. Li (2005). Progress in studies on chemical constituents and pharmacological activities of *Kadsura coccinea*, *Chem. Bioengineering*. **2**, 7-9.

[114] Z. H. Yan, L. Cheng, L. Y. Kong, Q. Q. He and J. Liu (2013). Chemical constituents and their anti-oxidative activities of *Kadsura coccinea, Chin. Trad. Herb. Drugs*. **44**, 2969-2973.

[115] L. Song (2007). Extraction and bioactivity of polyphenols and volatile oils from *Kadsura longipedunculata*, *Fudan. Univ*. **1**, 1-90.

[116] S. L. Jiang, W. Y. Zhang and D. F. Chen (2005). Effects of heteroclitin D, schisanhenol and (+)-anwulignan on platelet aggregation, *Fudan. Univ. J. Med. Sci*. **4**, 467-470+478.

[117] G. Hsiao, M. Y. Shen, D. S. Chou, Y. Chang, L. W. Lee and C. H. Lin (2004). Mechanisms of antiplatelet and antithrombotic activity of midazolam in in vitro and in vivo studies, *Eur. J. Pharm*. **487**, 159-166.

[118] Q. Y. Li, D. F. Chen and M. H. Jiang (1999). Effects of gomisin J and heteroclitind on rat thoracic aorta, *Fudan. Univ. J. Med. Sci*. **4**, 46-48.

[119] Y. X. Liu, X. M. Zhao, Z. Y. Wen, Y. Guo and J. Y. Zhao (2013). Comparison of two modes of administration of Carrageenan in the preparation of a mouse tail thrombosis model, *Chin. J. Integrative. Med. Cardio-Cerebrovascular. Disease*. **11**, 849-850.

[120] H. Su, F. He, G. N. Wei, Z. H. Nong, X. B. Zeng and H. C. Yang (2017). Effect of aqueous extract from root and root-bark of *Kadsura coccinea* (lem) A.C. Smith on coagulation time and thrombosis in mice, *J. Pharm. Res*. **36**, 565-566+582.

[121] N. Wang (2009). Studies on the constituents and their biological activities of the roots of *kadsura coccinea*, *Shenyang. Pharm. Univ*. **1**, 1-240.

[122] Y. H. Zuo, Y. B. Liu, C. S. Cheng, Y. P. Yang, Y. Xie and P. Luo (2020). Isovaleroylbinankadsurin A ameliorates cardiac ischemia/reperfusion injury through activating GR dependent RISK signaling. *Pharmacol. Res*. **158**, 104897.

[123] B. H. Ye, S. J. Lee, Y. W. Choi, S. Y. Park and C. D. Kim (2015). Preventive effect of gomisin J from *Schisandra chinensis* on angiotensin II-induced hypertension via an increased nitric oxide bioavailability. *Hypertens. Res*. **38**, 169-177.

[124] J. Y. Park, Y. W. Choi, J. W. Yun, J. U. Bae, K. W. Seo, S. J. Lee and S. Y. Park (2012). Gomisin J from *Schisandra chinensis* induces vascular relaxation via activation of endothelial nitric oxide synthase, *Vascul. Pharmacol*. **57**, 124-30.

[125] F. Zhou, M. D. Wang, J. Ju, Y. Wang, Z. B. Liu and X. P. Zhao (2019). Schizandrin A protects against cerebral ischemia-reperfusion injury by suppressing inflammation and oxidative stress and regulating the AMPK/Nrf2 pathway regulation, *Am. J. Transl. Res*. **11**, 199-209.

[126] J. Xu, J. Liu, B. Li, X. Wei, Y. Qi and B. Zhang (2022). Comparison of blood tonic efficacy and chemical constituents of *Kadsura interior* A.C. Smith and its closely related species, *Chin. Med*. **17**, 14.

[127] W. Xie, T. Yang and W. W. Zhao (2016). The functional components analysis and application prospect of *Kadsura coccinea* seed, *Food. Res. Develop*. **37**, 1-4.

[128] Y. Tan, L. L. Ye, Q. Y. Zhao and W. Q. Lv (2020). Schisandrin C alleviates Ang II-induced cardiac inflammation and myocardial remodeling, *Anhui. Med. Pharm. J*. **24**, 1291-1295.

[129] P. H. Zhao, X. C. Liu, Y. L. Wu, Y. Tian and S. Q. Ge (2018). Advances on the antioxidant effect of Schisandrin B, *Med. Res. Educ*. **35**, 1-5.

[130] J. B. Han, X. W. Shi, Y. Du, F. J. Shi, B. Zhang and Z. X. Zheng (2019). Schisandrin C targets $Keap_1$ and attenuates oxidative stress by activating Nrf_2 pathway in Ang II-challenged vascular endothelium, *Phytother. Res*. **33**, 779-790.

[131] L. P. Duan (2018). Study on chemical constituents of *Kadsura coccinea* and their bioactivities, *Nanjing. Agr. Univ*. **1**, 1-91.

[132] L. L. Shi and H. R. Li (2016). ldentification of sesquiterpenes from *Kadsura coccinea* and reaserch on their nitric oxide inhibitory activities, *Chin. Med. Herald*. **13**, 27-29+34.

[133] Y. Q. Ma, X. Yu, X. L. Huang and M. Yang (2010). Study on antimicrobial and anti-oxidation activities of extracts from *Kadsura longipedunculata*, *Food. Ferment. Ind*. **36**, 45-48.

[134] X. L. Huang, X. Yu, F. Y. Liu, Y. Q. Ma and M. Yang (2010). Optimization of extraction conditions and antibacterial effect of extracts from *Kadsura longipedunculata* by response surface methodology, *Cereals. Oils. Processing*. **10**, 157-160.

[135] S. H. Wu, W. J. Ye and X. Yu (2012). Study on stability of antibacterial activity of extract from *Kadsura longipedunculata, J. Chin. Institute. Food. Sci. Tech*. **12**, 144-151.

[136] M. M. Zhao, X. Y. Zhang and X. Yu (2012). Research on inhibition effect of spoilage bacteria in eggs by ethanol extracts from *Kadsura longipedunculata*, *J. Chin. Institute. Food. Sci. Tech*. **12**, 116-120.

[137] M. Miyazawa, Y. Okuno, K. Oshiro, H. Kasahara, H. Shimamura and S. Nakamura (1998). Suppression of the SOS-Inducing activity of Trp-P-1 and aflatoxin B_1 by meso-dihydroguaiaretic acid from machilus thunbergii in the salmonella typhimurium TA1535/pSK1002 umu test, *Biosci. Biotechnol. Biochem*. **62**, 1425-1427.

[138] A. F. Clemente-Soto, I. Balderas-Rentería, G. Rivera, A. Segura-Cabrera, E. Garza-González and M. del Rayo Camacho-Corona (2014). Potential mechanism of action of meso-dihydroguaiaretic acid on Mycobacterium tuberculosis H37Rv, *Molecules* **19**, 20170-82.

[139] Z. C. Li, J. Sun, Y. Feng, S. Y. Zhuo, N. Le and J. Y. Yao (2011). An experimental animal investigation on toxicity and blood lipid modulating effect of *Kadsura coccinea* fruit, *Food. Sci*. **32**, 203-205.

[140] X. L. Zhang, Z. H. Ling, Z. B. Long, X. J. Wang, L. X. Wu and Q. Tang (2022). Study on chemical composition, toxicity and hypolipidemic activity of *Kadsura coccinea* seed oil, *J. Chin. Cereals. Oils. Assoc*. **37**, 128-135.

[141] Y. S. Hsu, Y. H. Kuo, H. L. Cheng, P. R. Flatt and H. K. Liu (2012). *Schisandra arisanensis* extract attenuates cytokine-mediated cytotoxicity in insulin-secreting cells, *World. J. Gastroenterol*. **18**, 6809-6818.

[142] X. Li, J. Gao, Z. Yu, W. Jiang, W. Sun and C. Yu (2020). Regulatory effect of anwulignan on the immune function through its antioxidation and anti-apoptosis in D-galactose-induced aging mice, *Clin. Interv. Aging*. **15**, 97-110.

[143] Y. Liu, L. Y. Deng, L. Wang, J. H. Lv and L. Tan (2018). Effect of *Kadsura coccinea* alcohol extract on immunologic hepatic fibrosis in rats, *Chin. Pharm. J*. **53**, 1192-1197.

[144] H. J. Wang, H. Jiang and X. M. Deng (2011). Effects of Guizhou *Kadsura polysaccharide* (GKP) on cellular and humoral immunity of chicken, *Chin. J. Veterinary. Sci*. **31**, 884-886.

[145] W. Su, J. Zhao, M. Yang, H. W. Yan, T. Pang and S. H. Chen (2015). A coumarin lignanoid from the stems of *Kadsura heteroclite*, *Bioorg. Med. Chem. Lett*. **25**, 1506-1508.

[146] F. Xiao, H. M. Luo, X. G. Li and F. Gu (2002). The Effect of *Kadsura heteroclita* on the cultured hippocampai neurons, *J. Chin. Med. Materials*. **11**, 800-802.

[147] Y. Y. Zhou, Y. L. Liu, C. X. Dong and J. D. Yan (2013). Effect of schisandrin on expression of both SYP and α-syn in brain tissue of the APP/PS1 double transgenic dementia mice, *Chin. Pharm. Bull*. **29**, 1076-1079.

[148] R. Zang, T. Guo, X. H. Li, J. P. Yang, H. Y. He and Y. M. Wu (2021). Schisandrin A attenuates cerebral ischemia-reperfusion injury in rats by regulating autophagic flux, *Chin. J. Physiol*. **37**, 269-276.

[149] D. Hu (2012). Studies on active lignans from *Schisandra chinese* for anti-alzheimer's disease, *Shenyang. Pharm. Univ*. **1**, 1-195.

[150] Y. Jiang (2011). Studies on the chemical constituents and biological activities of *Schisandra sphenanthera*, *South-Central. Minzu. Univ*. **1**, 1-112.

[151] S. Mulyaningsih, M. Youns, M. Z. El-Readi, M. L. Ashour, E. Nibret and F. Sporer (2010). Biological activity of the essential oil of *Kadsura longipedunculata* (Schisandraceae) and its major components, *J. Pharm. Pharmacol*. **62**, 1037-44.

[152] H. Q. Li, C. Q. Bai, S. Chu, L. G. Zhou, S. Du and Z. Liu (2011). Chemical composition and toxicities of the essential oil derived from *Kadsura heteroclita* stems against Sitophilus zeamais and Meloidogyne incognita, *J. Med. Plants. Res*. **19**, 4943-4948.

[153] J. X. Liu, F. M. Dou and Y. P. Wang (2017). Insecticidal components of lignans in stems of *Schisandra chinensis*. *Nat. Prod. Res. Dev*. **29**, 1210-1217.

[154] C. R. Zhang (1990). Preliminary observations on the effect of *Kadsura longipedunculata* on experimental gastric ulcers in rats, *Chin. Trad. Herb. Drugs*. **21**, 27-28.

[155] X. Y. Zhang, S. Jing, H. J. Lin, W. Sun, W. H. Jiang and C. Y. Yu (2019). Anti-fatigue effect of anwulignan via the NRF2 and PGC-1α signaling pathway in mice, *Food. Funct*. **10**, 7755-7766.

[156] Y. J. Wu (2007). Effects of S*chisandra Chinensis* Baill and lignans on enzyme activity of hepatic CYP3A, *Chin. J. Clin. Pharm*. **5**, 267-271.

[157] A. D. Xiao, G. F. Guo and Q. L. Yu (2011). Anti-inflammatory effect and mechanism of methylgomisin O, *Chin. J. Veterinary. Sci*. **31**, 1309-1312+1317.

[158] J. Li, P. Zhang, W. Y. Li and Y. Song (2020). Research progress of deoxyschizandrin, *Chin. Pharm*. **29**, 53-56.

[159] X. Y. Zhang, Z. J. Wei, W. L. Qiao, X. M. Sun, Z. L. Jin and W. Gong (2021). Discovery of cyclooxygenase-2 inhibitors from *Kadsura coccinea* by affinity ultrafiltration mass spectrometry and the anti-inflammatory activity, *Fitoterapia*. **151**, 104872.

[160] W. C. Sim, S. Park, K. Y. Lee, Y. T. Je, H. Q. Yin and Y. J. Choi (2014). LXR-α antagonist meso-dihydroguaiaretic acid attenuates high-fat diet-induced nonalcoholic fatty liver, *Biochem. Pharmacol*. **90**, 414-424.

[161] P. T. Thuong, T. M. Hung, N. M. Khoi, H. T. Nhung, N. T. Chinh and N. T. Quy (2014). Cytotoxic and anti-tumor activities of lignans from the seeds of vietnamese nutmeg myristica fragrans, *Arch. Pharm. Res*. **37**, 399-403.

[162] X. M. Xie, X. Y. Wang, X. D. Shi, Y. Y. Zhang, K. V. Laster and K. D. Liu (2021). Anwulignan is a novel JAK_1 inhibitor that suppresses non-small cell lung cancer growth, *J. Cell. Mol. Med*. **25**, 2645-2654.

[163] Y. B. Liu, Y. P. Yang, S. Tasneem, N. Hussain, M. Daniyal and H. W. Yuan (2018). Lignans from Tujia ethnomedicine heilaohu: chemical characterization and evaluation of their cytotoxicity and antioxidant activities, *Molecules*. **23**, 2147.

[164] J. Q. Wang and J. Li (2018). Effects of schisandrin B in colon cancer cell line apoptosis through regulating PI3K/Akt signaling pathway, *Practical. Pharm. Clin. Remedies*. **21**, 487-490.

[165] X. W. Shi, Q. Q. Lu, X. J. Li, Y. F. Zhou, Y. Wan and W. M. Li (2020). Chemical constituents of the canes of *Schisandra sphenanthera* and their antioxidant activities, *J. Northwest. Forestry. Univ*. **35**, 207-212.

[166] M. C. Song, E. C. Kim, W. J. Kim and T. J. Kim (2014). Meso-dihydroguaiaretic acid inhibits rat aortic vascular smooth muscle cell proliferation by suppressing phosphorylation of platelet-derived growth factor receptor beta, *Eur. J. Pharm*. **744**, 36-41.

[167] H. Y. Li (2011). The study on Schisandrin and y-Schizandrin extraction by the ultrasonic extraction and the bacteriostatic action research, *Jilin. Agr. Univ*. **1**, 1-55.

[168] Y. P. Wang, T. F. Huang, D. S. Xu and K. Y. Wang (2007). Optimization of the extracting technique of deoxyschazandrin and study on antibacterial effect of *Schisandra* fruit extract, *J. Hubei. Eng. Univ*. **6**, 23-27.

[169] H. Dhakal, S. Lee, E. N. Kim, J. K. Choi, M. J. Kim and J. Kang (2019). Gomisin M_2 inhibits mast cell-mediated allergic inflammation via attenuation of FcεRI-Mediated Lyn and Fyn activation and intracellular calcium levels, *Front. Pharmacol*. **10**, 869.

[170] N. R. Han, P. D. Moon, N. R. Kim, H. Y. Kim, H. J. Jeong and H. M. Kim (2017). *Schisandra chinensis* and its main constituent schizandrin attenuate allergic reactions by down-regulating caspase-1 in ovalbumin-sensitized mice, *Am. J. Chin. Med*. **45**, 159-172.

[171] L. Z. Fang, C. F. Xie, H. Wang, D. Q. Jin, J. Xu and Y. Q. Guo (2014). Lignans from the roots of *Kadsura coccinea* and their inhibitory activities on LPS-induced NO production, *Phytochem. Lett*. **9**, 158-162.

[172] Z. R. Gu, A. X. Xu, F. Li, H. Qi, T. X. Ma and B. Ge (2019). Progress of central neuroprotective effects of TCMs and its active constituents based on PI3K/Akt signaling pathway, *Chin. J. New. Drugs*. **28**, 1593-1599.

[173] Z. Jin, Z. M. Wang, K. C. Liu, Q. X. He, Y. D. Qi and B. G. Zhang (2014). Chemical constituents of *Kadsura oblongifolia* and evaluation of their toxicity, *Acta. Pharmacol. Sin*. **49**, 1296-1303.

[174] Z. Xia, E. Hao, Z. Chen, M. Zhang, Y. Wei and M. Wei (2020). Roots and stems of *Kadsura coccinea* extract induced developmental toxicity in zebrafish embryos/larvae through apoptosis and oxidative stress, *Pharm. Biol*. **58**, 1294-1301.

[175] M. Deng (2018). Study on pharmacological long toxicity safety of extracts of *Kadsura heteroclita* on rats, S*henzhen. J. Integrated. Trad. Chin. West. Med*. **28**, 46-49.