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# Review article

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An updated and comprehensive review of the morphology, ethnomedicinal uses, phytochemistry, and pharmacological activity of *Aster tataricus* L. f

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## ABSTRACT

Ethnopharmacological relevance: Aster tataricus L.f., an extensively used herb in traditional Chinese medicine for more than 2000 years, is known as "Zi wan" or "Fan huncao". Its dried root and rhizome hold great promise in the treatment of cough, asthma, tumor, inflammation, etc. Aim of the study: This literature review summarizes the morphology characteristics, ethnopharmacological use, phytochemical properties, pharmacological effects, and potential applications of Aster tataricus. Furthermore, this review will discuss the future research trends and development prospects of this plant. Materials and methods: Using "Aster tataricus L.f.", "Traditional medicinal usage", "Phytochemistry", "Pharmacological effects" as the keywords and gathered relevant data on Aster tataricus L.f. using electronic databases (Elsevier, PubMed, ACS, CNKI, Google Scholar, Baidu Scholar, Web of Science), relevant books, and classic literature about Chinese herb. Result: A total of 186 compounds have been isolated and identified from Aster tataricus, including terpenes, organic acids, peptides, and flavonoids. And Aster tataricus has been widely used as a natural cough suppressant and has anti-oxidative, anti-inflammatory, anti-depressive, and antitumor effects. In addition, Aster tataricus has also been reported to have damaging effects on the liver as well as other toxicities were discussed in this review. Conclusions: Aster tataricus is an ancient herbal medicine with a broad spectrum of pharmaco logical activities that has been used for thousands of years in China, and has shown remarkable effectiveness in the treatment of various diseases, especially cough, asthma, inflammation. Although its rich chemical constituents have various pharmacological activities, the underlying mechanisms, as well as its toxicity and safety, remains unclear and warrant further investigation.

#### 1. Introduction

Aster tataricus L. f. (Aster tataricus), also named Qing wan, Fan huncao, and Guan gongxu, is a perennial herb in the Asteraceae

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### Abbreviations

TCM traditional Chinese medicine UHPLC-Q-TOF-MS Ultra-high performance liquid chromatography coupled with triple quadrupole mass spectrometry HPLC-Q-TOF/MS High-performance liquid chromatography quadrupole time-of-flight mass spectrometry HPLC-MS High performance liquid chromatography-mass spectrometry Ovalbumin OVA 1,1-Diphenyl-2-picrylhydrazyl radical DPPH Median lethal dose: LD<sub>50</sub>

family, and it is widely cultivated in wetlands on shady slopes of low mountains, hilltops, low-mountain grasslands, and marshes at an altitude of 400–2000 m [1]. The medicinal use of its dried root and rhizome was first reported in Shennong Materia Medica [2–4]. Chinese Materia Medica states that *Aster tataricus* is widely distributed in Anhui, Hebei, Neimenggu, northeast China, Korea, and Japan.

*Aster tataricus* has been used in traditional Chinese medicine (TCM) for more than 2000 years. It is acrid and bitter in flavor, warm, and acts on the lung channels. It has remarkable therapeutic effects, especially cough relief and phlegm elimination [5]. According to folklore, *Aster tataricus* is usually brewed or decocted and administered orally to treat cough and asthma (Runfeizhike and Huatan) [6, 7]. The active ingredients of medicinal plants are the material basis for the treatment and prevention of diseases and may guide the development of new and more effective therapeutic drugs. Phytochemical studies have shown that *Aster tataricus* is rich in various ingredients, encompassing terpenes, flavonoids, peptides, organic acids, and other compounds [8–11]. With increasing interest in research on the pharmacological activities of *Aster tataricus*, researchers have found it have potent pharmacological activities, such as anti-tussive, anti-asthmatic, anti-tumor, anti-inflammatory, anti-bacterial, anti-oxidant, and anti-depressant activities [5,12–14]. To date, *Aster tataricus* has been widely used in various proprietary Chinese medications. This review summarizes the morphology characteristics, phytochemical composition, pharmacological effects, and medicinal applications of *Aster tataricus*, providing a reference for further research and development.

## 2. Botany

Aster tataricus, a member of the Asteraceae family, is distributed worldwide, especially in China, Korea, and Japan [15]. It was first reported in the Han Dynasty, and its name has been changed over time (Table 1). Aster tataricus is usually harvested in spring and autumn. Subsequently, the rhizomes (commonly called "Mugen") and sediments are removed, and the roots are dried in the sun, either braided or unbraided.

According to Chinese Pharmacopoeia (2020 version), the rhizome of *Aster tataricus* exists as irregular lumps of varying sizes, with the stem and leaf stumps at the top, and its texture is slightly hard. According to Illustrations of Chinese Medicinal Plants and Colored Atlas of Chinese Folk Herbs, the stems of *Aster tataricus* (Fig. 1) grow erect to a height of approximately 1.5–2 m, are slightly branched at the upper end, and have sparsely distributed short bristles. Roots and foliage lush, withered at flowering time, and the leaves are long, elliptical, and obtuse-headed and sparsely setulose on both surfaces, with the base tapered or winged. The stalk is slender, and the margin is serrated. Capitula on branchlets with a dozen or more flowers are usually cephalic, and the stems are 2.5–3.3-cm long. The pedicels are long and densely setose. The involucre is hemispherical, with a length of 7 mm. The bracteolates are lanceolate, short, and slightly hairy and are arranged in whorls of three, with scarious margins. The corolla is purple, with a length of 1.6–1.7 cm and a width of 0.3–0.35 cm. The corolla tube is cylindrical with a yellow inner surface. The fruit is small and slightly compressed, with a length of 3 mm, and has white crown hair.

## 3. Ethnopharmacology

Since ancient times, scholars have been attempting to maximize the use of natural resources. The use of TCM in preventing and treating diseases has remarkably improved human health. Since the first mention of *Aster tataricus* in "Shen Nong Ben Cao Jing", its

Table 1
Names of Aster tataricus in different literary works.

	5	
Dynasty	Title	Name
Wei and Jin dynasties	Wupu Bencao	Qing wan
	Records of Famous Doctors	Zi qian, Qing wan
Southern Dynasty	Notes on the Materia Medica	Zi wan, Qing wan
Tang Dynasty	Xin Xiu Ben Cao	Zi qian, Qing wan
	Qianjin Yifang	Zi qian, Qing wan
Song Dynasty	Dou Men Fang	Fan huncao, Ye qianniu
Qing Dynasty	Ben Cao Shu	Zi wanrong
	Compendium of Materia Medica	Qing wan, Zi wan, Fan huncao, Ye qianniu
	Textual Research on Reality and Titles of Plants	Guan gongxu



Fig. 1. Plant morphology of Aster tataricus.

therapeutic effects on cough and asthma have been reported in various medical books. According to "Ming Yi Bie Lu", *Aster tataricus* can be used to treat cough with blood in phlegm. Similar therapeutic effects of *Aster tataricus* have been mentioned in "Xin Xiu Ben Cao", "Qian Jin Yi Fang", "Zheng Lei Ben Cao", and "Yao Jian". Some traditional medical books, such as "Bei Ji Qian Jin Yao Fang", "Ben Cao Cong Xin", and "Zhong Hua Ben Cao", have mentioned that *Aster tataricus* can be used to treat dyspepsia; however, this information is not found in modern books. In addition, "Dou Men Fang", "Ben Cao Shu", and "De Pei Ben Cao" have documented the use of *Aster tataricus* in the treatment of sore throats. The effects and contraindications of *Aster tataricus* reported in different literary works in different time periods are summarized in Table 2.

To enhance its therapeutic efficacy and reduce its side effects, *Aster tataricus* was traditionally processed using refined honey, vinegar and wine, processing children's feces and ginger. However, modern processing methods mainly involve the use of honey and bran. The standard of pharmaceutical concoctions varies across regions. The main purpose of processing *Aster tataricus* is to reduce its coldness and enhance its therapeutic effects. *Aster tataricus* can clear heat and phlegm, thereby relieving cough. When consumed raw, it

## Table 2

Ethnopharmacology	/ of Aster	tataricus	throughout	the	Chinese	dyn	asties.
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Dynasty	Efficacy	Contraindications	Title
Qin and Han dynasties	Relieves cough, increases Qi, regulates cold and heat in the chest, removes parasites and toxins, and tranquilizes the five viscera		Shen Nong Ben Cao Jing
Northern and Southern dynasties	Treats pulmonary abscess, weakness caused by the "five Lao", and pediatric convulsions	Not to be combined with Tian Xiong, Qu Mai, Lei Puan, Yuan Zhi, Fen Yin, and herba artemisias capillaris	Ming Yi Bie Lu
Tang dynasty	Relieves cough; increases Qi; regulates cold and heat in the chest; removes parasites and toxins; tranquilizes the five viscera; and treats pulmonary abscess, weakness caused by the "five Lao", and pediatric convulsions	Not to be combined with Tian Xiong, Qu Mai, Lei Puan, Yuan Zhi, Gao ben, Fen Yin, and herba artemisias capillaris	Xin Xiu Ben Cao
Song dynasty	Shi Zhu and fever due to deficiency	Not to be combined with Tian Xiong, Qu Mai, Lei Puan, Yuan Zhi, Gao ben, Fen Yin, and Artemisia Chen	Jia You Ben Cao
Ming dynasty	Treats shortness of breath and cough	Not to be combined with Tian Xiong, Qu Mai, Lei Puan, Yuan Zhi, Gao ben, Fen Yin, and herba artemisias capillaris	Bencao Pinhui Jingyao
Qing dynasty	Protects the lungs and treats vomiting blood and cough with blood in phlegm	An appropriate amount to be used in patients with yin deficiency and lung-heat syndrome	Ben Cao Hai Li
	Regulates cold and heat in the chest, relieves cough, increases Qi, and treats bloody sputum and pediatric convulsions	Not to be combined with Tian Xiong, Qu Mai, Yuan Zhi, Gao ben, and herba artemisias capillaris	Ben Cao Bei Yao
	Relieves cough due to exhaustion and treats hematochezia	Not to be combined with Tian Xiong, Qu Mai, Yuan Zhi, Gao ben, and herba artemisias capillaris	Ben Cao Qiu Zhen
1959	Regulates cold and heat in the chest and relieves cough, vomiting blood, breathlessness, and pharyngitis	Not suitable for patients with heat in the lungs	Zhong Yao Zhi
1999	Reduces phlegm, suppresses cough, and treats bacterial infections	Saponins derived from Aster tataricus have strong hemolytic effects and their crude forms are not suitable for intravenous injection; the volatile oil of Aster tataricus is more toxic than that of Ligularia fischeri	Chinese Materia Medica
2020	Relieves cough with excessive phlegm and wheezing, chronic cough, and coughing up blood with exertion		Chinese pharmacopoeia

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can Qingfei and has the effect of clearing heat and resolving phlegm, but it is only suitable for symptoms of obstructed lung qi and coughing up a lot of phlegm. Roasting *Aster tataricus* with honey increases its sweetness and enhances its effectiveness in moistening the lungs and relieving cough [2].

Aster tataricus can be used as not only a medication but also an ingredient in food products within a limited dose range. In particular, it has been used in tea, porridge, and soup. Ancient medical records show that Aster tataricus can be combined with other traditional Chinese herbs to treat asthma, cough, constipation, impotence, and carbuncles [16]. Shegan Mahuang Soup, which comprises 41.4-g Aster tataricus, Ephedra, and Belamcanda chinensis, is used to relieve phlegm, reduce cold, and treat lung and throat infections. Ze Qi Soup, which comprises 69-g Aster tataricus and Euphorbia helioscopia, is mainly used to treat occasional wheezing and coughing, body swelling, and restlessness. Bu Fei Soup, which comprises 3.1-g Aster tataricus and Sangbaipi, is used to treat cough and asthma due to lung deficiency. Zi Wan Soup, which comprises 13.8-g Aster tataricus, is effective in relieving upper airway obstruction [11].

With a long history of medicinal use, *Aster tataricus* has demonstrated good efficacy in the treatment of many complicated and recurrent diseases. It is a widely used source of natural bioactive components in TCM. In-depth research into the pharmacological effects of *Aster tataricus* is ongoing.

## 4. Phytochemistry

With the development of extraction and separation methods, scholars have identified several chemical constituents of *Aster tataricus*. To date, approximately 200 chemical compounds, including 73 terpenes, 34 flavonoids, 26 organic acids, 21 peptides, and 32 other compounds, have been isolated and identified from *Aster tataricus*, with terpenes being the main active components. The proportions of all chemical constituents are shown in Fig. 2, and their specific details are summarized in Table 3.

## 4.1. Terpenes

Terpenes are polymers of isoprene and its derivatives. They are synthesized from isoprene pyrophosphate, with most of them having a structure in which the isoprene residues are linked at the head and tail. Based on the number of isoprene units (5 carbon units), terpenes are classified as monoterpenes (2 units), sesquiterpenes (3 units), diterpenes (4 units), triterpenes (6 units), tetraterpenes (8 units), and polyterpenes (more than 8 units). Terpenes are the primary components of *Aster tataricus*. To date, 73 terpenes (Fig. 3) have been isolated from *Aster tataricus*, with triterpenes and triterpenoid saponins being the main types. In particular, shionane-type triterpenes have been identified as the main constituents of *Aster tataricus* and shown to have anti-tussive and expectorant activities [38]. According to the Chinese Pharmacopoeia (2020), shionone can be used as a maker for the quality control of *Aster tataricus*.

#### 4.2. Flavonoids

Flavonoids are one of the most important natural compounds widely found in the in the plant kingdom [39]. They have a core 2-phenyl chromone nucleus without the substitution of an oxygen-containing group at the 3' end [40]. In a study, *Aster tataricus* was ultrasonicated with 25 mL of methanol for 30 min and subjected to UHPLC-Q-TOF-MS to yield different flavonoids [3]. To date, 34 flavonoids have been isolated from *Aster tataricus*, including flavonols, flavones, and their glycoside. The chemical structures of these molecules and sources are presented in Table 3 and Fig. 4.

### 4.3. Peptides



Peptides are the characteristic components of *Aster tataricus* [41], mainly including oligopeptides, acyclic peptides, and chlorinated cyclic peptides [11]. They exhibit diverse biological activities, including anti-tumor and immune-regulatory activities [42]. However,

Fig. 2. Proportion of each chemical constituent in Aster tataricus.

#### Table 3

Specific details of the chemical constituents isolated from Aster tataricus.

No.	Compounds	MF	Resource	Extraction methods	References		
Terper	Terpenes (1–73)						
1	Shion-22-methoxy-20(21)-en-3-one	C31H52O2	Roots and rhizomes	95 % EtOH	[17]		
2	Shion-22(30)-en-3,2,1-dione	C <sub>30</sub> H <sub>48</sub> O <sub>2</sub>	Roots and rhizomes	95 % EtOH	[17]		
3	Shion-21-hvdroxyl-22(30)-en-3-one	C30H50O2	Roots and rhizomes	95 % EtOH	[17]		
4	Shion-22-methoxy-20(21)-en-3-ol	C31H54O2	Roots and rhizomes	95 % EtOH	[17]		
5	Shione	C <sub>30</sub> H <sub>50</sub> O	Roots and rhizomes	95 % EtOH	[17]		
6	Epishionol	C30H52O	Roots and rhizomes	95 % EtOH	[17]		
7	Friedelane	C30H52	Roots and rhizomes	95 % EtOH	[17]		
8	Epifriedelanol	C20H=2O	Roots and rhizomes	95 % EtOH	[17]		
9	24-Ethyl-5a-cholesta-7.22(E)-dien-3-one	C34H56O	Roots and rhizomes	95 % EtOH	[17]		
10	Xvlonenone	C20H=0O	Whole plant	MeOH	[18]		
11	Friedelan-4-α-methyl-3β-OH	C20H=2O	Whole plant	MeOH	[18]		
12	β-Sitosterol	C20H50O	Whole plant	MeOH	[18]		
13	Stigmasterol	C29H48O	Whole plant	MeOH	[18]		
14	Campesterol	C28H48O	Whole plant	MeOH	[18]		
15	Epifriedelanol	C20H50O	Roots and rhizomes	95 % EtOH	[19]		
16	α-Spinach sterols	C <sub>20</sub> H <sub>40</sub> O	Roots and rhizomes	95 % EtOH	[19]		
17	Betulin	C23-1480	Roots and rhizomes	95 % EtOH	[19]		
18	Oleanolic acid	C20H40O2	Roots and rhizomes	95 % EtOH	[19]		
19	Shionoside A	C21H26O10	Roots	MeOH	[20]		
20	Shionoside B	C22H38O10	Roots	MeOH	[20]		
21	Epifriedelinol	C20H=20	Roots	MeOH	[20]		
22	Astertarone A	C20HE0O	Roots	MeOH	[21]		
23	Shionone	C20H=0O	Roots and rhizomes	MeOH	[21]		
24	Friedelin	C20H=0O	Roots and rhizomes	MeOH	[21]		
25	Astertarone B	CatHraOa	Roots	MeOH	[21]		
26	Oleanic acid	C21H=0O2	Roots and rhizomes	Methanol	[22]		
27	Taraxerol	C20H40	Roots and rhizomes	Methanol	[22]		
28	Betulin	CaoH=aOa	Roots and rhizomes	Methanol	[22]		
29	Taraxasterol	C20H=00	Roots and rhizomes	Methanol	[22]		
30	Beta-amyrin	C20H=0O	Roots and rhizomes	Methanol	[22]		
31	Aster shionone A	C26H42O2	Roots and rhizomes	Methanol	[23]		
32	Aster shionone B	C20H46O2	Roots and rhizomes	Methanol	[23]		
33	Aster shionone C	C27H44O3	Roots and rhizomes	Methanol	[23]		
34	Aster shionone D	C27H46O	Roots and rhizomes	Methanol	[23]		
35	Aster shionone E	C <sub>27</sub> H <sub>42</sub> O <sub>3</sub>	Roots and rhizomes	Methanol	[23]		
36	Aster shionone F	C27H42O2	Roots and rhizomes	Methanol	[23]		
37	Friedelan-3-ol	C <sub>30</sub> H <sub>52</sub> O <sub>2</sub>	Roots	MeOH	[24]		
38	Echinocystic acid	C <sub>30</sub> H <sub>48</sub> O <sub>4</sub>	Roots and rhizomes	Methanol	[22]		
39	Betulinic acid	C <sub>30</sub> H <sub>48</sub> O <sub>3</sub>	Roots and rhizomes	Methanol	[22]		
40	2,3,24-Trihydroxyolean-12-en-28-oic acid	C <sub>30</sub> H <sub>48</sub> O <sub>5</sub>	Roots and rhizomes	Methanol	[22]		
41	23-Hydroxybetulinic acid	C31H50O4	Roots and rhizomes	Methanol	[22]		
42	Shion-22-methoxy-20(21)-en-3-one	C31H52O2	Rhizomes	Methanol	[23]		
43	Shion-22-methoxy-20(21)-en-3β-ol	C31H54O2	Rhizomes	Methanol	[23]		
44	Shion-22(30)-en-3,21-dione	C29H46O2	Rhizomes	Methanol	[23]		
45	15-Hydroxydehydroab ietic acid	C20H28O3	Roots	MeOH	[25]		
46	7β-Hydroxydehydroabietie acid	C21H30O2	Roots	MeOH	[25]		
47	Junicedric acid	C21H34O4	Roots	MeOH	[25]		
48	(13S)-15-hydroxylubd-8(17)-en-19-oic acid	C20H34O3	Roots	MeOH	[25]		
49	(11S)-1β-hydroxyeudesm-4(14)-eno-13,6α-lactone	C15H22O3	Roots	MeOH	[25]		
50	Aster saponin G2	C57H92O25	Underground parts	Methanol	[26]		
51	Aster saponin H	C46H74O18	Underground parts	Methanol	[26]		
52	3-O- $\alpha$ -L-arabinopyranosyl-(1 $\rightarrow$ 6)- $\beta$ -D-trihydroxyolean-12-en-28-oic	C41H66O14	Underground parts	Methanol	[26]		
	acid						
53	Aster saponin G	C57H92O26	Underground parts	Methanol	[26]		
54	Aster saponin C2	C73H118O37	Underground parts	Methanol	[26]		
55	Aster saponin A2	C <sub>67</sub> H <sub>108</sub> O <sub>33</sub>	Underground parts	Methanol	[26]		
56	Aster lingulatoside D	C <sub>27</sub> H <sub>46</sub> O	Whole plant	-	[27]		
57	Aster lingulatoside C	$C_{27}H_{44}O_3$	Whole plant	-	[27]		
58	Aster lingulatoside B	$C_{29}H_{46}O_2$	Whole plant	70 % EtOH	[28]		
59	Aster lingulatoside A	$C_{26}H_{42}O_3$	Whole plant	70 % EtOH	[28]		
60	Aster saponin A	C68H110O33	Roots	MeOH	[20]		
61	Aster saponin B	C62H100O29	Roots	MeOH	[20]		
62	Aster saponin C	C74H120O37	Roots	MeOH	[20]		
63	Aster saponin D	C73H188O36	Roots	MeOH	[20]		
64	Aster batanoside B	C44H72O15	Roots	70 % EtOH	[29]		
65	Aster batanoside C	C44H70O15	Roots	70 % EtOH	[29]		
66	Aster saponin Hb	C42H66O13	Aboveground parts	MeOH	[30]		

(continued on next page)

#### Table 3 (continued)

No.         Compounds         MP         Resource         Exaction methods           67         Anter saponin E         C <sub>10</sub> H <sub>10</sub> O <sub>20</sub> Rots         Molit           67         Anter saponin Fin         C <sub>10</sub> H <sub>10</sub> O <sub>20</sub> Antersequent Fin         MOIIt           70         Anter saponin Hin         C <sub>10</sub> H <sub>10</sub> O <sub>20</sub> Antersequent MOIIt         MOIIt           71         Anter saponin Hin         C <sub>10</sub> H <sub>10</sub> O <sub>20</sub> Antersequent MOIIt         MOIIt           71         Anter saponin Hin         MOIIt         C <sub>10</sub> H <sub>10</sub> O <sub>20</sub> Antersequent MOIIt         MOIIt           72         Arter staponin Hin         C <sub>10</sub> H <sub>10</sub> O <sub>20</sub> Rotsequent MOIIt         MOIIt           73         Fordifissionde A         C <sub>10</sub> H <sub>10</sub> O <sub>20</sub> Rotsequent Moint         MOIIt           74         Kaempferol         C <sub>10</sub> H <sub>10</sub> O <sub>10</sub> Wolor plant         MOIIt           75         Kaempferol         C <sub>10</sub> H <sub>10</sub> O <sub>10</sub> Rotse and ributes         Motion           76         Kaempferol         C <sub>10</sub> H <sub>10</sub> O <sub>10</sub> Rotse and ributes         Motion           76         Kaempferol         C <sub>10</sub> H <sub>10</sub> O <sub>10</sub> Rots and ributes         Motion           77         Fordifissin A         Rotse and ributes <t< th=""><th>Tuble J</th><th>(continued)</th><th></th><th></th><th></th><th></th></t<>	Tuble J	(continued)					
67Addre sponie FCall hussisModel68Addre sponie FCall hussisModel69Addre sponie HaCall hussisModel69Addre sponie HaCall hussisModel71Addre sponie HaCall hussisModel72Addre sponie HaCall hussisModel73Addre sponie HaCall hussisModel74Addre Sponie HaCall hussisModel75Addre Sponie HaCall hussisModel76Addre Sponie HaCall hussisModel77Addre Sponie HaCall hussisModel78Addre Sponie HaCall hussisModel79DilydoroxyricetinCall hussisRoots and hizonersMedha79DilydoroxyricetinCall hussisRoots and hizonersMedha81MyricetinCall hussisRoots and hizonersMedhanol82LiquiritigeniaCall hussisRoots and hizonersMedhanol83LaureolinCall hussisRoots and hizonersMedhanol84NaringeniaCall hussisRoots and hizonersMedhanol84NaringeniaCall hussisRoots and hizonersMedhanol84NaringeniaCall hussisRoots and hizonersMedhanol85Carl hussisRoots and hizonersMedhanol86AdzertinCall hussisRoots and hizonersMedhanol87Carl hussisRoots and hizonersMedhanol	No.	Compounds	MF	Resource	Extraction methods	References	
68         Atter saponin Fn         Call solog         Roots         MoCHI           70         Atter saponin Hn         Call solog         Aboreground parts         MoCHI           71         Atter saponin Hn         Call solog         Aboreground parts         MoCHI           71         Atter satunoide F         Call solog         Aboreground parts         MoCHI           72         Atter batanoide F         Call solog         Aboreground parts         MoCHI           73         Fortifissimoide A         Call solog         Aboreground parts         MoCHI           74         Kaempferol         Call solog         Wolog plant         MoCHI           75         Kaempferol         Call solog         Wolog plant         MoCHI           76         Kaempferol         Call solog         Roots and fritomers         MoCHI           76         Kaempferol         Call solog         Roots and fritomers         MoCHI           77         Kaempferol         Call solog         Roots and fritomers         MoCHI           78         Myrictrin         Call solog         Roots and fritomers         MoCHI           78         Kaempferol         Call solog         Roots and fritomers         MoCHI           78	67	Aster saponin E	C <sub>63</sub> H <sub>109</sub> O <sub>29</sub>	Roots	МеОН	[20]	
99Atter sponin Ha $C_{11}^{12}O_{12}^{12}$ Atter sponin Hk $MeOH$ 71Atter sponin Hk $C_{11}^{11}O_{12}^{12}$ Atter showind parts $MeOH$ 72Atter showinds FP $C_{11}^{11}O_{12}^{12}$ $MeoH$ $MeOH$ 73Foreidlissimoside A $C_{11}^{11}O_{12}^{12}$ $MeoH$ $MeOH$ 74Sarenpferol $C_{11}^{11}O_{12}^{12}$ $MeOH$ $MeOH$ 74Sarenpferol $C_{11}^{11}O_{12}^{12}$ $MeOH$ $MeOH$ 74Sarenpferol $C_{11}^{11}O_{12}^{12}$ $MeOH$ $MeOH$ 75Appennication Constraint $C_{11}^{11}O_{12}^{12}$ $MeOH$ $MeOH$ 76Sarenpferol $C_{11}^{11}O_{12}^{12}$ $MeOH$ $MeOH$ 78Marritchin $C_{11}^{11}O_{12}^{12}$ $MeOH$ $MeOH$ 79Dilydomyritchin $C_{11}^{11}O_{12}^{12}$ $Roots and fhizomesMehanol81MyritchinC_{11}^{11}O_{12}^{12}Roots and fhizomesMehanol82LiquittigeninC_{11}^{11}O_{12}^{12}^{12}^{12}^{12}^{12}^{12}^{12}^$	68	Aster saponin F	C <sub>63</sub> H <sub>108</sub> O <sub>28</sub>	Roots	MeOH	[20]	
70     Atter spanni Hc     Call Ago, Moveground parts     McOH       71     Atter stanoaide F     Call Ago, Moveground parts     McOH       73     Fortifismoide A     Call Ago, Moveground parts     McOH       74     Karengferol     Call Ago, Moveground parts     McOH       75     Fortifismoide A     Call Ago, Moveground parts     McOH       76     Karengferol     Call Ago, Moveground parts     McOH       77     Karengferol     Call Ago, Moveground Parts     McOH       78     Karengferol     Call Ago, Moveground Parts     McOH       78     Karengferol     Call Ago, Moveground Parts     McOH       78     Karengferol     Call Ago, Moveground Parts     McOH       79     Karengferol     Call Ago, Moveground Parts     McOH       70     Karengferol     Call Ago, Moveground Parts	69	Aster saponin Ha	C38H58O13	Aboveground parts	MeOH	[20]	
71Axter saponin HdCq.H $_{10}O_{20}$ RootsMeOH73Arter stanoide FCq.H $_{10}O_{10}$ Noveground parsNOH74KaempferolCq.H $_{10}O_{10}$ Whole plantMeOH75Apigenin C>-O-D-DucuronideCq.H $_{10}O_{10}$ Whole plantMeOH76Kaempferol >O ex-channoideCq.H $_{10}O_{10}$ Whole plantMeOH78Kaempferol >O ex-channoideCq.H $_{10}O_{10}$ Whole plantMeOH78Kaempferol >O ex-channoideCq.H $_{10}O_{10}$ Whole plantMeOH78Kaempferol >O ex-channoideCq.H $_{10}O_{10}$ Roots and frizomesMehanol80MyriterinCq.H $_{10}O_{10}$ Roots and frizomesMehanol81MyriterinCq.H $_{10}O_{10}$ Roots and frizomesMehanol82CardistrinCq.H $_{10}O_{10}$ Roots and frizomesMehanol84AvaitergeninCq.H $_{10}O_{10}$ Roots and frizomesMehanol85CardistrinCq.H $_{10}O_{10}$ Roots and frizomesMehanol86AscertinCq.H $_{10}O_{10}$ Roots and frizomesMehanol89IsoenanceinCq.H $_{10}O_{10}$ Roots and frizomesMehanol91IsochanceinCq.H $_{10}O_{10}$ Roots and frizomesMehanol92WogoninCq.H $_{10}O_{10}$ Roots and frizomesMehanol93IsochanceinCq.H $_{10}O_{10}$ Roots and frizomesMehanol94IscalinCq.H $_{10}O_{10}$	70	Aster saponin Hc	C58H92O25	Aboveground parts	MeOH	[20]	
72Aster banaoide FCall $A_Q_{24}$ NootsMeDH <b>Havroxids (74-107)</b> Call $A_Q_{16}$ Nohla plantMeCH <b>Flavorsids (74-107)</b> Call $A_Q_{16}$ Whola plantMeCH <b>75</b> Apigenin 7-O; P-D sucuronideCall $A_Q_{16}$ Whola plantMeCH <b>76</b> Keempferol 7-O; e-u-rhannosideCall $A_Q_{16}$ Nota drizionesAcctore <b>79</b> DibydromyricerinCall $A_Q_{16}$ Roots and drizionesMethanol <b>79</b> DibydromyricerinCall $A_Q_{16}$ Roots and drizionesMethanol <b>81</b> MyricerinCall $A_Q_{16}$ Roots and drizionesMethanol <b>82</b> LiquitrigeninCall $A_Q_{16}$ Roots and drizionesMethanol <b>83</b> LuteolinCall $A_Q_{16}$ Roots and drizionesMethanol <b>84</b> NaringeninCall $A_Q_{16}$ Roots and drizionesMethanol <b>85</b> GensteinCall $A_Q_{16}$ Roots and drizionesMethanol <b>86</b> AperininCall $A_Q_{16}$ Roots and drizionesMethanol <b>87</b> GensteinCall $A_Q_{16}$ Roots and drizionesMethanol <b>88</b> ApigenininCall $A_Q_{16}$ Roots and drizionesMethanol <b>89</b> DicomethinCall $A_Q_{16}$ Roots and drizionesMethanol <b>80</b> DicomethinCall $A_Q_{16}$ Roots and drizionesMethanol <b>81</b> MargenininCall $A_Q_{16}$ Roots and drizionesMethanol <b>82</b> JocamitriniCall $A_Q_{16}$ Roots and	71	Aster saponin Hd	C64H102O26	Aboveground parts	MeOH	[20]	
73Fortidisamoside $\Lambda$ $0.9 \pm 0.01$ Aboveground part $0.9 \pm 0.01$ 74Kaempferol $C_3H_0, O_h$ Whole plantMcOH75Angeinr. 7-Q-P-Diturcondie $C_2H_0, O_h$ Whole plantMcOH76Kaempferol-3-O-as-thannosite $C_2H_0, O_h$ Whole plantMcOH78Kompferol-3-O-as-thannosite $C_3H_0, O_h$ Nots and thizomesActence79Dixdyoryricetin $C_3H_0, O_h$ Rots and thizomesActence70Dixdyoryricetin $C_3H_0, O_h$ Rots and thizomesMethanol81Myricetin $C_3H_0, O_h$ Rots and thizomesMethanol82Liquivitigenin $C_3H_0, O_h$ Rots and thizomesMethanol83Larectin $C_3H_0, O_h$ Rots and thizomesMethanol84Naringenin $C_3H_0, O_h$ Rots and thizomesMethanol85Genistein $C_3H_0, O_h$ Rots and thizomesMethanol86Acacetin $C_3H_0, O_h$ Rots and thizomesMethanol87Genkwanin $C_3H_0, O_h$ Rots and thizomesMethanol88Apigenin $C_3H_0, O_h$ Rots and thizomesMethanol90Isorhammetin $C_3H_0, O_h$ Rots and thizomesMethanol91Baicalein $C_3H_0, O_h$ Rots and thizomesMethanol92Wogonin $C_3H_0, O_h$ Rots and thizomesMethanol93Biorohin $C_3H_0, O_h$ Rots and thizomesMethanol94Baicalin <td>72</td> <td>Aster batanoside F</td> <td>C56H90O24</td> <td>Roots</td> <td>MeOH</td> <td>[20]</td>	72	Aster batanoside F	C56H90O24	Roots	MeOH	[20]	
Favoracids (74-107)KampferolCirclino, Circlino, Cir	73	Foetidissimoside A	C56H90O18	Aboveground parts	70 % EtOH	[31]	
74KaempferolCapHapOaWhole plantMeCH75Apgemin 7-O;D-BgucuronideCapHa,OaWhole plantMeCH76Kaempferol-3-O-ar-channosideCapHa,OaWhole plantMeCH78QuercetinCapHa,OaWhole plantMeCH78QuercetinCapHa,OaRoots and hizomsKethanol79BhydromyrcetinCapHa,OaRoots and hizomsMethanol80MyrictrinCapHa,OaRoots and hizomsMethanol81MyricetinCapHa,OaRoots and hizomsMethanol82LaquiritigeninCapHa,OaRoots and hizomsMethanol83LatectinCapHa,OaRoots and hizomsMethanol84NaringeninCapHa,OaRoots and hizomsMethanol85GanisteinCapHa,OaRoots and hizomsMethanol86AacactinCapHa,OaRoots and hizomsMethanol87GankwaninCapHa,OaRoots and hizomsMethanol88ApigeninCapHa,OaRoots and hizomsMethanol90IsochammetinCapHa,OaRoots and hizomsMethanol91BaicalinCapHa,OaRoots and hizomsMethanol92WogoninCapHa,OaRoots and hizomsMethanol93BiorobinCapHa,OaRoots and hizomsMethanol94BaicalinCapHa,OaRoots and hizomsMethanol95Kaempferol-7-O-P-s-glucopyranosideCapHa,OaRoots and hi	Flavon	oids (74–107)		<b>0</b>			
75     Agigemin 7-Og-P-Oglucuronide     CapHa,O <sub>0</sub> Whole plant     McOH       77     Kæmpferol 3-Og-schammoside     CapHa,O <sub>0</sub> Whole plant     McOH       78     Quercein     CapHa,O <sub>1</sub> Whole plant     McOH       79     Dilydromyricetin     CapHa,O <sub>1</sub> Roots and hizoms     Methanol       81     Myricetin     CapHa,O <sub>4</sub> Roots and hizoms     Methanol       82     Liquitrigenin     CapHa,O <sub>4</sub> Roots and hizoms     Methanol       83     Lutcolin     CapHa,O <sub>4</sub> Roots and hizoms     Methanol       84     Naringemin     CapHa,O <sub>4</sub> Roots and hizoms     Methanol       85     Genistein     CapHa,O <sub>4</sub> Roots and hizoms     Methanol       86     Ascertin     CapHa,O <sub>4</sub> Roots and hizoms     Methanol       87     Genistein     CapHa,O <sub>4</sub> Roots and hizoms     Methanol       88     Apigemin     CapHa,O <sub>4</sub> Roots and hizoms     Methanol       91     Baicalein     CapHa,O <sub>4</sub> Roots and hizoms     Methanol       92     Wogomin     CapHa,O <sub>4</sub> Roots and hizoms     Methanol       93     Biorobin     CapHa,O <sub>4</sub> Roots and hizoms     Methanol       94     Baicalein     CapHa,O <sub>4</sub> R	74	Kaempferol	C15H10O6	Whole plant	MeOH	[18]	
76Kaempferol-3-0-sc-thannoside $C_{12}H_{10}O_{10}$ Whole plantMeCH78Quercetin $C_{12}H_{10}O_{10}$ Roots and hizzonsAcetone79Dilydrovrletin $C_{12}H_{10}O_{10}$ Roots and hizzonsMethanol80Myrictrin $C_{12}H_{10}O_{10}$ Roots and hizzonsMethanol81Myrictrin $C_{12}H_{10}O_{10}$ Roots and hizzonsMethanol82Lingvirtigenin $C_{12}H_{10}O_{10}$ Roots and hizzonsMethanol83Lurctolin $C_{12}H_{10}O_{10}$ Roots and hizzonsMethanol84Naringsenin $C_{12}H_{10}O_{10}$ Roots and hizzonsMethanol85Gentistria $C_{12}H_{10}O_{10}$ Roots and hizzonsMethanol86Acacetin $C_{12}H_{10}O_{10}$ Roots and hizzonsMethanol87Gentivavain $C_{11}H_{10}O_{10}$ Roots and hizzonsMethanol88Argigenin $C_{11}H_{10}O_{10}$ Roots and hizzonsMethanol90Isoentameetin $C_{11}H_{10}O_{10}$ Roots and hizzonsMethanol91Basclelin $C_{11}H_{10}O_{10}$ Roots and hizzonsMethanol92Wegonin $C_{21}H_{20}O_{10}$ Roots and hizzonsMethanol93Biorbin $C_{11}H_{20}O_{10}$ Roots and hizzonsMethanol94Basclelin $C_{21}H_{20}O_{10}$ Roots and hizzonsMethanol95Koempferol - 7.0 Proglucopyranoside $C_{21}H_{20}O_{10}$ Roots and hizzonsMethanol9	75	Apigenin-7-O-β-D-glucuronide	C22H20O10	Whole plant	MeOH	[18]	
77     Kaempiren/3-70-as-rhamnopyranoside     Cg.H.g.O.g.     Whole plant     Mechanol       79     Dibydromyricetin     Cg.H.g.O.g.     Noors and rhizomes     Methanol       81     Myricetin     Cg.H.g.O.g.     Noors and rhizomes     Methanol       81     Lutprilfrepin     Cg.H.g.O.g.     Noors and rhizomes     Methanol       82     Lutprilfrepin     Cg.H.g.O.g.     Noors and rhizomes     Methanol       83     Lutprilfrepin     Cg.H.g.O.g.     Noors and rhizomes     Methanol       84     Nariogenin     Cg.H.g.O.g.     Noors and rhizomes     Methanol       85     Gensterin     Cg.H.g.O.g.     Noors and rhizomes     Methanol       86     Accertin     Cg.H.g.O.g.     Noors and rhizomes     Methanol       87     Gensterin     Cg.H.g.O.g.     Noors and rhizomes     Methanol       88     Apjernin     Cg.H.g.O.g.     Noors and rhizomes     Methanol       91     Bakalelin     Cg.H.g.O.g.     Noors and rhizomes     Methanol       92     Wogonin     Cg.H.g.O.g.     Noors and rhizomes     Methanol       93     Biorohin     Cg.H.g.O.g.     Noors and rhizomes     Methanol       94     Bakalelin     Cg.H.g.O.g.     Noors and rhizomes     Methanol       9	76	Kaempferol-3-O-α-1-rhamnoside	C15H16O10	Whole plant	MeOH	[18]	
78OgeretinC <sub>2</sub> H <sub>3</sub> O <sub>2</sub> Roots and thizomesActone80MyrictrinC <sub>2</sub> H <sub>3</sub> O <sub>4</sub> Roots and thizomesMethanol81MyrictrinC <sub>2</sub> H <sub>3</sub> O <sub>4</sub> Roots and thizomesMethanol82LiquitifigeninC <sub>2</sub> H <sub>3</sub> O <sub>4</sub> Roots and thizomesMethanol83LutzolinC <sub>2</sub> H <sub>3</sub> O <sub>4</sub> Roots and thizomesMethanol84NaringerninC <sub>2</sub> H <sub>3</sub> O <sub>4</sub> Roots and thizomesMethanol85GenisteinC <sub>2</sub> H <sub>3</sub> O <sub>5</sub> Roots and thizomesMethanol86AcacetinC <sub>2</sub> H <sub>3</sub> O <sub>5</sub> Roots and thizomesMethanol87GeniswaninC <sub>2</sub> H <sub>3</sub> O <sub>5</sub> Roots and thizomesMethanol88AgigeninC <sub>2</sub> H <sub>3</sub> O <sub>5</sub> Roots and thizomesMethanol90IsorhamnetinC <sub>2</sub> H <sub>3</sub> O <sub>5</sub> Roots and thizomesMethanol91BasicaleinC <sub>2</sub> H <sub>3</sub> O <sub>5</sub> Roots and thizomesMethanol92WogoninC <sub>2</sub> H <sub>3</sub> O <sub>1</sub> Roots and thizomesMethanol93BiorobinC <sub>2</sub> H <sub>3</sub> O <sub>1</sub> Roots and thizomesMethanol94BaicalinC <sub>2</sub> H <sub>3</sub> O <sub>1</sub> Roots and thizomesMethanol95Kaemgferl-7-O <sub>7</sub> -g <sub>1</sub> ngcoyranosideC <sub>2</sub> H <sub>3</sub> O <sub>1</sub> Roots and thizomesMethanol96Kaemgferl-7-O <sub>7</sub> -g <sub>1</sub> ngcoyranosideC <sub>2</sub> H <sub>3</sub> O <sub>1</sub> Roots and thizomesMethanol97GenistinC <sub>2</sub> H <sub>3</sub> O <sub>1</sub> Roots and thizomesMethanol98HesperidinC <sub>2</sub> H <sub>3</sub> O <sub>1</sub> Roots and thizomesMethanol99Isorhamen	77	Kaempferol-7-O-α-1-rhamnopyranoside	C21H20O10	Whole plant	MeOH	[18]	
79       Dibydromyricetin $C_{1}H_{1}O_{1}$ Roots and thizomes       Methanol         81       Myricetin $C_{1}H_{1}O_{1}$ Roots and thizomes       Methanol         82       Liquitfigenin $C_{1}H_{1}O_{1}$ Roots and thizomes       Methanol         83       Latsolin $C_{1}H_{1}O_{2}$ Roots and thizomes       Methanol         84       Naringenin $C_{1}H_{1}O_{2}$ Roots and thizomes       Methanol         85       Genisterin $C_{1}H_{1}O_{2}$ Roots and thizomes       Methanol         86       Azcetcin $C_{1}H_{1}O_{2}$ Roots and thizomes       Methanol         86       Ajgenin $C_{1}H_{1}O_{2}$ Roots and thizomes       Methanol         90       Isorhammetin $C_{1}H_{1}O_{2}$ Roots and thizomes       Methanol         91       Baicalin $C_{1}H_{1}O_{2}$ Roots and thizomes       Methanol         92       Wogonin $C_{1}H_{2}O_{1}$ Roots and thizomes       Methanol         93       Biorobin $C_{2}H_{2}O_{1}$ Roots and thizomes       Methanol         94       Baicalin $C_{2}H_{2}O_{1}$ Roots and thizomes       Methanol         95	78	Quercetin	C15H12O7	Roots and rhizomes	Acetone	[32]	
80NyrictrinCirkinoloRoots and thizomesMethanol81MyrictrinCirkinoloRoots and thizomesMethanol82LutculinificationCirkinoloRoots and thizomesMethanol84NaringerninCirkinoloRoots and thizomesMethanol85GenisterinCirkinoloRoots and thizomesMethanol86AcacetinCirkinoloRoots and thizomesMethanol87GenisterinCirkinoloRoots and thizomesMethanol88ApgerninCirkinoloRoots and thizomesMethanol89DissmetinCirkinoloRoots and thizomesMethanol91IsotametinCirkinoloRoots and thizomesMethanol92WogoninCirkinoloRoots and thizomesMethanol93BiorobinCirkinoloRoots and thizomesMethanol94BaicaleinCirkinoloRoots and thizomesMethanol95Kaempferol-7-Op-glucopyranosideCirkinoloRoots and thizomesMethanol96Lutcolino-regulacitorideCirkinoloRoots and thizomesMethanol97GenistinCirkinoloRoots and thizomesMethanol98HesperdinCirkinoloRoots and thizomesMethanol99Isothametin-3-O-glucosideCirkinoloRoots and thizomesMethanol101Gordinelin-3-O-glucosideCirkinoloRoots and thizomesMethanol102SchaftsodeCirkinoloRoot	79	Dihydromyricetin	C15H12O8	Roots and rhizomes	Methanol	[22]	
81Myricetin $C_{1}H_{10}G_{11}$ Roots and thizomesMethanol82Luteolin $C_{1}H_{10}G_{11}$ Roots and thizomesMethanol83Luteolin $C_{1}H_{10}G_{11}$ Roots and thizomesMethanol84Naringgenin $C_{1}H_{10}G_{11}$ Roots and thizomesMethanol85Genistein $C_{1}H_{10}G_{11}$ Roots and thizomesMethanol86Azectin $C_{1}H_{10}G_{11}$ Roots and thizomesMethanol87Genkwanin $C_{1}H_{10}G_{11}$ Roots and thizomesMethanol88Apigenin $C_{1}H_{10}G_{11}$ Roots and thizomesMethanol90Isomentin $C_{1}H_{10}G_{11}$ Roots and thizomesMethanol91Batcalein $C_{1}H_{10}G_{11}$ Roots and thizomesMethanol92Wogorin $C_{2}H_{2}G_{11}$ Roots and thizomesMethanol93Biorobin $C_{2}H_{2}G_{11}$ Roots and thizomesMethanol94Batcalin $C_{2}H_{2}G_{11}$ Roots and thizomesMethanol95Kampferol-7-O_F-o-glucopyranoside $C_{2}H_{2}G_{11}$ Roots and thizomesMethanol96Interolin - 2, gatacturonide $C_{2}H_{2}G_{12}$ Roots and thizomesMethanol97Genitin - $C_{2}H_{2}G_{12}$ Roots and thizomesMethanol98Hesperidin $C_{2}H_{2}G_{13}$ Roots and thizomesMethanol99Isofhametin-3-O-zohospiedoside $C_{2}H_{2}G_{13}$ Roots and thizomesMethanol <td< td=""><td>80</td><td>Myrictrin</td><td>C15H10O8</td><td>Roots and rhizomes</td><td>Methanol</td><td>[22]</td></td<>	80	Myrictrin	C15H10O8	Roots and rhizomes	Methanol	[22]	
82Liquiritigenin $C_1H_1O_0$ Roots and hizomesMethanol84Naringenin $C_1H_1O_0$ Roots and hizomesMethanol84Naringenin $C_1H_1O_0$ Roots and hizomesMethanol85Genistria $C_1H_1O_2$ Roots and hizomesMethanol86Acacetin $C_1H_1O_2$ Roots and hizomesMethanol87Genkwanin $C_1H_1O_0$ Roots and hizomesMethanol88Algeenin $C_1H_1O_0$ Roots and hizomesMethanol89Disometin $C_1H_1O_0$ Roots and hizomesMethanol91Batcalein $C_1H_1O_0$ Roots and hizomesMethanol92Wogonin $C_1H_1O_0$ Roots and hizomesMethanol93Biorobin $C_2H_1O_0$ Roots and hizomesMethanol94Baicalin $C_2H_2O_1$ Roots and hizomesMethanol95Kaempferol-7-0h-e-glucopyranoide $C_2H_2O_1$ Roots and hizomesMethanol96Lutonin-7-galactionide $C_2H_2O_1$ Roots and hizomesMethanol97Genistin $C_2H_2O_1$ Roots and hizomesMethanol98Hesperidin $C_2H_2O_1$ Roots and hizomesMethanol99Isorhametin-3-O- nohespeidoside $C_2H_2O_1$ Roots and hizomesMethanol101Jourcitrin $C_2H_2O_1$ Roots and hizomesMethanol102Schaftoside $C_2H_2O_1$ Roots and hizomesMethanol103Rutin $C_2H_2O_1$	81	Myricetin	C <sub>15</sub> H <sub>10</sub> O <sub>8</sub>	Roots and rhizomes	Methanol	[22]	
83LateolnCi,H1,OSRoots and hizomesMethanol84NaringeninCi,H1,OSRoots and hizomesMethanol85GenistrinCi,H1,OSRoots and hizomesMethanol86AcacetinCi,H1,OSRoots and hizomesMethanol87GenistrinCi,H1,OSRoots and hizomesMethanol88ApigeninCi,H1,OSRoots and hizomesMethanol90IsomeninCi,H1,OSRoots and hizomesMethanol91BaicaleinCi,H1,OSRoots and hizomesMethanol92WogoninCi,H1,OSRoots and hizomesMethanol93BiorobinCi,H1,OSRoots and hizomesMethanol94BaicalinCi,H1,OSRoots and hizomesMethanol95Kaemeferl-7-O-B-glucopyranosideCi,H1,OSRoots and hizomesMethanol96Lateolin-7-galactronnideCi,H1,OSRoots and hizomesMethanol97GenistinCi,H1,OSRoots and hizomesMethanol98Isorhametin-3-O-glucospiranosideCi,H1,OSRoots and hizomesMethanol99Isorhametin-3-O-glucosideCi,H1,OSRoots and hizomesMethanol101QuercirinCi,H1,OSRoots and hizomesMethanol102SchaftosideCi,H1,OSRoots and hizomesMethanol103RutinCi,H1,OSRoots and hizomesMethanol104Isorbametin-3-O-glucosideCi,H1,OSRoots and hizomesMethanol </td <td>82</td> <td>Liquiritigenin</td> <td>C15H12O4</td> <td>Roots and rhizomes</td> <td>Methanol</td> <td>[22]</td>	82	Liquiritigenin	C15H12O4	Roots and rhizomes	Methanol	[22]	
84Naringerin $C_1H_1O_2$ Roots and thizomesMethanol85Genistria $C_1H_1O_2$ Roots and thizomesMethanol86Acacetin $C_1H_1O_2$ Roots and thizomesMethanol87Genkvarnin $C_1H_1O_2$ Roots and thizomesMethanol89Disometin $C_1H_1O_2$ Roots and thizomesMethanol89Disometin $C_1H_1O_2$ Roots and thizomesMethanol91Bastalein $C_1H_1O_2$ Roots and thizomesMethanol92Wogonin $C_1H_1O_2$ Roots and thizomesMethanol93Biorobin $C_2H_2O_1$ Roots and thizomesMethanol94Baicalin $C_2H_2O_1$ Roots and thizomesMethanol95Kaempferol.7-O.β-oglucopyranoside $C_2H_2O_1$ Roots and thizomesMethanol96Luteolin.7- galacturonide $C_2H_2O_1$ Roots and thizomesMethanol97Genistin $C_2H_2O_1$ Roots and thizomesMethanol98Isofammetin-3-O- neohespeidoside $C_2H_2O_1$ Roots and thizomesMethanol100Isorfametin-3-O- neohespeidoside $C_2H_2O_1$ Roots and thizomesMethanol101Quercirin $C_2H_2O_1$ Roots and thizomesMethanol102Schaftoside $C_2H_2O_1$ Roots and thizomesMethanol103Rutin $C_2H_2O_1$ Roots and thizomesMethanol104Isoschaftoside $C_2H_2O_1$ Roots and thizomesMethanol1	83	Luteolin	$C_{15}H_{10}O_{6}$	Roots and rhizomes	Methanol	[22]	
85Genixein $C_1H_1O_2$ Roots and hizomesMethanol87Genkwanin $C_1H_1O_2$ Roots and hizomesMethanol88Apigenin $C_1H_1O_2$ Roots and hizomesMethanol89Dissmetin $C_1H_1O_2$ Roots and hizomesMethanol90Isorhannetin $C_1H_1O_2$ Roots and hizomesMethanol91Baicalein $C_1H_1O_2$ Roots and hizomesMethanol92Wogonin $C_1H_1O_2$ Roots and hizomesMethanol93Biorobin $C_2H_2O_1$ Roots and hizomesMethanol94Baicalin $C_1H_2O_1$ Roots and hizomesMethanol95Kaempfeorl-Z-Q-1p-s-glucopyranoside $C_2H_2O_1$ Roots and hizomesMethanol96Luteolin-7-galacturomide $C_2H_2O_1$ Roots and hizomesMethanol97Genistin $C_2H_2O_1$ Roots and hizomesMethanol98Hesperidin $C_2H_2O_1$ Roots and hizomesMethanol100Isorhametin-3-O- ephcospidoside $C_2H_2O_1$ Roots and hizomesMethanol101Quercitrin $C_2H_2O_1$ Roots and hizomesMethanol102Schaftoside $C_2H_2O_1$ Roots and hizomesMethanol103Rutin $C_2H_2O_1$ Roots and hizomesMethanol104Isoschaftoside $C_2H_2O_1$ Roots and hizomesMethanol105Hyperoside $C_2H_2O_1$ Roots and hizomesMethanol106Aytigenin-5-mannoside<	84	Naringenin	C15H12O5	Roots and rhizomes	Methanol	[22]	
86AcacetinCraft $Q_2$ Roots and thizomesMethanol87Genkwanin $G_1B_{11}Q_2$ Roots and thizomesMethanol88Apjeenin $G_1B_{11}Q_2$ Roots and thizomesMethanol89Diosmetin $G_1B_{11}Q_2$ Roots and thizomesMethanol80IsorAmmetin $G_1B_{11}Q_2$ Roots and thizomesMethanol91IsorAmmetin $G_1B_{12}Q_2$ Roots and thizomesMethanol92Wogonin $G_1B_{12}Q_2$ Roots and thizomesMethanol93Biorobin $G_2B_{12}Q_1$ Roots and thizomesMethanol94Baicalin $G_2B_{12}Q_1$ Roots and thizomesMethanol95Kaemgferol 7-0 β-n-glucopyranoside $G_{21}B_{22}O_1$ Roots and thizomesMethanol96Luteolin 7- gaiacturonide $G_{21}B_{22}O_1$ Roots and thizomesMethanol97Genistin $G_{21}B_{22}O_1$ Roots and thizomesMethanol98Hesperidin $G_{21}B_{22}O_1$ Roots and thizomesMethanol100Isorhametin 3-O- neohespeidoside $G_{21}B_{22}O_1$ Roots and thizomesMethanol101Quercitrin $G_{21}B_{22}O_1$ Roots and thizomesMethanol102Schaftoside $G_{21}B_{22}O_1$ Roots and thizomesMethanol103Rutin $G_{21}B_{22}O_1$ Roots and thizomesMethanol104Isorhafoside $G_{21}B_{22}O_1$ Roots and thizomesMethanol105Apprepriside $G_{21}B_{22}$	85	Genistein	C <sub>15</sub> H <sub>10</sub> O <sub>5</sub>	Roots and rhizomes	Methanol	[22]	
87GenkwaninCrab Hi 2OsRoots and HizomesMethanol88ApigetinGrab Hi 2OsRoots and HizomesMethanol90IsometinGrab Hi 2OsRoots and HizomesMethanol91BaicaleinGrab Hi 2OsRoots and HizomesMethanol92WogoninGrab Hi 2OsRoots and HizomesMethanol93BiorobinGrab Hi 2OsRoots and HizomesMethanol94BaicalinGrab Hi 2OsRoots and HizomesMethanol95Kaemgferol Z-O-Pa-glucopyranosideGrab Hi 2OsRoots and HizomesMethanol96Lateolin -7. galacturonideGrab Hi 2OsRoots and HizomesMethanol97GenistinGrab HigonRoots and HizomesMethanol98HesperidinGrab HigonRoots and HizomesMethanol99Isorhammetin 3-O- neohespeidosideGrab HigonRoots and HizomesMethanol101QuercitrinGrab HigonRoots and HizomesMethanol102SchaftosideGrab HigonRoots and HizomesMethanol103RutinGrab HigonRoots and HizomesMethanol104IsoschaftosideGrab HigonRoots and HizomesMethanol105HyperosideGrab HigonRoots and HizomesMethanol104IsoschaftosideGrab HigonRoots and HizomesMethanol105HyperosideGrab HigonRoots and HizomesMethanol106Apigetin-S - thatmoside <td< td=""><td>86</td><td>Acacetin</td><td>C<sub>16</sub>H<sub>12</sub>O<sub>5</sub></td><td>Roots and rhizomes</td><td>Methanol</td><td>[22]</td></td<>	86	Acacetin	C <sub>16</sub> H <sub>12</sub> O <sub>5</sub>	Roots and rhizomes	Methanol	[22]	
88ApigeninCould and the second	87	Genkwanin	C <sub>16</sub> H <sub>12</sub> O <sub>5</sub>	Roots and rhizomes	Methanol	[22]	
89Dometin Califia Qb BoritammetinRotis and rhizomes Califia Qb Califia Qb Califia Qb Rotis and rhizomesMethanol Methanol90IsoritammetinCalifia Qb Califia Qb Rotis and rhizomesMethanol91BaicalcinCalifia Qb Califia Qb Rotis and rhizomesMethanol92WogoninCalifia Qb Califia Qb Rotis and rhizomesMethanol93BiorobinCalifia Qb Califia Qb Rotis and rhizomesMethanol94BaicalinCalifia Qb Califia Qb Rotis and rhizomesMethanol95Kaempferol 2-0-p-glucopyranosideCalifia Qb Califia Qb Rotis and rhizomesMethanol96Lutcolin-7- galacturonideCalifia Qb Califia Qb Rotis and rhizomesMethanol97GenisinCalifia Qb Califia Qb Rotis and rhizomesMethanol98HesperidinCalifia Qb Rotis and rhizomesMethanol99Isorhammetin 3-O- glucosideCalifia Qb Califia Qb Rotis and rhizomesMethanol101QuercitrinCalifia Qb Califia Qb Rotis and rhizomesMethanol102SchaftsoideCalifia Qb Califia Qb Rotis and rhizomesMethanol103RutinCalifia Qb Rotis and rhizomesMethanol104Isorhametin 3-O Rotis and rhizomesMethanol105HyperosideCalifia Qb Rotis and rhizomesMethanol106Apigenin-5-rhamnosideCalifia Qb Califia Qb Rotis and rhizomesMethanol105HyperosideCalifia Qb <b< td=""><td>88</td><td>Apigenin</td><td>C15H10O5</td><td>Roots and rhizomes</td><td>Methanol</td><td>[22]</td></b<>	88	Apigenin	C15H10O5	Roots and rhizomes	Methanol	[22]	
90IsorhammetinCirk Hu,Or Giblin/OFRoots and thizomesMethanol91BaicaleinCirk Hu,Or Giblin/OSRoots and thizomesMethanol93BiorobinCirk Hu,Or Giblin/OSRoots and thizomesMethanol94BaicalinCirk Hu,Or Giblin/OTRoots and thizomesMethanol95Kaempferol 7-0-Pa-glucopyranosideCirk Hu,Or Giblin/OTRoots and thizomesMethanol96Luteolin 7- galacturonideCirk Hu,Or Giblin/OTRoots and thizomesMethanol97GenistinCirk Hu,Or GenistinRoots and thizomesMethanol98HesperidinCost and thizomesMethanol100Isorhammetin 3-O- enchespeidosideCirk Hu,Or Cirk Hu,Or Giblin/OTRoots and thizomesMethanol101QuercitrinCirk Hu,Or Cirk Hu,Or Ot Sont and thizomesMethanolMethanol102SchaftosideCirk Hu,Or Cirk Hu,Or Ot Sont and thizomesMethanol103RutinCirk Hu,Or Cirk Hu,Or Ot Sont and thizomesMethanol104IsoschaftosideCirk Hu,Or Cirk Hu,Or Ot Sont and thizomesMethanol105HyperosideCirk Hu,Or Cirk Hu,Or Cirk Hu,Or Ot Sont and thizomesMethanol106Apieguris-F-thannosideCirk Hu,Or Cirk Hu,Or Cirk Hu,Or ORoots and thizomesMethanol107IsoschaftosideCirk Hu,Or Cirk Hu,Or ORoots and thizomesMethanol108Astin ACirk Hu,Or Cirk Hu,Or <td>89</td> <td>Diosmetin</td> <td>C16H14O6</td> <td>Roots and rhizomes</td> <td>Methanol</td> <td>[22]</td>	89	Diosmetin	C16H14O6	Roots and rhizomes	Methanol	[22]	
91Baicalein $C_{13}H_{10}O_{3}$ Roots and rhizomesMethanol92Wogonin $C_{13}H_{12}O_{3}$ Roots and rhizomesMethanol93Biorobin $C_{27}H_{30}O_{13}$ Roots and rhizomesMethanol94Baicalin $C_{21}H_{30}O_{11}$ Roots and rhizomesMethanol95Kæmpferol-7-O-P-glucopyranoside $C_{21}H_{30}O_{11}$ Roots and rhizomesMethanol96Luteolin-7- galacturonide $C_{21}H_{30}O_{11}$ Roots and rhizomesMethanol97Genistin $C_{21}H_{30}O_{14}$ Roots and rhizomesMethanol98Hesperidin $C_{21}H_{30}O_{14}$ Roots and rhizomesMethanol99Isorhammetin-3-O- nochespeidoside $C_{20}H_{30}O_{14}$ Roots and rhizomesMethanol101Quercitrin $C_{21}H_{30}O_{12}$ Roots and rhizomesMethanol102Schaftoside $C_{20}H_{30}O_{14}$ Roots and rhizomesMethanol103Rutin $C_{21}H_{30}O_{12}$ Roots and rhizomesMethanol104Isoschaftoside $C_{21}H_{30}O_{12}$ Roots and rhizomesMethanol105Apjecuritrin $C_{21}H_{30}O_{12}$ Roots and rhizomesMethanol106Apigenin-5-rhamnoside $C_{21}H_{30}O_{12}$ Roots-107Isoquercitrin $C_{21}H_{30}O_{12}$ Roots-108Astin A $C_{22}H_{31}ClN_{0}O_{7}$ Roots-109Astin B $C_{22}H_{32}ClN_{0}O_{7}$ Roots-110Ast	90	Isorhamnetin	C16H14O7	Roots and rhizomes	Methanol	[22]	
12Wogonin $C_{16}H_{10}S_{15}$ Roots and thizomesMethanol93Biorobin $C_{2}H_{30}G_{15}$ Roots and thizomesMethanol94Baicalin $C_{2}H_{30}G_{11}$ Roots and thizomesMethanol95Kaempferol.7-0.jb-glucopyranoside $C_{11}H_{30}G_{11}$ Roots and thizomesMethanol96Luteolin.7- galatcuronide $C_{2}H_{30}G_{10}$ Roots and thizomesMethanol97Genistin $C_{20}H_{30}G_{10}$ Roots and thizomesMethanol98Hesperidin $C_{20}H_{30}G_{10}$ Roots and thizomesMethanol100Isorhammetin-3-0- glucoside $C_{20}H_{30}G_{11}$ Roots and thizomesMethanol101Quercitrin $C_{20}H_{30}G_{11}$ Roots and thizomesMethanol102Schaftoside $C_{20}H_{30}G_{11}$ Roots and thizomesMethanol103Rutin $C_{20}H_{30}G_{11}$ Roots and thizomesMethanol104Isoschaftoside $C_{20}H_{30}G_{11}$ Roots and thizomesMethanol105Hyperoside $C_{21}H_{20}G_{11}$ Roots and thizomesMethanol106Apigenin.5-trhannoside $C_{21}H_{20}G_{12}$ Roots and thizomesMethanol107Isoguercitrin $C_{20}H_{30}G_{10}G_{10}$ Roots-108Astin A $C_{20}H_{30}G_{10}G_{20}$ Roots-109Astin B $C_{20}H_{30}G_{10}G_{20}G_{20}$ Roots-110Astin C $C_{20}H_{30}G_{10}G_{20}$ Roots-111	91	Baicalein	CicHioOr	Roots and rhizomes	Methanol	[22]	
10DisrobinCar HagO15 Car HagO15Roots and rhizomesMethanol94BaicalinCar HagO11 Car HagO11Roots and rhizomesMethanol95Kaempferol.7-O-J>-glucopyranosideCar HagO11 Car HagO11Roots and rhizomesMethanol96Luteolin.7- galacturonideCar HagO11 	92	Wogonin	C16H1005	Roots and rhizomes	Methanol	[22]	
3-2JointC21H30-13Roots and rhizomesMethanol95Kaempferol-7-0-Ja-s glucopyranosideC21H40-11Roots and rhizomesMethanol96Luteolin-7- galacturonideC21H40-11Roots and rhizomesMethanol97GenistinC21H40-11Roots and rhizomesMethanol98HesperidinC20H30-14Roots and rhizomesMethanol100Isorhamnetin-3-O- neohespeidosideC2H30-16Roots and rhizomesMethanol100Isorhamnetin-3-O- glucosideC2H30-11Roots and rhizomesMethanol101QuercitrinC2H30-11Roots and rhizomesMethanol102SchaftosideC2H30-12Roots and rhizomesMethanol103RutinC2H30-13Roots and rhizomesMethanol104IsoschaftosideC2H30-14Roots and rhizomesMethanol105HyperosideC2H30-14Roots and rhizomesMethanol106Apligenih-5-rhamnosideC2H30-04Roots and rhizomesMethanol107IsoquercitrinC2H30-07Roots-108Astin AC2H30-07Roots110Astin BC2H30-07Roots111Astin GC2H30-07Roots112Astin BC2H30-07Roots113Astin GC2H30-07Roots114Astin GC2H30-07Roots115Astin	93	Biorobin	Ca7H20015	Roots and rhizomes	Methanol	[22]	
2Examplerol-7-O- $\beta$ -D-glucopyranosideCall HgO11 Call HgO11 Roots and rhizomesMethanol96Luteolin-7- galacturonideCalHgO11 CalHgO10Roots and rhizomesMethanol97GenistinCapHgO10 CapHgO10Roots and rhizomesMethanol98HesperidinCapHgO10 CapHgO14Roots and rhizomesMethanol101Jornametin-3-O-noohespeidosideCapHgO10 CapHgO14Roots and rhizomesMethanol102SchaftosideCapHgO14 CapHgO14Roots and rhizomesMethanol103RutinCapHgO14 Roots and rhizomesMethanolMethanol104IsoschaftosideCapHgO14 CapHgO12 Roots and rhizomesMethanolMethanol105HyperosideCapHgO12 Roots and rhizomesMethanolMethanol106Aplgenin-5-rhamnosideCapHgO12 Roots and rhizomesMethanolMethanol107IsoquercitrinCapHgO12 Roots and rhizomesMethanolMethanol108Astin ACapHgO12 Roots and rhizomesMethanol109Astin BCapHgO12 Roots and rhizomesMethanol109Astin GCapHgO12 Roots and rhizomesMethanol101Astin GCapHgO12 Roots and rhizomesMethanol107IsoquercitrinCapHgO12 RootsRoots and rhizomesMethanol108Astin ACapHgO12 RootsRoots-109Astin BCapHgO12 RootsRoots-110Astin B	94	Baicalin	C2/1130013	Roots and rhizomes	Methanol	[22]	
2Lateolin-7. galaction ide $2_{21} r_{20} c_{11}$ Roots and hizomesMethanol97Genistin $C_{21} H_{20} O_{11}$ Roots and hizomesMethanol98Hesperidin $C_{21} H_{20} O_{11}$ Roots and hizomesMethanol100Isorhannetin-3-O- neohespeidoside $C_{21} H_{20} O_{11}$ Roots and hizomesMethanol100Isorhannetin-3-O- neohespeidoside $C_{21} H_{20} O_{11}$ Roots and hizomesMethanol101Quercitrin $C_{21} H_{20} O_{11}$ Roots and hizomesMethanol102Schaftoside $C_{21} H_{20} O_{11}$ Roots and hizomesMethanol103Rutin $C_{21} H_{20} O_{12}$ Roots and hizomesMethanol104Isoschaftoside $C_{21} H_{20} O_{12}$ Roots and hizomesMethanol105Hyperoside $C_{21} H_{20} O_{12}$ Roots and hizomesMethanol106Apigenin-5-thannoside $C_{21} H_{20} O_{12}$ Roots and hizomesMethanol107Isoguercitrin $C_{22} H_{20} O_{12}$ Roots and hizomesMethanol108Astin A $C_{22} H_{32} Cl_N O_0$ Roots-109Astin B $C_{22} H_{32} Cl_N O_0$ Roots-110Astin G $C_{21} H_{20} Cl_N O_0$ Roots-111Astin G $C_{21} H_{32} Cl_N O_0$ Roots-112Astin B $C_{22} H_{32} Cl_N O_0$ Roots-113Astin F $C_{22} H_{32} Cl_N O_0$ Roots-114Astin B	95	Kaempferol-7-O-B-p-glucopyranoside	C21H18011	Roots and rhizomes	Methanol	[22]	
JoJoseff LationCalifactionCalifactionCalifactionMethanol98HesperidinCalifactionKethanolMethanol99Isorhannetin-3-O- neohespeidosideCalifactionCalifactionMethanol100Isorhannetin-3-O- glucosideCalifactionCalifactionMethanol101QuercitrinCalifactionCalifactionMethanol102SchaftosideCalifactionCalifactionMethanol103RutinCalifactionCalifactionMethanol104IsoschaftosideCalifactionCalifactionMethanol105HyperosideCalifactionCalifactionMethanol106Apigenin-5- thannosideCalifactionCalifactionMethanol107IsoquercitrinCalifactionCalifactionMethanol108Astin ACalifactionRoots and thizomesMethanol109Astin BCalifactionCalifaction-109Astin BCalifaction111Astin CCalifactionCalifaction-112Astin BCalifactionCalifaction-113Astin FCalifaction114Astin GCalifactionCalifaction-115Astin HCalifactionCalifaction-116Astin ICalifaction117Astin GCalifaction118Astin FCalifaction <td>96</td> <td>Luteolin-7- galacturonide</td> <td>C21H20O11</td> <td>Roots and rhizomes</td> <td>Methanol</td> <td>[22]</td>	96	Luteolin-7- galacturonide	C21H20O11	Roots and rhizomes	Methanol	[22]	
$J_{1}$ Contain $2_{1}P_{12}(D_{1})$ Roots and rhizomes $Methanol$ 98Hesperidin $C_{2}H_{30}O_{14}$ Roots and rhizomesMethanol99Isorbannetin-3-O- neohespeidoside $C_{2}H_{32}O_{12}$ Roots and rhizomesMethanol100Isorbannetin-3-O- glucoside $C_{2}H_{22}O_{12}$ Roots and rhizomesMethanol101Quercitrin $C_{2}H_{22}O_{13}$ Roots and rhizomesMethanol102Schaftoside $C_{2}H_{22}O_{13}$ Roots and rhizomesMethanol103Rutin $C_{2}H_{22}O_{12}$ Roots and rhizomesMethanol104Isoschaftoside $C_{2}H_{22}O_{12}$ Roots and rhizomesMethanol105Hyperoside $C_{2}H_{20}O_{12}$ Roots and rhizomesMethanol106Apigenin-5-rhannoside $C_{2}H_{20}O_{12}$ Roots and rhizomesMethanol107Isoquercitrin $C_{2}H_{30}O_{14}O_{10}$ Roots and rhizomesMethanol108Astin A $C_{2}H_{30}O_{14}O_{10}O_{10}$ Roots-109Astin B $C_{2}H_{30}C_{18}O_{10}$ Roots-110Astin C $C_{2}H_{32}C_{18}O_{10}O_{10}$ Roots-111Astin D $C_{2}H_{32}C_{18}O_{10}O_{10}$ Roots-112Astin F $C_{2}H_{32}C_{18}O_{10}O_{10}$ Roots-113Astin G $C_{2}H_{32}C_{18}O_{10}O_{10}$ Roots-114Astin G $C_{2}H_{32}C_{18}O_{10}O_{10}$ Roots-115Astin H $C_{2}H_{32}C_$	97	Genistin	Ca1HaaO10	Roots and rhizomes	Methanol	[22]	
Joe HapfendCapitagO16CapitagO16Notis and HizomesMethanol100Isorhammetin-3-O- glucosideCapItagO16Roots and HizomesMethanol101QuercitrinCapItagO112Roots and HizomesMethanol102SchaftosideCapItagO112Roots and HizomesMethanol103RutinCapItagO113Roots and HizomesMethanol104IsoschaftosideCapItagO12Roots and HizomesMethanol105HyperosideCapItagO12Roots and HizomesMethanol106Apigenin-5- rhannosideCapItagO12Roots and HizomesMethanol107IsoquercitrinCapItagO12Roots and HizomesMethanol108Astin ACapItagO12Roots and HizomesMethanol109Astin BCapItagO12Roots and HizomesMethanol109Astin BCapItagO120Roots and HizomesMethanol110Astin CCapItagClaN507Roots-111Astin BCapItagClN507Roots-112Astin BCapItagClN507Roots-113Astin FCapItagClN507Roots-114Astin GCapItagClN507Roots-115Astin ICapItagClN507Roots-116Astin ICapItagClN507Roots-117Astin JCapItagClN507Roots-118Astin BCapItagClN507Roots-119Astin I <td>98</td> <td>Hesperidin</td> <td></td> <td>Roots and rhizomes</td> <td>Methanol</td> <td>[22]</td>	98	Hesperidin		Roots and rhizomes	Methanol	[22]	
Johnmuttin 3-O glucosideCapitagO12Roots and hizomesMethanol100gordanitationariaGaptagO12Roots and hizomesMethanol101QuercitrinCapHagO14Roots and hizomesMethanol102SchaftsödeCapHagO14Roots and hizomesMethanol103RutinCapHagO14Roots and hizomesMethanol104IsoschaftosideCapHagO14Roots and hizomesMethanol105HyperosideCapHagO12Roots and hizomesMethanol106Apigenin-5- rhamnosideCapHagO12Roots and hizomesMethanol107IsoguercitrinCapHagO12Roots and hizomesMethanol108Astin ACapHagO12Roots and hizomesMethanol109Astin BCapHagClapO12Roots-109Astin BCapHagClNoO6Roots-111Astin CCapHagClNoO7Roots-112Astin FCapHagClNoO7Roots-113Astin FCapHagClNoO7Roots-114Astin GCapHagClNoO7Roots-115Astin HCapHagClNoO7Roots-116Astin ICapHagClNoO7Roots-117Astin JCapHagClNoO7Roots-118Astin KCapHagClNoO7Roots-120Astin MCapHagClNoO8RootsMethanol121Astin NCapHagClNoO8RootsMethanol <td< td=""><td>99</td><td>Isorhamnetin-3-0- neohesneidoside</td><td></td><td>Roots and rhizomes</td><td>Methanol</td><td>[22]</td></td<>	99	Isorhamnetin-3-0- neohesneidoside		Roots and rhizomes	Methanol	[22]	
100Quercitrin $C_{21}H_{20}O_{11}$ Roots and rhizomesMethanol101Quercitrin $C_{21}H_{20}O_{11}$ Roots and rhizomesMethanol103Rutin $C_{26}H_{32}O_{15}$ Roots and rhizomesMethanol104Isoschaftoside $C_{20}H_{20}O_{14}$ Roots and rhizomesMethanol105Hyperoside $C_{21}H_{20}O_{12}$ Roots and rhizomesMethanol106Apigenin-5- rhamoside $C_{21}H_{20}O_{12}$ Roots and rhizomesMethanol107Isoquercitrin $C_{21}H_{20}O_{12}$ Roots and rhizomesMethanol108Astin A $C_{25}H_{33}Cl_2N_{5}O_{7}$ Roots-109Astin B $C_{25}H_{33}Cl_2N_{5}O_{7}$ Roots-110Astin C $C_{25}H_{32}Cl_N_{5}O_{6}$ Roots-111Astin F $C_{25}H_{32}Cl_N_{5}O_{7}$ Roots-112Astin F $C_{25}H_{32}Cl_N_{5}O_{7}$ Roots-113Astin F $C_{25}H_{32}Cl_N_{5}O_{7}$ Roots-114Astin G $C_{25}H_{32}Cl_N_{5}O_{7}$ Roots-115Astin H $C_{25}H_{32}Cl_N_{5}O_{7}$ Roots-116Astin H $C_{25}H_{32}Cl_N_{5}O_{7}$ Roots-117Astin I $C_{25}H_{32}Cl_N_{5}O_{7}$ Roots-118Astin K $C_{25}H_{32}Cl_N_{5}O_{8}$ RootsMethanol120Astin M $C_{25}H_{32}Cl_N_{5}O_{8}$ RootsMethanol121Astin I $C_{25}H_{32}Cl_N$	100	Isorhamnetin-3-O- alucoside	C291136016	Roots and rhizomes	Methanol	[22]	
101Chi 102Chi 103Chi 103Nutriani in thino in the second in th	100	Quercitrin	$C_{22}I_{22}O_{12}$	Roots and rhizomes	Methanol	[22]	
102SchmitsingCgh H32014Nots and ThizonesMethanol103RutinC2aH32014Roots and rhizonesMethanol104IsoschaftosideC2H32012Roots and rhizonesMethanol105HyperosideC21H30012Roots and rhizonesMethanol106Apigenin-5- rhamnosideC21H30012Roots and rhizonesMethanol107IsoquercitrinC21H30012Roots and rhizonesMethanol108Astin AC2sH33Cl2Ns07Roots-109Astin BC2sH33Cl2Ns06,Roots-110Astin CC2sH33Cl2Ns06,Roots-111Astin BC2sH32ClNs06,Roots-112Astin EC2sH32ClNs06,Roots-113Astin FC2sH32ClNs06,Roots-114Astin GC2sH32ClNs06,Roots-115Astin HC2sH32ClNs06,Roots-116Astin IC2sH32ClNs06,Roots-117Astin GC2sH32ClNs06,Roots-118Astin KC2sH32ClNs06,RootsMethanol120Astin MC2sH32ClNs06,RootsMethanol121Astin NC2sH32ClNs06,RootsMethanol121Astin KC2sH32ClNs06,RootsMethanol121Astin NC2sH32ClNs06,RootsMethanol122Astin NC2sH32ClNs06,RootsMethanol123Astin NC2sH	101	Schaftoside	C211120011	Roots and rhizomes	Methanol	[22]	
100KuthCash RayonKoots and HizzonesMethanol104Isoschaftoside $C_{2}H_{20}O_{12}$ Roots and hizzonesMethanol105Hyperoside $C_{2}H_{20}O_{12}$ Roots and hizzonesMethanol106Apigenin-5- rhamnoside $C_{2}H_{20}O_{12}$ Roots and rhizzonesMethanolPeptides(108–128) $C_{2}H_{30}O_{12}$ Roots and rhizzonesMethanolPeptides(108–128) $C_{2}H_{33}Cl_NSO_7$ Roots-109Astin A $C_{2}H_{33}Cl_NSO_7$ Roots-111Astin C $C_{2}H_{33}Cl_NSO_7$ Roots-112Astin C $C_{2}H_{33}Cl_NSO_7$ Roots-113Astin F $C_{2}H_{32}Cl_NSO_7$ Roots-114Astin G $C_{2}H_{32}Cl_NSO_7$ Roots-115Astin H $C_{2}H_{32}Cl_NSO_7$ Roots-116Astin I $C_{2}H_{32}Cl_NSO_7$ Roots-117Astin J $C_{2}H_{33}Cl_NSO_8$ Roots-118Astin H $C_{2}H_{33}Cl_NSO_8$ Roots-119Astin J $C_{2}H_{33}Cl_NSO_8$ Roots-110Astin I $C_{2}H_{33}Cl_NSO_8$ Roots-111Astin J $C_{2}H_{33}Cl_NSO_8$ Roots-112Astin M $C_{2}H_{33}Cl_NSO_8$ RootsMethanol120Astin M $C_{2}H_{33}Cl_NSO_8$ RootsMethanol121Astin M $C_{2}H_{33}Cl_NSO_7$ RootsMeth	102	Putin	C261128014	Roots and rhizomes	Methanol	[22]	
107IsoschartosateC22H2071 PaperosideRoots and rhizomesMethanol106Apigenin-S-rhamnoside $C_{21}H_{20}O_{12}$ Roots and rhizomesMethanol107Isoquercitrin $C_{21}H_{20}O_{12}$ Roots and rhizomesMethanol108Astin A $C_{22}H_{30}Cl_NSO7$ Roots-109Astin A $C_{22}H_{33}Cl_NSO7$ Roots-109Astin C $C_{22}H_{33}Cl_NSO6$ Roots-111Astin C $C_{22}H_{33}Cl_NSO6$ Roots-112Astin G $C_{22}H_{32}Cl_NSO6$ Roots-113Astin G $C_{22}H_{32}Cl_NSO6$ Roots-114Astin G $C_{22}H_{32}Cl_NSO7$ Roots-115Astin G $C_{22}H_{32}Cl_NSO7$ Roots-116Astin G $C_{22}H_{32}Cl_NSO7$ Roots-117Astin G $C_{22}H_{32}Cl_NSO7$ Roots-118Astin G $C_{22}H_{32}Cl_NSO7$ Roots-119Astin I $C_{22}H_{32}Cl_NSO7$ Roots-110Astin I $C_{22}H_{32}Cl_NSO7$ Roots-117Astin L $C_{22}H_{32}Cl_NSO8$ Roots-118Astin L $C_{22}H_{32}Cl_NSO8$ RootsMethanol120Astin L $C_{22}H_{32}Cl_NSO7$ RootsMethanol121Astin L $C_{22}H_{32}Cl_NSO7$ RootsMethanol122Astin I $C_{22}H_{32}Cl_NSO8$ RootsMethanol123	103	Isoschaftoside	C_H_O	Roots and rhizomes	Methanol	[22]	
106AppendixCp120012Note and HinzonesMethanol107IsoquercitrinC21H20012Roots and HinzonesMethanol107IsoquercitrinC21H20012Roots and HinzonesMethanol108Astin AC25H33Cl2N507Roots-109Astin BC25H33Cl2N507Roots-110Astin CC28H33Cl2N507Roots-111Astin DC28H33Cl2N506Roots-112Astin FC28H33ClN506Roots-113Astin FC28H32ClN507Roots-114Astin GC28H32ClN507Roots-115Astin HC28H32ClN507Roots-116Astin IC28H32ClN507Roots-117Astin IC28H32ClN507Roots-118Astin IC28H32ClN507Roots-119Astin IC28H32ClN507Roots-116Astin IC28H32ClN508RootsMethanol120Astin MC28H32ClN508RootsMethanol121Astin RC28H32ClN508RootsMethanol122Astin MC28H32ClN508RootsMethanol123Astin PC28H32ClN507RootsMethanol124Asterinin AC28H33Cl2N507RootsMethanol125Asterinin BC28H33Cl2N507RootsMethanol124Asterinin AC28H33N508RootsEthyl acetate125<	105	Huperoside	C H O	Roots and rhizomes	Methanol	[22]	
Note       Appletities       Control       Returned       Control       Returned         107       Isoquercitrin       C21H2gO12       Roots and rhizomes       Methanol         Peptides       (108       Astin A       C2sH33Cl2N5O7       Roots       -         109       Astin B       C2sH33Cl2N5O7       Roots       -       -         110       Astin C       C2sH33Cl2N5O6       Roots       -       -         111       Astin D       C2sH32ClN5O6       Roots       -       -         111       Astin C       C2sH32ClN5O6       Roots       -       -         111       Astin F       C2sH32ClN5O6       Roots       -       -         112       Astin F       C2sH32ClN5O7       Roots       -       -         113       Astin H       C2sH32ClN5O7       Roots       -       -         114       Astin J       C2sH32ClN5O7       Roots       -       -         115       Astin H       C2sH32ClN5O7       Roots       -       -         116       Astin K       C2sH32ClN5O8       Roots       Methanol         120       Astin M       C2sH34ClN5O6       Roots       Methanol	105	Anigenin 5. rhamnoside	$C_{21}\Pi_{20}O_{12}$	Roots and rhizomes	Methanol	[22]	
107       Isoquer(1111) $C_{21}P_2O_{12}$ Rest and finizonies       Methanion         108       Astin A $C_{25}H_{33}Cl_2N_5O_7$ Roots       -         109       Astin A $C_{25}H_{33}Cl_2N_5O_7$ Roots       -         110       Astin C $C_{25}H_{32}Cl_N_5O_6$ Roots       -         111       Astin D $C_{25}H_{32}Cl_N_5O_6$ Roots       -         112       Astin E $C_{25}H_{32}Cl_N_5O_6$ Roots       -         113       Astin G $C_{25}H_{32}Cl_N_5O_6$ Roots       -         114       Astin G $C_{25}H_{32}Cl_N_5O_7$ Roots       -         115       Astin H $C_{25}H_{32}Cl_N_5O_7$ Roots       -         116       Astin I $C_{25}H_{32}Cl_N_5O_7$ Roots       -         117       Astin J $C_{25}H_{33}Cl_N_5O_8$ Roots       -         118       Astin K $C_{25}H_{34}Cl_N_5O_8$ Roots       Methanol         120       Astin M $C_{25}H_{34}Cl_N_5O_8$ Roots       Methanol         121       Astin M $C_{25}H_{35}Cl_N_5O_7$ Roots       Methanol         122       Astin N	100	Aprgenni-5- mannoside	C H O	Roots and rhizomes	Methanol	[22]	
Prepriors108Astin AC25H33Cl2N5O7Roots-109Astin BC25H33Cl2N5O6Roots-110Astin CC25H33Cl2N5O6Roots-111Astin DC25H33Cl2N5O6Roots-111Astin FC25H34ClN5O6Roots-113Astin FC25H34ClN5O7Roots-114Astin GC25H33N5O6Roots-115Astin HC25H33ClN5O7Roots-116Astin IC25H33ClN5O7Roots-117Astin JC25H33ClN5O7Roots-118Astin KC25H33ClN5O8Roots-119Astin NC25H33ClN5O8Roots-119Astin NC25H33ClN5O8Roots-119Astin NC25H33ClN5O6Roots-118Astin LC25H33ClN5O8RootsMethanol120Astin NC25H32ClN5O7RootsMethanol121Astin NC25H32ClN5O6 <th c<="" td=""><td>Dontid</td><td>100 (108, 138)</td><td><math>C_{21}\Pi_{20}O_{12}</math></td><td>Roots and mizomes</td><td>Methanor</td><td></td></th>	<td>Dontid</td> <td>100 (108, 138)</td> <td><math>C_{21}\Pi_{20}O_{12}</math></td> <td>Roots and mizomes</td> <td>Methanor</td> <td></td>	Dontid	100 (108, 138)	$C_{21}\Pi_{20}O_{12}$	Roots and mizomes	Methanor	
100       Astin A $C_25H_33C_12ySO7$ Roots       -         109       Astin B $C_25H_33C_12ySO7$ Roots       -         110       Astin C $C_25H_33C_12ySO6$ Roots       -         111       Astin D $C_25H_32C_1N_5O_6$ Roots       -         112       Astin F $C_25H_32C_1N_5O_6$ Roots       -         113       Astin G $C_25H_32C_1N_5O_6$ Roots       -         114       Astin G $C_25H_32C_1N_5O_6$ Roots       -         115       Astin H $C_25H_3C_1N_5O_6$ Roots       -         116       Astin I $C_25H_3C_1N_5O_7$ Roots       -         117       Astin J $C_25H_3C_1N_5O_7$ Roots       -         118       Astin K $C_25H_3C_1N_5O_8$ Roots       Methanol         120       Astin M $C_25H_3C_1N_5O_6$ Roots       Methanol         121       Astin N $C_25H_3C_1N_5O_7$ Roots       Methanol         122       Astin M $C_25H_3C_1N_5O_7$ Roots       Methanol         123       Astin N $C_26H_3S_1S_0S_0$ Roots       Ethyl acetate	100	Astin A	C U CINO	Deete		[00]	
100Astin DC2sH33Cl2N5O7ROOTS $-$ 110Astin CC2sH33Cl2N5O6Roots $-$ 111Astin DC2sH32ClN5O6Roots $-$ 112Astin FC2sH32ClN5O7Roots $-$ 113Astin FC2sH32ClN5O7Roots $-$ 114Astin GC2sH32ClN5O7Roots $-$ 115Astin HC2sH32ClN5O7Roots $-$ 116Astin IC2sH32ClN5O7Roots $-$ 117Astin JC2sH32ClN5O7Roots $-$ 118Astin RC2sH32ClN5O7Roots $-$ 119Astin IC2sH32ClN5O8RootsMethanol120Astin NC2sH32ClN5O6RootsMethanol121Astin NC2sH32ClN5O6RootsMethanol122Astin NC2sH32ClN5O6RootsMethanol123Astin PC2sH32ClN5O6RootsMethanol124Asterinin AC2sH33N5O8RootsEthyl acetate125Asterinin BC2eH3SN5O8RootsEthyl acetate126Asterinin CC2sH33N5O8RootsEthyl acetate127Asterinin CC2sH33N5O8RootsEthyl acetate128Asterinin CC2sH33N5O8RootsEthyl acetate129Nethyl caffeateC10H10O4Roots and rhizomes95 % EtOH130O-hydroxybenzoic acidC7H603Roots and rhizomes95 % EtOH1324-Hydroxybenzoic acidC7	100	Astin P	C H C N C	Roots	-	[33]	
111       Astin D $C_{25}H_{33}C_{1}N_{5}O_{6}$ ROOTS $-$ 111       Astin D $C_{25}H_{32}ClN_{5}O_{6}$ Roots $-$ 113       Astin F $C_{25}H_{34}ClN_{5}O_{6}$ Roots $-$ 114       Astin G $C_{25}H_{34}ClN_{5}O_{6}$ Roots $-$ 115       Astin H $C_{25}H_{34}ClN_{5}O_{7}$ Roots $-$ 116       Astin J $C_{25}H_{34}ClN_{5}O_{7}$ Roots $-$ 117       Astin J $C_{25}H_{34}ClN_{5}O_{7}$ Roots $-$ 118       Astin J $C_{25}H_{34}ClN_{5}O_{8}$ Roots       Methanol         119       Astin L $C_{25}H_{34}ClN_{5}O_{8}$ Roots       Methanol         120       Astin M $C_{25}H_{34}ClN_{5}O_{8}$ Roots       Methanol         121       Astin N $C_{25}H_{34}ClN_{5}O_{7}$ Roots       Methanol         122       Astin P $C_{26}H_{35}Cl_{2}N_{5}O_{7}$ Roots       Methanol         123       Astin P $C_{26}H_{35}N_{5}O_{8}$ Roots       Ethyl acetate         124       Asterinin A $C_{26}H_{35}N_{5}O_{8}$ Roots       Ethyl ac	109	Astin C	C H C N C	Roots	-	[34]	
111       Astin D       C2gH32ClNS06       Roots       -         112       Astin E       C2gH32ClN506       Roots       -         113       Astin F       C2gH32ClN506       Roots       -         114       Astin G       C2gH32SlN506       Roots       -         115       Astin H       C2gH32ClN507       Roots       -         116       Astin I       C2gH32ClN507       Roots       -         117       Astin K       C2gH33Ns09       Roots       -         118       Astin K       C2gH33ClN507       Roots       -         119       Astin K       C2gH33ClN508       Roots       Methanol         120       Astin M       C2gH32ClN506       Roots       Methanol         121       Astin N       C2gH32ClN506       Roots       Methanol         122       Astin N       C2gH32ClN506       Roots       Methanol         123       Astin P       C2gH32ClN506       Roots       Methanol         124       Asterinin A       C2gH32N508       Roots       Ethyl acetate         125       Asterinin A       C2gH33N508       Roots       Ethyl acetate         126       Asterinin C       C2	110	Actin D	C H CN C	Roots	-	[33]	
112       Astin E $C_{25}H_{32}ClN_5O_6$ Roots       -         113       Astin F $C_{25}H_{34}ClN_5O_6$ Roots       -         114       Astin G $C_{25}H_{32}ClN_5O_7$ Roots       -         115       Astin H $C_{25}H_{32}ClN_5O_7$ Roots       -         116       Astin I $C_{25}H_{32}ClN_5O_7$ Roots       -         117       Astin J $C_{25}H_{33}Cl_3N_5O_8$ Roots       -         118       Astin K $C_{25}H_{33}Cl_3N_5O_8$ Roots       -         119       Astin L $C_{25}H_{34}ClN_5O_8$ Roots       Methanol         120       Astin M $C_{25}H_{32}ClN_5O_8$ Roots       Methanol         121       Astin N $C_{25}H_{32}ClN_5O_8$ Roots       Methanol         122       Astin O $C_{27}H_{35}Cl_NSO_7$ Roots       Methanol         123       Astin P $C_{26}H_{35}Cl_NSO_7$ Roots       Methanol         124       Asterinin A $C_{26}H_{35}N_5O_8$ Roots       Ethyl acetate         125       Asterinin C $C_{26}H_{35}N_5O_8$ Roots       Ethyl acetate         126       Asterinin	111	Astin E	$C_{25}\Pi_{32}CIN_5U_6$	ROOLS	-	[33]	
113       Astun F $C_{25}H_{34}ClN_5O_6$ Roots       -         114       Astin G $C_{22}H_{35}N_5O_6$ Roots       -         115       Astin H $C_{25}H_{32}ClN_5O_7$ Roots       -         116       Astin J $C_{25}H_{33}ClN_5O_7$ Roots       -         117       Astin J $C_{25}H_{33}ClN_5O_8$ Roots       -         118       Astin K $C_{25}H_{33}ClN_5O_8$ Roots       Methanol         120       Astin M $C_{25}H_{34}ClN_5O_8$ Roots       Methanol         121       Astin M $C_{25}H_{32}ClN_5O_8$ Roots       Methanol         122       Astin M $C_{25}H_{32}ClN_5O_8$ Roots       Methanol         123       Astin P $C_{26}H_{32}ClN_5O_8$ Roots       Methanol         124       Asterinin A $C_{25}H_{33}N_5O_8$ Roots       Ethyl acetate         125       Asterinin C $C_{26}H_{35}N_5O_8$ Roots       Ethyl acetate         125       Asterinin D $C_{26}H_{33}N_5O_8$ Roots       Ethyl acetate         126       Asterinin C $C_{26}H_{35}N_5O_9$ Roots       -         128 <tha< td=""><td>112</td><td>Astin E</td><td><math>C_{25}\Pi_{32}CIN_5U_7</math></td><td>ROOIS</td><td>-</td><td>[33]</td></tha<>	112	Astin E	$C_{25}\Pi_{32}CIN_5U_7$	ROOIS	-	[33]	
114       Astin G       C25H35N506       ROOTS       -         115       Astin H       C25H32ClN507       Roots       -         116       Astin I       C25H34ClN507       Roots       -         117       Astin J       C25H33N509       Roots       -         118       Astin K       C25H33Cl2N508       Roots       Methanol         119       Astin N       C25H34ClN506       Roots       Methanol         120       Astin M       C25H34ClN506       Roots       Methanol         121       Astin N       C25H34ClN506       Roots       Methanol         122       Astin O       C25H33ClN506       Roots       Methanol         123       Astin P       C26H35Cl2N507       Roots       Methanol         124       Asterinin A       C25H33N508       Roots       Methanol         125       Asterinin B       C26H35N508       Roots       Ethyl acetate         126       Asterinin C       C26H35N508       Roots       Ethyl acetate         127       Asterinin E       C26H35N509       Roots       -         128       Asterinin E       C26H35N509       Roots and rhizomes       -        129       <	113	Astin C	$C_{25}H_{34}CIN_5O_6$	ROOIS	-	[33]	
115       Astin ri $C_{25}H_{32}ClN_5O_7$ Roots $-$ 116       Astin I $C_{25}H_{34}ClN_5O_7$ Roots $-$ 117       Astin J $C_{25}H_{33}N_5O_9$ Roots $-$ 118       Astin K $C_{25}H_{33}Cl_N_5O_8$ Roots       Methanol         119       Astin I $C_{25}H_{34}ClN_5O_8$ Roots       Methanol         120       Astin M $C_{25}H_{34}ClN_5O_6$ Roots       Methanol         121       Astin N $C_{25}H_{32}ClN_5O_6$ Roots       Methanol         122       Astin N $C_{25}H_{32}ClN_5O_6$ Roots       Methanol         123       Astin P $O$ Roots       Methanol         124       Asterinin A $C_{25}H_{35}Cl_N_5O_7$ Roots       Methanol         125       Asterinin B $C_{26}H_{35}N_5O_8$ Roots       Ethyl acetate         126       Asterinin C $C_{26}H_{35}N_5O_8$ Roots       Ethyl acetate         126       Asterinin B $C_{26}H_{35}N_5O_9$ Roots $-$ 127       Asterinin E $C_{26}H_{35}N_5O_9$ Roots $-$ 128 <tha< td=""><td>114</td><td>Astin G</td><td>C<sub>25</sub>H<sub>35</sub>N<sub>5</sub>O<sub>6</sub></td><td>KOOTS</td><td>-</td><td>[33]</td></tha<>	114	Astin G	C <sub>25</sub> H <sub>35</sub> N <sub>5</sub> O <sub>6</sub>	KOOTS	-	[33]	
110       Astin 1 $C_25H_3A(ClN_5O_7)$ Roots       -         117       Astin J $C_25H_{33}N_5O_9$ Roots       -         118       Astin K $C_25H_{33}O_9$ Roots       Methanol         119       Astin M $C_{25}H_{34}ClN_5O_8$ Roots       Methanol         120       Astin M $C_{25}H_{34}ClN_5O_8$ Roots       Methanol         121       Astin M $C_{25}H_{34}ClN_5O_6$ Roots       Methanol         122       Astin O $C_{25}H_{32}ClN_5O_7$ Roots       Methanol         123       Astin P $C_{26}H_{35}Cl_2N_5O_7$ Roots       Methanol         124       Asterinin A $C_{26}H_{35}N_5O_8$ Roots       Ethyl acetate         125       Asterinin B $C_{26}H_{35}N_5O_8$ Roots       Ethyl acetate         126       Asterinin C $C_{26}H_{35}N_5O_9$ Roots       Ethyl acetate         127       Asterinin E $C_{26}H_{35}N_5O_9$ Roots       Ethyl acetate         127       Asterinin E $C_{26}H_{35}N_5O_9$ Roots       -         128       Asterinin E $C_{26}H_{35}N_5O_9$ Roots       -         129 </td <td>115</td> <td>ASUN H</td> <td>C25H32CIN5O7</td> <td>ROOTS</td> <td>-</td> <td>[33]</td>	115	ASUN H	C25H32CIN5O7	ROOTS	-	[33]	
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124Asterinin A $C_{25}H_{33}N_5O_8$ RootsEthyl acetate125Asterinin B $C_{26}H_{35}N_5O_8$ RootsEthyl acetate126Asterinin C $C_{26}H_{35}N_5O_8$ RootsEthyl acetate127Asterinin D $C_{25}H_{33}N_5O_7$ Roots-128Asterinin E $C_{26}H_{35}N_5O_9$ Roots-Organization E129Nethyl caffeate130O-hydroxybenzoic acid $C_{10}H_{10}O_4$ Roots and rhizomes95 % EtOH131P-hydroxyacetophenone $C_{8}H_8O_2$ Roots and rhizomes95 % EtOH1324-Hydroxybenzoic acid $C7H_6O_3$ Roots and rhizomes95 % EtOH	123	Astin P	C26H35Cl2N5O7	Roots	Methanol	[35]	
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126Asterinin CC26 $H_{35}N_5O_8$ RootsEthyl acetate127Asterinin D $C_{25}H_{33}N_5O_7$ Roots-128Asterinin E $C_{26}H_{35}N_5O_9$ Roots-Organization (129-154)129Nethyl caffeate $C_{10}H_{10}O_4$ Roots and rhizomes95 % EtOH130O-hydroxybenzoic acid $C_7H_6O_3$ Roots and rhizomes95 % EtOH131P-hydroxybenzoic acid $C7H_6O_3$ Roots and rhizomes95 % EtOH1324-Hydroxybenzoic acid $C7H_6O_3$ Roots and rhizomes95 % EtOH	125	Asterinin B	$C_{26}H_{35}N_5O_8$	Roots	Ethyl acetate	[36]	
127Asterinin DC25H33N5O7Roots-128Asterinin EC26H35N5O9Roots-Organitation EC194Nots-129Nethyl caffeateC10H10O4Roots and rhizomes95 % EtOH130O-hydroxybenzoic acidC7H6O3Roots and rhizomes95 % EtOH131P-hydroxybenzoic acidC7H6O3Roots and rhizomes95 % EtOH1324-Hydroxybenzoic acidC7H6O3Roots and rhizomes95 % EtOH	126	Asterinin C	C26H35N5O8	Roots	Ethyl acetate	[36]	
128Asterinin EC26H35N5O9Roots-Organic acids (129-154)88-129Nethyl caffeateC10H10O4Roots and rhizomes95 % EtOH130O-hydroxybenzoic acidC7H6O3Roots and rhizomes95 % EtOH131P-hydroxybenzoic acidC8H8O2Roots and rhizomes95 % EtOH1324-Hydroxybenzoic acidC7H6O3Roots and rhizomes95 % EtOH	127	Asterinin D	C <sub>25</sub> H <sub>33</sub> N <sub>5</sub> O <sub>7</sub>	Roots	-	[37]	
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130O-hydroxybenzoic acidC7H6O3Roots and rhizomes95 % EtOH131P-hydroxyacetophenoneC8H8O2Roots and rhizomes95 % EtOH1324-Hydroxybenzoic acidC7H6O3Roots and rhizomes95 % EtOH	129	Nethyl caffeate	$C_{10}H_{10}O_4$	Roots and rhizomes	95 % EtOH	[17]	
131P-hydroxyacetophenoneC_8H_8O_2Roots and rhizomes95 % EtOH1324-Hydroxybenzoic acidC7H <sub>6</sub> O_3Roots and rhizomes95 % EtOH	130	O-hydroxybenzoic acid	$C_7H_6O_3$	Roots and rhizomes	95 % EtOH	[17]	
<b>132</b> 4-Hydroxybenzoic acid C7H <sub>6</sub> O <sub>3</sub> Roots and rhizomes 95 % EtOH	131	P-hydroxyacetophenone	$C_8H_8O_2$	Roots and rhizomes	95 % EtOH	[17]	
	132	4-Hydroxybenzoic acid	C7H <sub>6</sub> O <sub>3</sub>	Roots and rhizomes	95 % EtOH	[17]	

(continued on next page)

#### Table 3 (continued)

No.	Compounds	MF	Resource	Extraction methods	References
133	3-Hydroxy-4-methoxy benzoic acid	C <sub>8</sub> H <sub>8</sub> O <sub>4</sub>	Roots and rhizomes	95 % EtOH	[17]
134	3,4-Dihydroxybenzoic acid	$C_7H_6O_4$	Roots and rhizomes	95 % EtOH	[17]
135	Pyrogallic acid	C <sub>6</sub> H <sub>6</sub> O <sub>3</sub>	Roots and rhizomes	Methanol	[22]
136	Benzoic acid	$C_7H_6O_2$	Roots and rhizomes	Methanol	[22]
137	Protocatechuate	$C_9H_{10}O_4$	Roots and rhizomes	Methanol	[22]
138	Caffeic acid	C <sub>9</sub> H <sub>8</sub> O <sub>4</sub>	Roots and rhizomes	Methanol	[22]
139	Paeonol	$C_9H_{10}O_3$	Roots and rhizomes	Methanol	[22]
140	Ferulic acid	C10H10O4	Roots and rhizomes	Methanol	[22]
141	Isoferulic acid	C10H10O4	Roots and rhizomes	Methanol	[22]
142	Methyl caffeate	C10H12O4	Roots and rhizomes	Methanol	[22]
143	Succinic acid	$C_4H_6O_4$	Roots and rhizomes	Methanol	[22]
144	2,2-Dimethylsuccinic acid	$C_{6}H_{10}O_{4}$	Roots and rhizomes	Methanol	[22]
145	Chlorogenic acid	C16H18O9	Roots and rhizomes	Methanol	[22]
146	Cryptochlorogenic acid	C16H18O9	Roots and rhizomes	Methanol	[22]
147	5-Caffeoylquinic acid	C16H18O9	Whole plant	MeoH	[18]
148	4-Caffeoylquinicacid	C16H18O9	Whole plant	MeoH	[18]
149	3-O-trans-feruloylquinicacid	C18H22O8	Whole plant	MeoH	[18]
150	Cynarin	C25H24O12	Roots and rhizomes	Methanol	[22]
151	3,5-Dicaffeoylquinic acid	C25H24O12	Roots and rhizomes	Methanol	[22]
152	4,5-Dicaffeoylquinicacid	C25H26O12	Whole plant	MeoH	[19]
153	3,4-Dicaffeoylquinic acid	C25H24O12	Roots and rhizomes	Methanol	[22]
154	4,5-Dicaffeoylquinic acid	C25H24O12	Roots and rhizomes	Methanol	[22]
Other	compounds (155–186)				
155	11β, 13-Dihydro-3-epizaluzanin C	$C_{16}H_{22}O_2$	Roots	MeoH	[25]
156	Dihydroestafiatol	C15H22O3	Roots	MeoH	[25]
157	Dihydroestafiatone	$C_{15}H_{20}O_3$	Roots	MeoH	[25]
158	Dsoamberboin	$C_{15}H_{20}O_4$	Roots	MeoH	[25]
159	Daryolane-1,9β-diol	$C_{14}H_{24}O_2$	Roots	MeoH	[25]
160	7-Hydroxycoumarin	$C_9H_6O_3$	Roots and rhizomes	95 % EtOH	[17]
161	(-)-Clovane-2,9-diol	$C_{15}H_{26}O_2$	Roots	MeoH	[25]
162	5-Hydroxymeth-yl-furfural	$C_6H_6O_3$	Roots and rhizomes	95 % EtOH	[25]
163	P-hydroxybenzaldehyde	$C_7H_6O_2$	Roots and rhizomes	95 % EtOH	[25]
164	Ferulic acid hexacosanyl ester	C37H64O4	Roots and rhizomes	95 % EtOH	[17]
165	Trans-hexacosane-1,2-dihydroxyethyl cinnamate vinegar	C37H64O4	Roots and rhizomes	95 % EtOH	[17]
166	Ethanone	$C_{13}H_{14}O_4$	Roots and rhizomes	95 % EtOH	[17]
167	Viscidone	$C_{13}H_{14}O_4$	Roots and rhizomes	95 % EtOH	[17]
168	Scopoletin	$C_{10}H_8O_4$	Roots and rhizomes	-	[32]
169	Emodin	$C_{15}H_{10}O_5$	Roots and rhizomes	-	[32]
170	Emodin anthrone	$C_{15}H_{10}O_5$	Roots and rhizomes	Methanol	[22]
171	Esculin	$C_{15}H_{16}O_9$	Roots and rhizomes	Methanol	[22]
172	5-Hydroxymethyl-2- furaldehyde	$C_6H_{10}O_4$	Roots and rhizomes	Methanol	[22]
173	Benzaldehyde	C <sub>7</sub> H <sub>6</sub> O	Roots and rhizomes	Methanol	[22]
174	P-hydroxybenzaldehyde	$C_7H_6O_2$	Roots and rhizomes	Methanol	[22]
175	Esculetin	$C_9H_6O_4$	Roots and rhizomes	Methanol	[22]
176	Fraxetin	$C_{10}H_8O_5$	Roots and rhizomes	Methanol	[22]
177	Xanthotoxin	$C_{12}H_8O_4$	Roots and rhizomes	Methanol	[22]
178	Bergapten	$C_{12}H_8O_4$	Roots and rhizomes	Methanol	[22]
179	Isoscopoletin	$C_{10}H_8O_4$	Roots and rhizomes	Methanol	[22]
180	Psoralen	$C_{11}H_6O_3$	Roots and rhizomes	Methanol	[22]
181	Rhein	$C_{15}H_8O_6$	Roots and rhizomes	Methanol	[22]
182	1-Acetoxy-2-ene€-4,6-decandiyne	$C_{12}H_{14}O_2$	Roots and rhizomes	95 % EtOH	[17]
183	(E)-2-decend-4,6-diyn-1-ol	C10H12O	Roots and rhizomes	95 % EtOH	[17]
184	Lachnophyllic acid	$C_{10}H_{10}O_2$	Roots and rhizomes	95 % EtOH	[17]
185	N-octadecane	C18H38	Whole plant	MeoH	[18]
186	N-triacontanol	C <sub>30</sub> H <sub>62</sub> O	Whole plant	MeoH	[18]

the number of peptides isolated from *Aster tataricus* is limited. The two main types of peptide analogs identified in *Aster tataricus* are cyclic (**117**, **124–128**) and chain (**108–116**, **118–123**). The structures and sources of these peptides are presented in Table 3 and Fig. 5.

#### 4.4. Organic acids

Multiple organic acids are found in *Aster tataricus*, such as fatty acids, polyphenols, and carboxylic acids. These compounds are abundant in the leaves, roots, and especially fruits and are usually found in the form of salts or esters. To date, 26 organic acids have been isolated from *Aster tataricus*, all of which contain aromatic rings and are mostly classified as small molecules. The structures of these organic acids (**129–154**) are shown in Fig. 6.



Fig. 3. Structures of terpenes from Aster tataricus.

#### 4.5. Other compounds

In addition to the abovementioned common chemical compounds, more than 30 other compounds have been isolated from *Aster tataricus*. These compounds include **155–159**, which are 7-membered cyclic compounds isolated from the methanolic extract of *Aster tataricus* [43], and **182–184**, which are acetylenes isolated from the 95 % ethanolic extract of *Aster tataricus* [17]. Two chained alkanes named *N*-octadecane and *N*-triacontanol have been extracted from the methanolic extracts of whole plants of *Aster tataricus* [19]. In addition, coumarins and quinones have been identified in *Aster tataricus* (Fig. 7).

## 5. Pharmacological activities

*Aster tataricus* has been used in TCM for the treatment of respiratory diseases for more than 2000 years. With the continuous progress of science and technology, numerous studies have investigated the pharmacological activities and mechanisms of action of the abovementioned bioactive compounds. Modern pharmacological studies have shown that *Aster tataricus* has a wide range of therapeutic effects (Fig. 8), including anti-cough and pro-expectoration, anti-asthmatic, anti-inflammatory, anti-tumor, anti-oxidant, anti-depressant, anti-bacterial, and anti-viral effects.



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#### 5.1. Anti-cough and pro-expectoration effects

In TCM, Zi wan is an important drug for suppressing coughs and promoting expectoration. The expectoration-inducing effects of *Aster tataricus* can be attributed to asterone and epimedanol, which have been isolated from petroleum ether and ethyl acetate extracts [44].

In a study, the composition of the volatile oil of *Aster tataricus* was analyzed via gas chromatography-mass spectrometry, and seven compounds were eventually identified. *In vivo* experiments and phenol red assay showed that 1-acetyl-trans-2-en-4,6-decadiyne, the main component of the volatile oil, had expectoration-inducing effects [45]. Aqueous extracts of *Aster tataricus* have been shown to reduce the frequency of cough induced by ammonia liquor in mice [46]. Yu et al. showed that *Aster tataricus* extracts (Fr-50) exerted remarkable pro-expectoration, anti-tussive, and anti-inflammatory effects at doses of 40 and 80 mg/kg. They used HPLC-Q-TOF/MS to investigate Fr-50 and found that chlorogenic acids (CGAs) eliminated or reduced tracheal inflammation, which is one of the main causes of cough and phlegm [47]. In addition, shionone and 1-acetoxy-2-ene (E)-4,6-decandiyne extracted from *Aster tataricus* have been identified as effective expectorants [48].

Triterpenoid saponins, which are one of the chemical constituents of *Aster tataricus*, are often considered expectorants [49]. Some studies have reported that shionone and epi-friedelanol isolated from *Aster tataricus* extracts can substantially decrease the frequency of ammonia-induced cough in mice [50].

Therefore, we speculate that triterpenoid saponins found in *Aster tataricus* may serve as primary expectorants that reduce airway inflammation and relieve cough, and its mechanism of action needs to be further investigated.

#### 5.2. Anti-asthmatic effects

Asthma is a prime example of a "complex disease". It is considered a syndrome instead of a disease because it is defined based on clinical characteristics rather than underlying mechanisms [51]. The principal clinical characteristics of asthma are reversible airflow obstruction, airway hyperresponsiveness, and airway inflammation [52].

Peng et al. [53] showed that the ethanolic extracts of *Aster tataricus* exhibited potent anti-asthmatic activity in guinea pigs. The mechanism of action was found to be related to the inhibition of tracheal smooth muscle M receptor,  $H_1$  receptor, and  $Ca^{2+}$  channels, which resulted in the inhibition of the inward flow of  $Ca^{2+}$ . In addition, Chen et al. [54] showed that *Aster tataricus* extracts exerted anti-asthmatic effects by attenuating OVA-induced immune responses and inhibiting tracheal ring contraction.

#### 5.3. Anti-inflammatory effects

According to folkloric and scientific literature, *Aster tataricus* has potential anti-inflammatory effects. In TCM, inflammation is called "Fa Yan", which is a defense response to harmful stimuli and manifests as redness, swelling, heat, pain, and dysfunction. Inflammation is one of the common pathological conditions observed in clinical practice and is considered the first line of defense against invading pathogens [40]. However, unregulated inflammation can lead to allergies, cancer, and atherosclerosis [54].

Du et al. [55] reported that the ethanolic extract of *Aster tataricus* suppressed pro-inflammatory cytokines and activated the NF- $\kappa$ B signaling pathway, thereby exerting therapeutic effects against diabetes mellitus.

Zhang et al. [56] found that Aster tataricus exerted anti-neuroinflammatory effects by preventing the generation of free radicals,



Fig. 4. Structures of flavonoids from Aster tataricus.



Fig. 5. Structures of peptides from Aster tataricus.

enhancing the activity of antioxidant enzymes, and suppressing the activity of pro-inflammatory cytokines.

Wang et al. [57] evaluated the protective effects of *Aster tataricus* extracts on CYP- or LPS + ATP-induced interstitial cystitis. The results showed that *Aster tataricus* extracts alleviated inflammation in rat bladder and urothelial cells by inhibiting the expression of pyroptosis-related proteins and downregulating the NLRP3/GSDMD-N signaling pathway.

Liu et al. [58] found that 4-hydroxyphenylacetic acid isolated from *Aster tataricus* alleviated inflammation by inhibiting the hypertonicity- and hypoxia-induced production of hypoxia-inducible factor 1-alpha in rats with seawater aspiration-induced lung injury.

Su et al. [59] analyzed the chemical composition of the methanolic extract of the rhizomes and roots of *Aster tataricus* and evaluated its anti-inflammatory activity. The results showed that lachnophyllol acetate was a candidate drug for the treatment of inflammatory diseases mediated by the NF- $\kappa$ B and MAPK signaling pathways.

### 5.4. Anti-tumor effects

Despite remarkable advancements in science and technology, malignant tumors remain a serious threat to human health worldwide [60]. The demand for anti-tumor drugs remains high as the global incidence of tumor increases. Natural active ingredients used in TCM have been reported to have therapeutic effects against tumors to some extent [61,62]. Pharmacological studies have shown that *Aster tataricus* has potential anti-tumor activity. For example, Zhou et al. [23] found that terpenes isolated from *Aster tataricus* induced tumor cell apoptosis.

Furthermore, plant-derived polysaccharides have been shown to possess anti-tumor properties [63]. Zhang et al. [64] reported that



Fig. 6. Structures of organic acids from Aster tataricus.

a water-soluble polysaccharide isolated from *Aster tataricus* induced apoptosis in SGC-7901 cells through calcium- and  $\Delta \Psi_m$ -dependent pathways, indicating that it may be used as a natural anti-cancer agent. Du et al. [65] isolated a homogeneous polysaccharide (ATP-II) from the 80 % ethanolic extract of *Aster tataricus* and assessed its anti-cancer effects and mechanism of action in glioma C6 cells. In vitro experiments showed that ATP-II effectively inhibited the proliferation of C6 cells by inducing DAN injury and apoptosis. In vivo experiments showed that ATP-II markedly inhibited the growth of C6-transplanted tumors and induced tumor cell apoptosis by increasing the Bax/Bcl-2 ratio and stimulating the activation of caspase-3, caspase-8, and caspase-9. These findings suggest that ATP-II is a safe and effective drug for the treatment of malignant glioma. Yao et al. [66] showed that the aqueous extract of *Aster tataricus* attenuated the proliferative and invasive abilities of human lung cancer A549 cells and inhibited the growth of transplanted tumors in nude mice by suppressing the Wnt/ $\beta$ -catenin signaling pathway.

### 5.5. Anti-oxidant effects

Anti-oxidants can prevent oxidation, both endogenously and exogenously, at low doses [67]. Phenolic acids and other classes of phenylpropanoids derived from medicinal plants are strong anti-oxidants and effective free radical scavengers [68]. Anti-oxidants are vital for human health, as they reduce the risk of free radical damage to cells [69].

Ng et al. [33] found that quercetin and kaempferol isolated from *Aster tataricus* exhibited the highest potency and possessed minimal pro-oxidant activity.

Zhang et al. [70] isolated active ingredients from the roots and flowers of *Aster tataricus* through solvent extraction and investigated the anti-oxidant activity of the extracts using DPPH assay. The results showed that both flower and roots extracts exerted strong anti-oxidant effects in a concentration- and solvent polarity-dependent manner.



Fig. 7. Structures of other compounds from Aster tataricus.

Du et al. [55] found that the root extracts of *Aster tataricus* effectively alleviated diabetic retinopathy by controlling blood glucose levels and attenuating attenuating oxidative stress, and suppressing inflammatory mediators.

#### 5.6. Anti-depressant effects

Depression is a common mental disorder. According to the World Health Organization, 5 % of adults have depression worldwide, with the incidence being higher among women than among men. Commercially available anti-depressants often have slow results and many side effects [71]. Wan et al. [72] identified the chemical constituents of *Aster tataricus* via HPLC-MS and evaluated their anti-depressant activity. The results revealed high levels of kaempferol, quercetin, chlorogenic acid, caffeic acid, and ferulic acid in *Aster tataricus* extracts. Among these compounds, quercetin, chlorogenic acid, and ferulic acid were found to have anti-depressant effects. However, the anti-depressant activity of *Aster tataricus* has been reported in limited studies and warrants further investigation.

### 5.7. Anti-bacterial and anti-viral effects

The anti-bacterial and anti-viral activities of *Aster tataricus* have been extensively investigated [73]. For instance, Zhou et al. [74] evaluated the anti-viral activities of six triterpenoids isolated from *Aster tataricus*. The results showed that Aster shionoes C remarkably inhibited the surface antigen of hepatitis B virus as well as its secretion and viral DNA replication.

Liu et al. [75] showed that the ethanolic extract of *Aster tataricus* exerted strong bacteriostatic effects against *Varistaptyoccus aureas*, *Pasteurella maltocida*, *E.coli.*, *Streptococci* and *Salmonella*, with the lowest inhibitory concentrations of 0.80 g/mL, 0.05 g/mL, 0.50 g/mL, 0.20 g/mL, 0.20 g/mL, 0.20 g/mL, respectively.



Fig. 8. Pharmacological activities of Aster tataricus.

### 5.8. Other pharmacological effects

In addition to the abovementioned effects, other pharmacological effects of *Aster tataricus* have been reported in previous studies. Astin C, one of the compounds isolated from the roots of *Aster tataricus*, can exert immunosuppressive effects by inducing T-cell apoptosis [76]. Li et al. [77] found that the cyclopeptide astin C exerted potent anti-cancer and immunosuppressive effects by binding to STING, a key cytosolic DNA sensor protein involved in natural immunity in humans.

Chen et al. [78] investigated the protective effects of *Aster tataricus* on acute lung injury caused by an endotoxin from *Acanthopanax quinquefolia*. Network pharmacology and experiments showed that the candidate compound in *Aster tataricus* extracts alleviated LPS-induced acute lung injury mainly by inhibiting the release of inflammatory factors and promoting the repair of the vascular endothelium.

Rho et al. [79] showed that *Aster tataricus* alleviated testosterone-induced benign prostatic hyperplasia in rats by promoting apoptosis and inhibiting inflammation. These results indicate that *Aster tataricus* can be used to treat inflammation associated with benign prostatic hyperplasia in clinical settings.

Recently, Li et al. [80] examined the bioactivities of five undescribed  $\alpha$ -pyrone (neuropyrones A–E) derivatives from the endophytic fungus *Neurospora dictyophora* WZ-497 derived from the stems of *Aster tataricus*. The results showed that neuropyrones A–C exerted potent inhibitory effects on tyrosinase, with IC<sub>50</sub> values of 0.38  $\pm$  0.07, 0.49  $\pm$  0.06, and 0.12  $\pm$  0.01 mM, respectively.

Lee et al. [81] found that ethanolic extracts of *Aster tataricus* regulated osteoclast differentiation and alleviated osteoporosis as well as related metabolic changes after estrogen depletion. These results indicate that *Aster tataricus* can be used as an alternative treatment strategy for postmenopausal osteoporosis accompanied by metabolic imbalance.

## 5.9. Toxicity and safety

Modern pharmacological studies have primarily focused on the therapeutic effects of *Aster tataricus* against cough, tumors, and other diseases; however, studies investigating its toxic effects are limited.

To further improve the safety of *Aster tataricus* medication, toxicity and subtoxicity of it was evaluated by Peng et al. [5]. The study showed that *Aster tataricus* could produce toxic effects, mainly on the liver; much less on the heart. The acute oral toxicity experiment showed that *Aster tataricus* is capable of toxic effects and resulted in an  $LD_{50}$  of 15.74 g/kg BW in mice, The subchronic experiment, conducted at a dose of 0.34 g/kg/d.BW, demonstrated that the toxic components of *Aster tataricus* were mainly concentrated in the petroleum ether fraction, followed by the ethyl acetate fraction, the n-butyl alcohol fraction, the lower aqueous phase and the 75 % ethanol extract. In addition, terpenes can cause toxicity in tumor cells by inducing apoptosis and DNA mutations [23].

To provide an experimental basis for evaluating the safety of the utilization and development of *Aster tataricus*, in-depth studies on its potential toxicity should be carried out.

#### 6. Conclusions and perspectives

The dried roots and rhizomes of *Aster tataricus* have been used in TCM for thousands of years [56]. Approximately 250 *Aster* species are found worldwide; of which, 100 species are found in China, mainly in Anhui and Hebei [5]. Ancient literary records indicate that *Aster tataricus* suppresses cough, alleviates asthma, improves eclampsia in children, urination, and relieves constipation. It is rich in active ingredients and has a wide range of pharmacological effects. This review summarized the morphology characteristics, chemical composition, and therapeutic effects of *Aster tataricus* based on traditional literature and modern evidence, providing a scientific basis for further research and exploitation of medicinal plants to develop more effective therapeutic drugs.

With the continuous development of research tools and instruments, numerous compounds have been isolated and identified from *Aster tataricus*, which has not only improved the understanding of its chemical constituents but also provided more comprehensive and accurate information for its medicinal and nutritional applications. Terpenes, flavonoids, organic acids, peptides, esters, coumarins, quinones, alkanes, and alkynes isolated from it exhibit a wide range of pharmacological activities. For example, terpenes, the main chemical constituents of *Aster tataricus*, can induce apoptosis and DNA mutations in tumor cells, thereby exerting anti-tumor effects. Caffeoylquinic acids and epifriedelinol possess strong anti-oxidant, anti-inflammatory, and anti-cancer activities. Scopoletin can effectively treat diabetes and alleviate inflammation and oxidative stress. In addition, astin C can suppresses the immune system by inducing T-cell apoptosis [33]. And its distinctive chlorinated pentacyclic structure and potential pharmacological activities have received substantial attention from researchers. Although several studies have reported the pharmacological effects of *Aster tataricus*, the translation of research findings into clinical practice is limited.

Remarkable progress has been made in research on the phytochemical composition and pharmacological effects of *Aster tataricus*. However, certain gaps in knowledge remain to be addressed. First, the pharmacological effects of terpenes, the main chemical constituents of *Aster tataricus*, should be evaluated comprehensively. Cyclic peptides have effective anti-tumor and immunosuppressive activities; however, few peptides have been extracted from *Aster tataricus*. Second, cancer is a leading cause of death worldwide, accounting for approximately 10 million deaths in 2020. The cyclopeptide astin C, isolated from the endophytic fungus *Cyanodermella asteris* derived from *Aster tataricus*, has been reported to have potent anti-cancer and immunosuppressive activities. It functions by binding to STING, a crucial cytosolic DNA sensor protein involved in innate immunity. Therefore, to facilitate the rational utilization of *Aster tataricus* resources and determine the optimal concentrations of its active compounds, the chemical composition and pharmacological effects of *Cyanodermella asteris* should be extensively investigated. Third, since ancient times, *Aster tataricus* has been used as an effective anti-cough agent and expectorant. Although modern pharmacological studies have validated these effects, the development of *Aster tataricus* into a drug remains an unaddressed concern. Last but not least, considering the pharmacological activities and potential health benefits of *Aster tataricus*, its toxicological profile should be analyzed intensively.

In addition to its medicinal value, the toxicity and safety of *Aster tataricus* warrants strict consideration, in order to provide experimental basis for the development and utilization of *Aster tataricus*. However, further research is warranted to validate these findings.

In conclusion, *Aster tataricus* is an important source of active components, with a wide range of pharmacological activity. However, the chemical compounds isolated from *Aster tataricus* are inadequate, and their mechanism of action warrants further investigation. Therefore, future research should be focused on the isolation and identification of chemical components from *Aster tataricus*, systematic analysis of their biological activities, in-depth exploration of pulmonary diseases, and strengthening drug development to expand the application of *Aster tataricus*.

## Data availability

No data was used for the research described in the article.

## CRediT authorship contribution statement

Xi-Ling Fan: Writing – review & editing, Writing – original draft. Zhong-Peng Qin: Writing – original draft, Formal analysis. Jian-Hui Wen: Writing – review & editing, Supervision. Zhen-Zhong Wang: Writing – review & editing, Supervision, Funding acquisition. Wei Xiao: Writing – review & editing, Supervision, Funding acquisition.

#### **Declaration of Competing interest**

No potential declaration of interest statement was reported by the authors.

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#### References

- L.L. Fan, X. Wang, X.J. Zhu, J. Liu, H. Yin, J.P. Luo, Y. Xue, Q.J. Jin, W.D. Yu, Advances in research on chemical constituents and pharmacological effects of Aster, Jilin. J. Tradit. Chin. Med 39 (2) (2019) 269–273.
- [2] J.J. Zhai, M.Y. Duan, J.Y. Li, T.T. Hu, X.S. Meng, W.J. Wang, Textual research of aster. J. Liaoning. Univ. Tradit. Chin, Med 1–14 (2023).
- [3] Y.J. Cai, X.L. Shi, H.Y. Liu, L. Wu, Y.T. Gu, R. Wang, Effective components and pharmacological effects of Asteris Radix, J. Tradit. Chin. VeterMed 42 (2) (2023) 39–42.
- [4] H.Y. Li, W.J. Li, X.Y. Ding, D. Zhang, Z.J. Xue, Q. An, Z.L. Zhan, Y.G. Zheng, Herbal textual research on Asteris Radix et rhizoma in famous classical formulas, Chin. J. Exp. Tradit. Med. Form (2023) 1–13.
- [5] W.J. Peng, R.H. Xin, Y.J. Luo, G. Liang, L.H. Ren, Y. Liu, G.B. Wang, J.F. Zheng, Evaluation of the acute and subchronic toxicity of Aster tataricus L. F. Afr. J. Tradit. Complement. Altern, Med 13 (6) (2016) 38–53.
- [6] P. Yu, S. Cheng, J. Xiang, B. Yu, M. Zhang, C. Zhang, X. Xu, Expectorant, antitussive, anti-inflammatory activities and compositional analysis of *Aster tataricus*, J. Ethnopharmacol. 164 (2015) 328–333.
- [7] K. Jiang, Q. Song, L. Wang, T.Z. Xie, X. Wu, P. Wang, G. Yin, W.C. Ye, T.J. Wang, Antitussive, expectorant and anti-inflammatory activities of different extracts from *Exocarpium Citri* grandis, J. Ethnopharmacol. 156 (2014) 97–101.
- [8] S.J. Guo, X.H. Zhao, D.L. Cheng, A new diterpenoid glucoside from Aster smithianus, Chin. Chem. Lett. 15 (12) (2004) 1451-1453.
- [9] Y.P. Sun, L. Li, M. Liao, M. Su, C.C. Wan, L.T. Zhang, H.L. Zhang, A systematic data acquisition and mining strategy for chemical profiling of Aster tataricus rhizoma (Ziwan) by UHPLC-Q-TOF-MS and the corresponding anti-depressive activity screening, J. Pharmaceut. Biomed 154 (2018) 216–226.
- [10] X.V. Dong, J. Fu, X.B. Yin, S.L. Cao, X.C. Li, L.F. Lin, J. Ni, Emodin: a review of its pharmacology, toxicity and pharmacokinetics. Phytother, Res. 30 (2016) 1207–1218.
- [11] K.J. Li, Y.Y. Liu, D. Wang, P.Z. Yan, D.C. Lu, D.S. Zhao, Radix Asteris: traditional Usage, phytochemistry and pharmacology of an important traditional Chinese medicine, Molecules 27 (17) (2022) 5388.
- [12] G.M. Barton, A calculated response: control of inflammation by the innate immune system, J. Clin. Invest. 118 (2) (2008) 413-420.
- [13] J.L. Fisher, J.A. Schwartzbaum, M. Wrensch, J.L. Wiemels, Epidemiology of brain tumors. Neurol, Clin 25 (4) (2007) 867-890.
- [14] M.R. Oliveira, A.L. Chenet, A.R. Duarte, G. Scaini, J. Quevedo, Molecular mechanisms underlying the anti-depressant effects of resveratrol: a review, Mol. Neurobiol. 55 (6) (2018) 4543-4559.
- [15] Y.Y. Han, F. Gao, P.Y. Qin, R. Bai, J.Y. Tian, X.C. Liu, C.C. Yuan, Q.H. Guo, Advances in studies on Asteris Radix et rhizoma and prediction of its quality markers, Modern. Chin. Med 25 (3) (2023) 655–664.
- [16] H. Tian, K.Y. Xu, J.S. Hang, C.L. Piao, On clinical application and dosage of Tatarian aster root, Jilin. J. Tradit. Chin. Med 41 (1) (2021) 99-102.
- [17] W.B. Zhou, Studies on chemical constituents from Aster tataricus L.f., 2010. Hu. Bei, Chin. Med. (2010).
- [18] J. Shen, Study on the Chemical Constituents of Aster lingua. Southwest. Mizu, Univ., 2022.
- [19] J. Ye, Study on the Constituents and Their Primary Antitumor Effect in Aster tataricus & Semiaquilegia Adoxoides, Tianjing. Univ., 2007.
- [20] T. Nagao, H. Okabe, T. Yamaucchi, Studies on the constituents of Aster tataricus L.f.I. structures of shionosides A and B, monoterpene glycosides isolated from the root, Chem. Pharm. Bull. 36 (2) (1988) 571–577.
- [21] T. Akihisa, Y. Kimura, K. Koike, K. Yasukawa, K. Arai, Y. Suzuki, T. Nikaido, Astertarone A: a triterpenoid ketone isolated from the roots of Aster tataricus L, Chem. Pharm. Bull. 46 (1998) 1824–1826.
- [22] Y.P. Sun, L. Li, M. Liao, M. Su, C.C. Wan, L.T. Zhang, H.L. Zhang, A systematic data acquisition and mining strategy for chemical profiling of Aster tataricus rhizoma (Ziwan) by UHPLC-Q-TOF-MS and the corresponding anti-depressive activity screening, J. Pharmaceut. Biomed 154 (2018) 216–226.
- [23] W.B. Zhou, G.Z. Zeng, H.M. Xu, W.J. He, Y.M. Zhang, N.H. Tan, Astershionones A-F, six new anti-HBV shionane-type triterpenes from Aster tataricus, Fitoterapia 93 (2014) 98–104.
- [24] L. Virginia, Bioactive saponins from Allium and aster plants 4 (2-3) (2005) 95-110.
- [25] X.C. Sun, Studies on the Chemical Constituents and Anti-inflammatory Activities from Callicarpa nudiflora and Ligularia fischeri, Nan. Kai. Univ., 2017.
- [26] X.D. Su, H.J. Jang, C.Y. Wang, S.W. Lee, M.C. Rho, Y.H. Kim, S.Y. Yang, Anti-inflammatory potential of Saponins from Aster tataricus via NF-κB/MAPK activation, J. Nat. Prod. 82 (5) (2019) 1139–1148.
- [27] Y. Shao, C.T. Ho, C.K. Chin, O. Poobrasert, S.W. Yang, G.A. Cordell, Asterlingulatosides C and D, cytotoxic triterpenoid saponins from Aster lingulatus, J. Nat. Prod. 60 (7) (1997) 743-746.
- [28] Y. Shao, C.T. Ho, C.K. Chin, R.T. Rosen, B. Hu, G.W. Qin, Triterpenoid saponins from Aster lingulatus, Phytochemistry 44 (2) (1997) 337-430.
- [29] Y. Shao, Y.L. Li, B.N. Zhou, Phenolic and triterpenoid glycosides from Aster batangensis, Phytochemistry 41 (6) (1996) 1593–1598.
- [30] T. Tanaka, T. Nagao, H. Okabe, T. Yamauchi, Studies on the constituents of Aster tataricus L.f.IV. structures of Aster saponins isolated from the herb, Chem Pharm Bull 38 (5) (1990) 1153–1157.
- [31] Y. Shao, B.N. Zhou, L.Z. Lin, G.A. Cordell, Triterpenoid saponins from Aster batangensis, Phytochemistry 38 (4) (1995) 927–933.
- [32] T.B. Ng, F. Liu, Y.H. Lu, C.H.K. Cheng, Z.T. Wang, Antioxidant activity of compounds from the medicinal herb Aster tataricus, Comp. Biochem. Physiol. C Toxicol. Pharmacol. 136 (2) (2003) 109–115.
- [33] H. Morita, S. Nagashima, Y. Uchiumi, O. Kuroki, K. Takeya, H. Itokawa, Cyclic peptides from higher plants. XXVIII. Antitumor activity and hepatic microsomal biotransformation of cyclic pentapeptides, astins, from Aster tataricus, Chem. Pharm. Bull. 44 (1996) 1026–1032.
- [34] L. Wang, M.D. Li, P.P. Cao, C.F. Zhang, F. Huang, X.H. Xu, B.L. Liu, M. Zhang, Astin B, a cyclic pentapeptide from Aster tataricus, induces apoptosis and autophagy in human hepatic L-02 cells, Chem. Biol. Interact. 223 (2014) 1–9.
- [35] H.M. Xu, G.Z. Zeng, W.B. Zhou, W.J. He, N.H. Tan, Astins K-P, six new chlorinated cyclopentapeptides from Aster tataricus, Tetrahedron 69 (2013) 7964-7969.
- [36] D. Cheng, Y. Shao, R. Hartman, E. Roder, K. Zhao, Oligopeptides from Aster tataricus, Phytochemistry 36 (4) (1994) 945–948.
- [37] D.L. Cheng, Y. Shao, K. Zhao, R. Hartmann, E. Roeder, Pentapeptides from the roots of Aster tataricus, Pharmazie 51 (1996) 185-186.
- [38] S. Sawai, H. Uchiyama, S. Mizuno, T. Aoki, T. Akashi, S.-I. Ayabe, T. Takahashi, Molecular characterization of an oxidosqualene cyclase that yields shionone, a unique tetracyclic triterpene ketone of *Aster tataricus*, Febs. Lett. 585 (2011) 1031–1036.
- [39] M. Wang, Q.X. Bai, X.X. Zheng, W.J. Hu, S. Wang, H.P. Tang, A.Q. Yu, B.Y. Yang, H.X. Kuang, Smilax China L.: a review of its botany, ethnopharmacology, phytochemistry, pharmacological activities, actual and potential applications, J. Ethnopharmacol. 318 (Pt B) (2024) 116992.
- [40] M. Wang, H.P. Tang, S. Wang, W.J. Hu, J.Y. Li, A.Q. Yu, Q.X. Bai, B.Y. Yang, H.X. Kuang, Acorus tatarinowii Schott: a Review of its botany, traditional uses, phytochemistry, and pharmacology, Molecules 28 (11) (2023) 4525.
- [41] S.L. Chen, J. Liu, M.H. Feng, Y.T. Li, Z.X. Jia, S. Yang, H.B. Xiao, Identification of peptides in *Aster tataricus* by the strategy of UPLC-Q-TOF-MS/MS combined with molecular network, J. Chin. Mass Spectrom. Soc. 44 (3) (2023) 397–411.
- [42] M. Pernot, R. Vanderesse, C. Frochot, F. Guillemin, M. Barberi-Heyob, Stability of peptides and therapeutic success in cancer, Expert. Opin. Drug. Metab. Toxicol. 7 (7) (2011) 793–802.
- [43] X.C. Sun, Studies on the Chemical Constituents and Anti-inflammatory Activities from Callicarpa nudiflora and Ligularia fischeri, Nan. Kai. Univ., 2017.
- [44] Y.J. Cai, X.L. Shi, H.Y. Liu, L. Wu, Y.T. Gu, R. Wang, Effective components and pharmacological effects of Asteris Radix, J Tradit Chin Veteri Med 42 (2) (2023) 39–42.
- [45] B. Yang, Y.Q. Xiao, R.X. Liang, Studies on Expectorant Compounds in Volatile Oil from Root and Rhizome of Aster tataricus, 2008, pp. 281–283, 03.
- [46] J.W. Zhang, C.G. Dou, M. Zhang, S.P. Ma, F. Huang, Toxicity of Radix Asteris, flos farfarae and their combination, Chin. J. Clin. Pharmacol. Ther. (4) (2007) 405–411.
- [47] P. Yu, S. Cheng, J. Xiang, B. Yu, M. Zhang, C. Zhang, X. Xu, Expectorant, antitussive, anti-inflammatory activities and compositional analysis of Aster tataricus, J. Ethnopharmacol. 164 (2015) 328–333.

- [48] B. Yang, Y.Q. Xiao, R.X. Liang, R.J. Wang, W. Li, C. Zhang, Y. Cao, Q.P. Wang, L. Wang, Y.Y. Wang, Studies on expectorant compounds in volatile oil from root and rhizome of *Aster tataricus*, China, J. Chin. Matera. Med. 33 (2008) 281–283.
- [49] H.L. Wang, J. Gao, D.N. Zhu, B.Y. Yu, Quality evaluation of *Polygala japonica* through simultaneous determination of six bioactive triterpenoid saponins by HPLC-ELSD, J. Pharm. Biomed. Anal. 43 (4) (2007) 1552–1556.
- [50] K.Y. Liu, J.T. Zhang, W.Y. Gao, Y.N. Zheng, H.X. Chen, Triterpenes and steroids from Aster tataricus, Nat. Prod. Res. Dev. 18 (2006) 4-6.
- [51] V. Brusasco, R. Pellegrino, Complexity of factors modulating airway narrowing in vivo: relevance to assessment of airway hyperresponsiveness, J. Appl. Physiol. 95 (2003) 1305–1313.
- [52] J.H. Bates, M. Rincon, C.G. Irvin, Animal models of asthma, Am. J. Physiol. Lung Cell Mol. Physiol. 297 (3) (2009) L401–L410.
- [53] W.J. Peng, R.H. Xin, Y. Liu, Y.J. Luo, G.B. Wang, C.Y. Luo, J.S. Xie, J.Y. Li, J.F. Zheng, Effects of alcohol extract of Aster tataricus L.f. on the contraction of Guinea pig trzcheal smooth muscle in vitro. Chin. Animal. Husbandry. Veterinary, Med. 43 (6) (2016) 1572–1578.
- [54] Y.J. Chen, H. Wu, Y.T. Li, J. Liu, Z.X. Jia, W.J. Xu, H.B. Xiao, W. Wang, Aster tataricus attenuates asthma efficiently by simultaneously inhibiting trcheal ring contraction and inflammation, Biomed. Pharmacother. 130 (2020) 110616.
- [55] H. Du, M. Zhang, K.J. Yao, Z.T. Hu, Protective effect of Aster tataricus extract on retinal damage on the virtue of its antioxidant and anti-inflammatory effect in diabetic rat, Biomed. Pharmacother. 89 (2017) 617–622.
- [56] H.T. Zhang, M. Tian, Q.W. He, N. Chi, C.M. Xiu, Y.B. Wang, Effect of Aster tataricus on production of inflammatory mediators in LPS stimulated rat astrocytoma cell line (C6) and THP-1 cells, Saudi. Pharm. J. 25 (3) (2017) 370–375.
- [57] X. Wang, L. Fan, H. Yin, Y.Q. Zhou, X.L. Tang, X.J. Fei, H.L. Tang, J. Peng, X.Q. Ren, Y. Xue, C.L. Zhu, J.P. Luo, Q.L. Jin, Q.J. Jin, Protective effect of Aster tataricus extract on NLRP3-mediated pyroptosis of bladder urothelial cells, J. Cell Mol. Med. 24 (22) (2020) 13336–13345.
- [58] Z.Y. Liu, R.G. Xi, Z.R. Zhang, W.P. Li, Y. Liu, F.G. Jin, g X.B. Wan, 4-hydroxyphenylacetic acid attenuated inflammation and edema via suppressing HIF-1α in seawater aspiration-induced lung injury in rats, Int. J. Mol. Sci. 15 (7) (2014) 12861–12884.
- [59] X.D. Su, H.J. Jang, H.X. Li, Y.H. Kim, S.Y. Yang, Identification of potential inflammatory inhibitors from *Aster tataricus*, Bioorg. Chem. 92 (2019) 103208.
   [60] M. Wang, W.J. Hu, X. Zhou, K. Yu, Y. Wang, B.Y. Yang, H.X. Kuang, Ethnopharmacological use, pharmacology, toxicology, phytochemistry, and progress in
- Chinese crude drug processing of the lateral root of *Aconitum carmichaelii Debeaux*. (Fuzi): a review, J. Ethnopharmacol. 301 (2023) 115838. [61] W.J. Hu, A.Q. Yu, S. Wang, Q.X. Bai, H.P. Tang, B.Y. Yang, M. Wang, H.X. Kuang, Extraction, purification, structural characteristics, biological activities, and
- applications of the polysaccharides from *Zingiber officinale* Roscoe. (Ginger): a review, Molecules 28 (9) (2023) 3855.
  [62] J. Wan, C.X. Jiang, Y. Tang, G.L. Ma, Y.P. Tong, Z.X. Jin, Y. Zang, E.E.A. Osman, J. Li, J. Xiong, J.F. Hu, Structurally diverse glycosides of secoiridoid, bisiridoid, and triterpene-bisiridoid conjugates from the flower buds of two *Caprifoliaceae* plants and their ATP-citrate lyase inhibitory activities, Bioorg. Chem. 120 (2022) 105630.
- [63] T. Xin, F.B. Zhang, Q.Y. Jiang, C.H. Chen, D.Y. Huang, Y.J. Li, W.X. Shen, Y.H. Jin, G.J. Sui, The inhibitory effect of a polysaccharide from *Codonopsis pilosula* on tumor growth and metastasis in vitro, Int. J. Biol. Macromol. 51 (5) (2012) 788–793.
- [64] Y.X. Zhang, Q.S. Wang, T. Wang, H.K. Zhang, Y. Tian, H. Luo, S. Yang, Y. Wang, X. Huang, Inhibition of human gastric carcinoma cell growth in vitro by a polysaccharide from Aster tataricus, Int. J. Biol. Macromol. 51 (4) (2012) 509–513.
- [65] L. Du, H.F. Mei, X. Yin, Y.Q. Xing, Delayed growth of glioma by a polysaccharide from Aster tataricus involve upregulation of Bax/Bcl-2 ratio, activation of caspase-3/8/9, and downregulation of the Akt, Tumour. Biol. 35 (3) (2014) 1819–1825.
- [66] P.B. Yao, Y.L. Liu, Z.G. Zhu, H.H. Zhao, J.X. Zhang, Effects and aster water extract on proliferation and invasion on human lung cancer A549 cells, and tumorigenesis ability of nude mice, Chin. J. Pharm. Anal. 42 (3) (2022) 380–386.
- [67] Z.Q. Liu, Anti-oxidant in China: a thirty-year journey, Am. J. Chin. Med. 47 (5) (2019) 1005–1024.
- [68] C.H. Ma, K.V. Dastmalchi, B.D. Whitaker, E.J. Kennelly, Two new antioxidant malonated caffeoylquinic acid isomers in fruits of wild eggplant relatives, J. Agric. Food Chem. 59 (17) (2011) 9645–9651.
- [69] K. Li, T.S. Xia, Y.P. Jiang, N.N. Wang, L.Y. Lai, S.Y. Xu, X.Q. Yue, H.L. Xin, A review on ethnopharmacology, phytochemistry, pharmacology and potential uses of Portulaca oleracea L, J. Ethnopharmacol. 319 (Pt 2) (2024) 117211.
- [70] Y.P. Zhang, H.L. Zhang, Y.S. Yang, Z.C. Shi, In vitro antioxidant activity of different polar parts of Aster tataricus L. f. extracts, Lishizhen. Med. Mater. Med. Res. 22 (11) (2011) 2799–2800.
- [71] M.R. de Oliveira, A.L. Chenet, A.R. Duarte, G. Scaini, J. Quevedo, Molecular mechanisms underlying the anti-depressant effects of *Resveratrol*: a review, Mol. Neurobiol. 55 (6) (2018) 4543–4559.
- [72] Y.C. Wan, Y.Y. Liu, H.T. Yang, Q.Y. Zhang, M. Liao, X. Zhang, L.T. Zhang, Simultaneous determination of nine constituents in Asteris Radix by HPLC-MS/MS, Chin. Tradit. Herb. Drugs 47 (14) (2016) 2534–2539.
- [73] Y.X. Zhang, Q.S. Wang, T. Wang, H.K. Zhang, Y. Tian, H. Luo, S. Yang, Y. Wang, X. Huang, Inhibition of human gastric carcinoma cell growth in vitro by a polysaccharide from Aster tataricus, Int. J. Biol. Macromol. 51 (4) (2012) 509–513.
- [74] W.B. Zhou, G.Z. Zeng, H.M. Xu, W.J. He, N.H. Tan, Astataricusones A-D and astataricusol A, five new anti-HBV shionane-type triterpenes from Aster tataricus L. f, Molecules 18 (12) (2013) 14585–14596.
- [75] X.X. Liu, Y.L. Tang, Y.L. Liu, K.H. Xu, Analysisi of effective constituents from Aster tataricus L.f. and extracting of alkaloid and its antibacterial test in vitro, J. Tradit. Chin. Vet. Med. (1) (2006) 16–18.
- [76] Y. Shen, Q. Luo, H.M. Xu, F.Y. Gong, X.B. Zhou, Y. Sun, X.F. Wu, W. Liu, G.Z. Zeng, N.H. Tan, Q. Xu, Mitochondria-dependent apoptosis of activated T lymphocytes induced by astin C, a plant cyclopeptide, for preventing murine experimental colitis, Biochem. Pharmacol. 82 (3) (2011) 260–268.
- [77] S.L. Li, Z. Hong, Z. Wang, F. Li, J.H. Mei, L.L. Huang, X.W. Lou, S.M. Zhao, L.H. Song, W. Chen, Q. Wang, H. Liu, Y.N. Cai, H.S. Yu, H.M. Xu, G.Z. Zeng, Q. Y. Wang, J.J. Zhu, X. Liu, N.H. Tan, C. Wang, The cyclopeptide astin C specifically inhibits the innate immune CDN sensor STING, Cell Rep. 25 (2018) 3405–3421.
- [78] Y.J. Chen, J.J. Dong, J. Liu, W.J. Xu, Z.Y. Wei, Y.T. Li, H. Wu, H.B. Xiao, Network pharmacology-based investigation of protective mechanism of Aster tataricus on lipopolysaccharide-induced acute lung injury, Int. J. Mol. Sci. 20 (3) (2019) 543.
- [79] J.H. Rho, C.S. Seo, H.S. Park, H.Y. Jeong, O.S. Moon, Y.W. Seo, H.Y. Son, Y.S. Won, H.J. Kwun, Asteris Radix et rhizoma suppresses testosterone-induced benign prostatic hyperplasia in rats by regulating apoptosis and inflammation, J. Ethnopharmacol. 255 (2020) 112779.
- [80] X. Li, Y.X. Gong, L. Feng, X.J. Wang, J.W. Wang, A.X. Zhang, N.H. Tan, Z. Wang, Neuropyrones A-E, five undescribed α-pyrone derivatives with tyrosinase inhibitory activity from the endophytic fungus Neurospora dictyophora WZ-497, Phytochemistry 207 (2023) 113579.
- [81] S.J. Lee, H. Yang, S.C. Kim, D.R. Gu, J.A. Ryuk, S.A. Jang, H. Ha, Ethanol extract of *Radix Asteris* suppresses osteoclast differentiation and alleviates osteoporosis, Int. J. Mol. Sci. 24 (22) (2023) 16526.