Journal of Ethnopharmacology 128 (2010) 279–313

Contents lists available at ScienceDirect

Journal of Ethnopharmacology

journal homepage: www.elsevier.com/locate/jethpharm

Review

The genus *Scutellaria* an ethnopharmacological and phytochemical review

Xiaofei Shang[a,b], Xirui He[a,c], Xiaoying He[a], Maoxing Li[a,*], Ruxue Zhang[a], Pengcheng Fan[a], Quanlong Zhang[a], Zhengping Jia[a,*]

[a] Department of Pharmacy, Lanzhou General Hospital of PLA, Lanzhou 730050, PR China
[b] Department of Life Sciences, Lanzhou University, Lanzhou 730000, PR China
[c] Department of Pharmacy, Lanzhou University, Lanzhou 730000, PR China

ARTICLE INFO

Article history:
Received 26 September 2009
Received in revised form 1 January 2010
Accepted 2 January 2010
Available online 11 January 2010

Keywords:
Scutellaria
Ethnopharmacology
Phytochemistry
Flavonoids
Antitumor
Hepatoprotective

ABSTRACT

Scutellaria (*HUANG QIN*) (Lamiaceae), which includes about **350** species commonly known as skullcaps, is widespread in Europe, the United States and East Asia. Some species are taken to clear away the heat-evil and expel superficial evils in traditional Chinese medicine (TCM). The present paper reviews the ethnopharmacology, the biological activities and the correlated chemical compounds of *Scutellaria* species. More than **295** compounds have been isolated, among them flavonoids and diterpenes. Studies show that *Scutellaria* and its active principles possess wide pharmacological actions, such as antitumor, anti-angiogenesis, hepatoprotective, antioxidant, anticonvulsant, antibacterial and antiviral activities. Currently, effective monomeric compounds or active parts have been screened for pharmacological activity from Scutellaria *in vivo* and *in vitro*. Increasing data supports application and exploitation for new drug development.

Contents

1. Introduction 280
2. Biology and ethnopharmacology 280
3. Phytochemistry 289
  3.1. Flavonoids 289
    3.1.1. Flavones and flavonols 289
    3.1.2. Flavanones and flavanonols 289
    3.1.3. Biflavonoids 294
    3.1.4. Flavonolignans 294
    3.1.5. Chalcones 295
  3.2. Phenylethanoid glycosides 295
  3.3. Iridoid glycosides 295
  3.4. Diterpenes 296
  3.5. Triterpenoids 297
  3.6. Neo-clerodane diterpenoid alkaloids 297
  3.7. Alkaloids 298
  3.8. Essential oils 298
  3.9. Other compounds 299
4. Qualitative and quantitative analysis 300
5. Effects of crude extract 302
  5.1. Antitumor 302
  5.2. Anti-angiogenesis 305
  5.3. Hepatoprotective 305

* Corresponding author. Tel.: +86 931 899 4676.
E-mail addresses: limaox2005@yahoo.com.cn (M. Li), limaox2005@yahoo.com.cn (Z. Jia).

0378-8741/$ – see front matter
doi:10.1016/j.jep.2010.01.006

5.4. Antioxidant 305
5.5. Anticonvulsant 307
5.6. Antibacterial and antiviral 307
5.7. Neuroprotective effects and memory improvement 308
6. Conclusion 310
References 311

1. Introduction

Scutellaria (Lamiaceae) includes about **350** species commonly known as skullcaps (Willis, 1966). The genus is widespread in temperate regions and tropical mountains including Europe, North America and East Asia (Bruno et al., 2002). Plants of this genus have been widely used in local medicine for thousands of years (Jiangsu New Medical College, 1977). Modern pharmacology research has confirmed that the extracts or monomeric compounds of the genus *Scutellaria* posses antitumor, hepatoprotective, antioxidant, anti-inflammatory, anticonvulsant, antibacterial and antiviral effects.

The chemical compounds of the genus *Scutellaria* have been studied since 1889. In 1910, Goldschmiedt and Lerner isolated the first flavonoid scutellarein from *Scutellaria altissima* in Vietnam (Zeng and Chen, 1957). Since then, more than 295 compounds have been obtained from 35 species. Phenolic compounds (Flavonoids, Phenylethanoid glycosides) and Terpene compounds (Iridoid glycosides, Diterpenes and Triterpenoids) are the two main groups of constituents, and the plants also contain alkaloids, phytosterols and polysaccharides among others. The main compounds of flavonoids, baicalin, baicalein, wogonin and ganhuangenin possess anti-cancer, anti-HIV, anti-bacterial, anti-viral, anti-inflammatory and anticonvulsant effects. Jodrellin A, jodrellin B, scutalbin A and scutecyprol B, which are the main compounds of diterpenes have antifeedant effects, etc. In this review, the advances in ethnopharmacology, phytochemistry, biological and pharmacological activities of the genus *Scutellaria* are presented.

2. Biology and ethnopharmacology

Most *Scutellaria* species are annual or perennial herbaceous plants from 5 cm to 1 m tall, but a few are subshrubs and some are aquatic. They have four-angled stems and opposite leaves. The flowers have upper and lower lips. The genus is most easily recognized by the typical shield on the calyx (Jiangsu New Medical College, 1977) (Fig. 1).

In East Asia, some *Scutellaria* species are widely used as traditional medicine, especially in China, Korea and Japan due to its anti-inflammatory, antiviral, sedative, antithrombotic and antioxidant effects. Radix Scutellariae baicalensis (*HUANG QIN*) and Herba Scutellariae Barbatae (*BAN-ZHI-LIAN*) have been listed in the Pharmacopoeia of the People's Republic of China and Japan (MHWJ, 1996; PCMPH, 2000), and seven species have been listed in 'Zhong Yao Dictionary' in China (Jiangsu New Medical College, 1977).

Fig. 1. The aerial parts and the roots of *Scutellaria baicalensis*.

Scutellaria baicalensis is indigenous to the Korean peninsula and to China, Japan, Mongolia and Russian Federation. In the Chinese medical classic "Shennong's Herba", it was thought as a "middle grade" herb. The general appearance of radix Scutellariae is conical, twisted or flattened root, 5–25 cm long, 0.5–3.0 cm in diameter. Externally it is yellow-brown, with coarse and marked longitudinal wrinkles and with scattered scars of lateral roots and remains of brown periderm; scars of stem or remains of stem at the crown; xylem rotted in old roots; hard in texture and easily broken; fibrous with a fractured surface and yellow in color, reddish-brown in the centre (FAPA, 1978; MHWJ, 1996; MHWK, 1998; PCMPH, 2000).

In China, *S. baicalensis* is widely distributed in Hebei, Shandong, Sichuan, Neimenggu, Gansu, Shannxi, Shanxi, Yunnan and other provinces. In local medicine, the roots have been used to clear away the heat-evil and expel superficial evils, eliminate stasis and activate blood circulation, induce diuresis and reduce edema in China. In the clinic, it is widely applied to cure pneumonia, hypertension, jaundice, dysentery and intestinal catarrh, pyogenic infection, etc. Recently, due to the marked decrease of wild resources, *S. baicalensis* has been listed as a nationally protected plant in China (Jiang Su New Medical College, 1977) (Fig. 1). Along with the development of pharmacology, chemistry and pharmaceutics, *S. amoena*, *S. rehderiana*, *S. likiangensis*, *S. viscidula* have been studied systematically as substitutes for *S. baicalensis*. The roots of these plants are used as a key ingredient in combination with other Chinese herbs in a number of prescriptions such as *Huangqin Tang*, *Huangqin Qingfei Tang*, *Huangqin Lige Tang*, etc. (Table 1).

Scutellaria barbata, a plant native to southern China, is widely distributed in Anhui, Zhejiang, Henan, Jiangsu, Fujian, Guizhou, Yunnan, Shandong, Hebei and other provinces. This plant often grows in wet meadows and nearby pools and brooks. This herb was known in traditional Chinese medicine as *Ban-Zhi-Lian* and has been used to cure the pain and swelling of throat, edema and hemorrhoids. Moreover, it was thought to be an external agent for the treatment of snake bites (Jiangsu New Medical College, 1977). Extracts of *S. barbata* have shown *in vivo* growth inhibitory effects in a number of cancers. The herb has been used in the treatment of digestive system cancers, hepatoma, lung cancer, breast cancer and chorioepithelioma. In particular, sixty-two percent of patients suffering from hepatoma were completely cured when treated with *S. barbata* (Qian, 1987).

In Europe and North America, dried aerial parts of *S. galericulata* and *S. lateriflora* are mainly used as skullcap, and the latter plant grows in meadows and swampy woods in North America. In the Pharmacopoeia and National Formulary of the United States, the dried aerial parts of *S. lateriflora* were recorded as sedative/nerve tonics as well as an antispasmodic to treat epilepsy, anxiety, neuralgia and withdrawal from barbiturates and tranquilizers. In Canada, the skullcap herb is generally sold as a tea in health food stores, but can also be found as a tonic or in combination with other herbs such as valerian and passion flower in sleep-inducing tablets (Awad et al., 2003).

In addition, *S. indica* was employed for analgesia, detoxification, promoting blood circulation effects in China, Korea and India.

Table 1
The traditional use of *S. baicalensis* in China.

Name	Compositions	Traditional uses	References
Huangqin Tang I	**Radix Scutellariae**, Radix Platycodi Radix Paeoniae Alba, Radix Ophiopogonis, Radix Ginseng, Radix Rehmanniae, Radix Puerariae, Radix Trichosanthis, Radix Angelicae Sinensis, Fructus Mume, Fructus Gardeniae.	Removing heat to promote salivation, and curing the diabetes involving the upper warmer	'Wan Bing Hui Chun', Vol. 5
Huangqin Tang II	**Radix Scutellariae**	Hemostasis by clearing away heat, curing haemorrhagia nasalis	'Shang Han Zong Bing Lun', Vol. 3
Huangqin Tang III	**Radix Scutellariae**, Radix Peucedani, Cortex Cinnamomi, Rhizoma Pinelliae, Poria.	Curing typhoid fever and its complication	'Wai Tai Mi Yao', Vol. 'Sheng Shi Fang'
Huangqin Tang IV	**Radix Scutellariae**, Radix Paeoniae Alba, Radix Glycyrrhizae, Semen Ziziphi Spinosae.	Removing heat and alleviating pain	'Shang Han Lun'
Huangqin Shegan Tang	**Radix Scutellaria**, Radix Peucedani, Radix Glycyrrhizae, Rhizoma Belamcandae, Rhizoma Cimicifugae, Fructus Aurantii Immaturus, Cortex Cinnamomi.	Curing the dieases of gullet	'Shen Ji Zong Lu', Vol. 124
Huangqin Shaoyao Tang	**Radix Scutellariae**, Radix Paeoniae Alba, Radix Rehmanniae, Rhizoma Atractylodes Macrocephalae.	Curing women's typhoid fever and its complication	'Lei Zheng Huo Ren Book', Vol. 19
Huangqin Qingfei Tang	**Radix scutellariae**, Fructus Gardeniae.	Curing difficulty in micturition induced by pulmonary dryness	'Wei Sheng Bao Jian', Vol. 17
Huangqin Mudan Tang	**Radix Scutellariae**, Radix Paeoniae Alba, Radix et Rhizoma Rhei, Rhizoma Belamcandae, Fructus Aurantii Immaturus, Cortex Moutan, Semen Persicae, Sargassum, Tabanus, Hirudo, Larva holotrichiae.	Curing menstruation diease	'Bei Ji Qian JinYao Fang', Vol. 4
Huangqin Maohua Tang	**Radix Scutellariae**, Rhizoma Curculiginis, Radix Paeoniae Alba, Radix Glycyrrhizae.	Curing about vomiting immediately after intake of food	Xing Yuan Sheng Chun', Vol. 5
Huangqin Lige Tang	**Radix Scutellariae**, Radix Peucedani, Radix Coptidis, Rhizoma Alismatis, Rhizoma Arisaematis, Alumen. Fructus Aurantii, Pericarpium Citri Reticulatae, Rhizoma Atractylodes Macrocephalae.	Eliminating phlegm by cooling	'Lan Shi Mi Cang'
Huangqin Banxia Shengjiang Tang	**Radix Scutellariae**, Radix Paeoniae Alba, Radix Glycyrrhizae, Radix peucedani, Semen Ziziphi Spinosae.	Curing typhoid fever and its complication	'Shang Han Lun'
Huangqin Huashi Tang	**Radix Scutellariae**, Talcum, Fructus Amomi Rotundus, Pericarpium Arecae, Poria, Medulla Tetrapanacis, Polyporus.	Clearing away heat evil and promoting diuresis	'Wen Bing Tiao Bian', Vol. 2
Huangqin Houbu Tang	**Radix Scutellariae**, Radix Paeoniae Alba, Radix Puerariae, Radix Glycyrrhizae, Radix Bupleuri, Cortex Magnoliae Officinalis, Fructus Aurantii, Pericarpium Citri Reticulatae.	Curing diarrhea due to internal cold and superficial heat	'Gu Jin Yi Che', Vol. 1
Huangqin Beimu Tang	**Radix Scutellariae**, Radix Bupleuri, Radix Scrophulariae, Radix Platycodi, Radix Paeoniae Alba, Semen Armeniacae Amarum, Bulbus Fritillariae Cirrhosae, Fructus Schisandrae.	Curing the dieases of nostril	'Yi Xue Zhai Cui', Vol. 3
Huangqin Banxia Tang	**Radix Scutellariae**, Radix Peucedani Radix Glycyrrhizae, Radix Platycodi, Fructus Aurantii Immaturus, Folium Perillae, Herba Ephedrae, Semen Armeniacae Amarum.	Curing the syndrome of dyspnea	'Gu Jin Yi Tong', Vol. 44
Huangqin Shenma Tang	**Radix Scutellariae**, Radix Puerariae, Radix paeoniae Alba, Radix Glycyrrhizae, Rhizoma Cimicifugae.	Curing the body pain and headache of children.	'Pu Ji Fang', Vol. 369
Huangqin Siwu Tang	**Radix Scutellariae**, Radix Rehmanniae, Radix Angelicae Sinensis, Radix Paeoniae Alba, Rhizoma Chuanxiong, Rhizoma Atractylodes Macrocephalae.	Removing heat to cool blood, promoting blood flow and regualting menstruation	'Yi Zong Jin Jian', Vol. 44
Huangqin Renshen Tang	**Radix Scutellariae**, Radix Ginseng, Radix Glycyrrhizae, Cortex Cinnamomi, Semen Ziziphi Spinosae.	Curing typhoid fever and its complication	'Wai Tai Mi Fang', Vol. 2

Table 1 (*Continued*)

Name	Compositions	Traditional uses	References
Huangqin Jingjie Tang	**Radix Scutellariae**, Radix Bupleuri, Radix Glycyrrhizae, Radix Paeoniae Alba, Radix Angelicae Sinensis, Radix Saposhnikoviae, Herba Chenopodii Ambrosiodis, Fructus Arctii, Fructus Forsythiae, Semen Plantaginis, Perisostracum Cicadae, Fructus Gardeniae, Caulis Aristolochiae Manshuriensis, Talcum.	Curing common cold in children and its complication	'Liang Peng Hui Ji', Vol. 4
Huangqin Liuhe Tang	**Radix Scutellariae**, Radix Rehmanniae, Radix Angelicae Sinensis, Radix Paeoniae Alba, Rhizoma Chuanxiong, Rhizoma Atractylodes Macrocephalae.	Curing menstruation diease	'Yuan Rong'
Huangqin Jiegeng Tang	**Radix Scutellariae**, Radix Platycodi, Radix Paeoniae Alba, Bulbus Fritillariae Cirrhosae, Rhizoma Anemarrhenae, Herba Menthae.	Curing acute seasonal febrile disease and distention of head, pyrophobia	'Yi Fang Jian Yi', Vol. 2
Huangqin Jupi Tang	**Radix Scutellariae**, Radix Puerariae, Radix Glycyrrhizae, Semen Armeniacae Amarum, Fructus Aurantii Immaturus, Herba Ephedrae, Pericarpium Citri Reticulatae, Cortex Magnoliae Officinalis.	Curing the measles	'Ma Zhen Bei Yao Fang Lun'
Huangqin Lugen Tang	**Radix Scutellariae**, Radix Ginseng, Cortex Cinnamomi, Poria.	Curing typhoid fever and its complication	'Shen Ji Zong Lu', Vol. 23
Huangqin Qianhuo Tang	**Radix Scutellariae**, Radix Saposhnikoviae, Radix Glycyrrhizae, Rhizoma Seu Radix Notopterygii.	Curing the pain of supra-orbital bone and phlegmatic hygrosis	'Hui Yue', Vol. 6
Huangqin San	**Radix Scutellariae**, Radix Puerariae, Radix Glycyrrhizae, Radix et Rhizoma Rhei, Herba Ephedrae, Rhizoma Anemarrhenae,	Curing typhoid fever and its complication	'Shen Hui', Vol. 14
Huangqin Shigao Tang	**Radix Scutellariae**, Radix paeoniae Alba, Radix Glycyrrhizae, Radix peucedani, Rhizoma Cimicifugae, Gypsum Fibrosum.	Curing the toothache and uloncus	'Si Shen Xin Yuan', Vol. 8
Huangqin Wuwei San	**Radix Scutellariae**, Radix Coptidis, Radix Astragali, Cortex Phellodendri, Fossilia Ossis Mastodi.	Curing dysentery and abdominal pain	'Wai Tai Mi Fang', Vol. 25
Huangqin Xiebai Tang	**Radix Scutellariae**, Radix Glycyrrhizae, Cortex Mori, Cortex Lycii.	Curing the lung-heat and the difficulty in micturition	'Zheng Yin Mai Zhi', Vol. 4
Huangqin Zhimu Tang	**Radix Scutellariae**, Radix Glycyrrhizae, Rhizoma Anemarrhenae, Cortex Phellodendri.	Curing dysentery and abdominal pain of children.	'Shen Ji Zong Lu' Vol 178
Huangqin Yin	**Radix Scutellariae**, Radix Coptidis, Cortex Phellodendri,	Curing the dieases of intestine	'Shen Ji Zong Lu', Vol. 143
Huangqin Wuwu Tang	**Radix Scutellariae**, Radix Coptidis, Radix Astragali, Cortex Phellodendri, Fossilia Ossis Mastodi.	Curing dysentery and abdominal pain	'Wai Tai Mi Fang', Vol. 25
Huangqin Shaoyao San	**Radix Scutellariae**, Radix paeoniae Alba, Poria.	Nourishing *yin* and removing the heat	"Yi Fang Lei Ju", Vol. 215
Huangqin Huanglian Tang	**Radix Scutellariae**, Radix Coptidis, Radix Gentianae, Radix Rehmanniae.	Curing cataracta	'Lan Shi Mi Cang'
Huangqin Gao	**Radix Scutellariae**.	Curing non-traumatic hemorrhage, haematemesis, haematemesis of children	'Yong Le Da Dian', Vol. 133
Huangqin Dingluan Tang	**Radix Scutellariae**, Radix peucedani, Rhizoma Polygonati Odorati, Rhizoma Coptidis, Fructus Evodiae, Fructus Gardeniae, Pericarpium Citri Reticulatae.	Curing the cholera, hydrodipsia	'Huo Luan Lun', Vol. 4
Huangqin Baizhi San	**Radix Scutellariae**, Radix Angelicae Sinensis, Radix Stephaniae Tetrandrae, Radix Platycodi, Radix paeoniae Alba, Radix Angelicae Dahuricae, Radix Saposhnikoviae, Rhizoma Cassiae, Rhizoma Chuanxiong, Rhizoma Anemarrhenae, Fructus Atriplicis, Concha Haliotidis. Flos Chrysanthemi, Herba Ephedrae	Curing the dieases of eyes	'Yin Hai Jin Wei'
Huangqin Baizhi Tang	**Radix Scutellariae**, Radix Angelicae Dahuricae,	Clearing wind-heat pain	'Yi Bu Quan Lu', Vol. 165
Huangqin Beijia Tang	**Radix Scutellariae**, Radix Bupleuri, Radix Glycyrrhizae, Fructus Gardeniae, Fructus Mume, Carapax Trionycis	Curing typhoid fever and its complication	'Shen Ji Zong Lu', Vol. 33

The references in this table was cited from the Website: http://www.39yao.cn and http://www.zysj.com.cn.

Table 2
The compounds isolated from the genus *Scutellaria*. (The structure of the compounds illustrated in Fig. 2.).

No.	Compounds	Species	References
Flavonoids			
1	Chrysin	*S. amoena*	Zhou (1997)
		S. baicalensis	Takagi et al. (1980)
		S. linearis	Hussain et al. (2008)
		S. viscidula	Zhang et al. (2005)
		S. strigillosa	Miyaichi et al. (2006)
2	Chrysin-7-O-D-glucuronopyranoside	*S. amoena*	Zhou (1997)
		S. prostrata	Kikuchi et al. (1991a)
		S. grossas	Kikuchi et al. (1991b)
3	Chrysin-6-C-D-glu-8-C-L-arabinopyranoside	*S. baicalensis*	Takagi et al. (1981)
		S. amoena	Zhou and Yang (2000)
4	Chrysin-6-C-L-Ara-8-C-D-glucopyranside	*S. baicalensis*	Takagi et al. (1981)
			Miyaichi and Tomimori (1994)
5	Chrysin-8-C-D-glucopyranside	*S. amoena*	Zhou and Yang (2000)
		S. baicalensis	Miyaichi and Tomimori (1995)
6	6-Hydroxyflavone	*S. baicalensis*	Miyaichi and Tomimori (1994)
7	Baicalin	*S. baicalensis*	Tomimori et al. (1984a)
		S. amoena	Xiao et al. (2003)
		S. viscidula	Zhang et al. (2005)
		S. barbata	Lin and Shieh (1996)
		S. lateriflora	Makino et al. (2008)
8	Baicalein	*S. baicalensis*	Tomimori et al. (1984a)
		S. hypericifolia	Dong and Chen (1992)
		S. amoena	Liu et al. (1980)
		S. viscidula	Tomimori and Imoto (1984b)
		S. barbata	Zhang et al. (2005)
		S. lateriflora	Makino et al. (2008)
9	Baicalein-6-O-D-glucuronopyranoside	*S. grossas*	Kikuchi et al. (1991b)
10	Baicalein-7-O-D-glucopyranside	*S. baicalensis.*	Tomimori et al. (1984a)
		S. amoena	Zhou (1997)
11	Baicalein-7-O-L-rhamnoside	*S. galericulata*	Li and Wei (1994)
12	Norwogonin	*S. amoena*	Xiao et al. (2003)
		S. baicalensis	Tomimori et al. (1983)
		S. viscidula	Zhang et al. (2005)
		S. strigillosa	Miyaichi et al. (2006)
13	Norwogonin-7-O-D-glucuronopyranoside	*S. grossas*	Kikuchi et al. (1991b)
		S. prostrata	Kikuchi et al. (1991a)
14	Norwogonin-8-O-D-glucuronopyranoside	*S. discolor*	Tomimori et al. (1988)
15	5-Hydroxy-7,8-dimethoxyflavone	*S. baicalensis*	Tomimori et al. (1983)
		S. barbata	Zhang et al. (2005)
16	Oroxylin A	*S. hypericifolia*	Dong and Chen (1992)
		S. amoena	Zhou (1997)
		S. baicalensis	Huen et al. (2003)
		S. rehderiana	Su et al. (2004)
		S. viscidula	Zhang et al. (2005)
		S. seleriana	Esquivel et al. (1998)
17	Oroxylin A-7-O-D-glucuronopyranoside	*S. prostrata*	Kikuchi et al. (1991a)
		S. baicalensis	Tomimori et al. (1982)
18	Oroxylin A-7-O-D-glucopyranside	*S. ovata*	Li and Wei (1994)
19	Oroxylin A-7-O-D-glucuronopyranoside methyl ester	*S. amoena*	Zhou (1997)
20	Wogonin	*S. baicalensis*	Takagi et al. (1980)
		S. amoena	Xiao et al. (2003)
		S. barbata	Tomimori et al. (1984a)
		S. viscidula	Wang et al. (2003)
		S. rehderiana	Su et al. (2004)
		S. linearis	Hussain et al. (2008)
		S. lateriflora	Makino et al. (2008)
21	Wogonoside	*S. baicalensis*	Takagi et al. (1980)
		S. amoena	Liu et al. (1980)
		S. linearis	Wang et al. (2003)
		S. viscidula	Zhang et al. (2005)
22	5,8-Dihydroxy-6,7-dimethoxyflavone	*S. baicalensis*	Tomimori et al. (1984a)
23	5,6-Dihydroxy-7-O-glucosideflavone	*S. baicalensis*	Tomimori et al. (1984a)
24	5,7,2′-Trihydroxyflavone	*S. baicalensis*	Tomimori et al. (1984a)

Table 2 (*Continued*)

No.	Compounds	Species	References
25	5,7,2′-Trihydroxyflavone-7-O-D-glucuronopyranoside	*S. likiangensis*	Wang et al. (1988)
26	5,7,2′-Trihydroxy-6-methoxyflavone	*S. amoena*	Zhou (1997)
		S. baicalensis	Tomimori et al. (1984a)
		S. viscidula	Zhang et al. (2005)
27	5,7,2′-Trihydroxy-6-methoxyflavone-7-O-D-glucuronopyranoside methyl ester	*S. amoena*	Zhou (1997)
28	5,7,2′-Trihydroxy-6-methoxyflavone-7-O-D-glucuronopyranoside	*S. amoena*	Zhou (1997)
29	5,7,2′-Trihydroxy-6-methoxyflavone-7-O-D-glucopyranside	*S. amoena*	Zhou (1997)
30	Tenaxin-I	*S. tenax*	Liu et al. (1984)
		S. baicalensis	Tomimori et al. (1988)
31	Tenaxin-II	*S. viscidula*	Liu et al. (1986)
		S. baicalensis	Tomimori et al. (1988)
32	Scutevurin	*S. indica*	Miyaichi et al. (1987)
		S. barbata	Tomimori et al. (1984a)
		S. baicalensis	Tomimori et al. (1988)
33	Scutevurin-7-O-D-glucuronide	*S. prostrata*	Kikuchi et al. (1991a)
34	Ikonnikoside I	*S. likiangensis*	Wang et al. (1988)
35	5,2′-Dihydroxy-6,7,8-trimethoxyflavone	*S. baicalensis*	Tomimori et al. (1983)
36	Apigenin	*S. prostrata*	Kikuchi et al. (1991a)
		S. barbata	Wang (1981)
		S. linearis	Hussain et al. (2008)
		S. strigillosa	Miyaichi et al. (2006)
37	Apigenin-7-O-D-glucopyranside	*S. creticola*	Li and Wei (1994)
38	Apigenin-7-O-D-glucuronopyranoside	*S. prostrata*	Kikuchi et al. (1991a)
		S. alpina	Kikuchi et al. (1991c)
39	Scutellarein	*S. barbata*	Wang (1981)
		S. baicalensis	Huen et al. (2003)
		S. viscidula	Wang et al. (2003)
		S. rehderiana	Su et al. (2004)
40	Scutellarin	*S. barbata*	Wang (1981)
41	Scutellarein-7-O-D-glucopyranside	*S. indica*	Miyaichi et al. (1989)
42	4′-Hydroxy wogonin	*S. barbata*	Liu (2005)
43	Hispidulin	*S. barbata*	Wang (1981)
44	Hispidulin-7-O-D-glucuronide	*S. creticola*	Li and Wei (1994)
45	5,7,4′-Trihydroxy-8-methoxyflavone	*S. baicalensis*	Tomimori et al. (1984a)
		S. barbata	Liu (2005)
		S. viscidula	Wang et al. (2003)
46	Luteloin	*S. discolor*	Miyaichi et al. (1987)
		S. barbata	Wang (1981)
		S. linearis	Hussain et al. (2008)
47	Luteloin-7-O-D-glucuronopyranoside	*S. prostrata*	Kikuchi et al. (1991a)
48	Luteloin-7-O-D-glucopyranside	*S. creticola*	Li and Wei (1994)
49	(2S)5,7,3′,4′-Tetrahydroxyflavone (eriodictyol)	*S. barbata*	Wang (1981)
		S. baicalensis	Takagi et al. (1980)
50	5,7,2′-Trihydroxy-8,6′-dimethoxyflavone	*S. baicalensis*	Li and Wei (1994)
51	5,8,2′-Trihydroxy-7-methoxyflavone	*S. baicalensis*	Li and Wei (1994)
52	5,8,2′-Trihydroxy-7-O-D-glucopyranoside	*S. barbata*	Wang (1981)
53	5,8,2′-Trihydroxy-6,7-dimethoxyflavone	*S. baicalensis*	Takagi et al. (1980)
54	5,6,2′-Trihydroxy-7,8-dimethoxyflavone	*S. grossa*	Kikuchi et al. (1991b)
		S. barbata	Lin (1988a)
55	5,6,2′-Trihydroxy-7,8,6′-trimethoxyflavone	*S. prostrata*	Kikuchi et al. (1991a)
56	5,7,2′-Trihydroxy-6′-methoxyflavone	*S. baicalensis*	Xiao et al. (2003)
57	5,2′-Dihydroxy-6,7,8,6′-tetramethoxyflavone	*S. amoena*	Hu et al. (1990)
58	5,2′-Dihydroxy-7,8,6′-trimethoxyflavone	*S. barbata*	Lin (1988a)
		S. baicalensis	Tomimori et al. (1984a)
		S. indica	Miyaichi et al. (1989)
59	Skullcapflavone I	*S. baicalensis*	Takagi et al. (1980)
60	Rehderianin I	*S. rehderiana*	Su et al. (2004)
61	5,2′,5′-Trihydroxy-6,7,8-trimethoxyflavone	*S. baicalensis*	Tomimori et al. (1984a)
62	Viscidulin II	*S. viscidula*	Yu et al. (1984)
63	Visciduli II-2′-O-D-glucuronide	*S. barbata*	Liu (2005)
64	5,2′,6′-Trihydroxy-6,7,8-trimethoxyflavone	*S. alpina*	Kikuchi et al. (1991c)
65	5,2′,6′-Trihydroxy-6,7,8-trimethoxyflavone-2′-O-D-glucoside	*S. baicalensis*	Ishimaru et al. (1995)
66	5,6,2′,6′-Tetrahydroxy-7,8-dimethoxyflavone	*S. prostrata*	Kikuchi et al. (1991d)

Table 2 (*Continued*)

No.	Compounds	Species	References
67	Skullcapflavone II	*S. amoena*	Hu et al. (1990)
		S. baicalensis	Makino et al. (2008)
		S. viscidula	Zhang et al. (2005)
68	5,2′,6′-Trihydroxy-6,7-dimethoxyflavone-2′-O-D-glucoside	*S. baicalensis*	Ishimaru et al. (1995)
69	5,7,6′-Trihydroxy-8-methoxyflavone-2′-O-D-(2-caffeoly)-glucoside	*S. discolor*	Tomimori et al. (1988)
70	Viscidulin III	*S. hypericifolia*	Dong and Chen (1992)
		S. baicalensis	Tomimori et al. (1984a)
		S. viscidula	Wang et al. (2003)
71	Viscidulin III-2′-O-D-glucopyranoside	*S. baicalensis*	Takagi et al. (1980)
72	5,7,8,2′-Tetraflavone-7-O-D-glucuronide	*S. barbata*	Tomimori et al. (1984a)
73	5,7-Dihydroxy-2′-methoxyflavone	*S. prostrata*	Kikuchi et al. (1991a)
74	5,7-Dihydroxy-2′-methoxyflavone-7-O-D-glucuronide	*S. prostrata*	Kikuchi et al. (1991a)
75	5,7-Dihydroxy-8,2′-dimethoxyflavone	*S. discolor*	Miyaichi et al. (1987)
		S. barbata	Liu (2005)
76	5,7-Dihydroxy-8,2′-dimethoxyflavone-7-O-D-glucuronide	*S. indica*	Miyaichi et al. (1989)
77	Savligenin	*S. baicalensis*	Li and Wei (1994)
78	Acacetin	*S. prostrata*	Kikuchi et al. (1991a)
79	Acacetin-7-O-D-glucoside (tilianin)	*S. polydon*	Li and Wei (1994)
80	Pectolinarigenin	*S. polydon*	Li and Wei (1994)
81	5,7,2′,3′-Tetrahydroxyflavone	*S. baicalensis*	Tomimori et al. (1984a)
		S. barbata	Sonoda et al. (2004)
82	5,7,2′,6′-Tetrahydroxyflavone	*S. baicalensis*	Tomimori et al. (1984a)
		S. amoena	Hu and Liu (1989)
		S. viscidula	Zhang et al. (2005)
83	Altisin	*S. grossas*	Kikuchi et al. (1991b)
		S. altissima	Li and Wei (1994)
84	5,7-Dihydroxy-8,2′,6′-trimethoxyflavone	*S. discolor*	Miyaichi et al. (1987)
85	Ganhuangenin	*S. rehderiana*	Su et al. (2004)
		S. baicalensis	Ma et al. (2002)
86	5,7,2′,5′-Tetrahydroxyflavone	*S. baicalensis*	Takagi et al. (1980)
87	5,7,2′,5′-Tetrahydroxy-8,6′-dimethoxyflavone	*S. baicalensis*	Tomimori et al. (1984a)
88	5,7-Dihydroxy-6,8,2′,3′-tetramethoxyflavone	*S. baicalensis*	Tomimori et al. (1982)
89	5,2′-Dihydroxy-7,8,6′-trimethoxyflavone-2′-O-D-glucuronopyranoside	*S. barbata*	Liu (2005)
90	Ovatin	*S. ovata*	Li and Wei (1994)
91	5,8-dimethoxyflavone-7-O-D-glucuronopyranoside	*S. barbata*	Li et al. (2004)
92	6,2′-Dihydroxy-5,7,8,6′-tetramethoxyflavone	*S. baicalensis*	Tomimori et al. (1981)
93	7-Hydroxy-5,8,2′-trimethoxyflavone	*S. discolor*	Miyaichi et al. (1987)
94	Cirsilineol	*S. barbata*	Li et al. (2004)
95	Isoscutellarein	*S. prostrata*	Li and Wei (1994)
		S. indica	Miyaichi et al. (1989)
96	Isoscutellarein-8-O-D-glucuronide	*S. indica*	Miyaichi et al. (1989)
		S. baicalensis	Huen et al. (2003)
97	8-Methoxy-5-O-glucoside flavone	*S. baicalensis*	Tomimori et al. (1981)
98	Wogonin-5-O-D-glucoside	*S. baicalensis*	Tomimori et al. (1981)
99	3,5,7,2′,6′-Pentahydroxyflavone	*S. baicalensis*	Tomimori et al. (1981)
100	5,7,2′6′-Tetrahydroxyflavonol (Viscidulin I)	*S. amoena*	Hu et al. (1990)
		S. hypericifolia	Dong and Chen (1992)
		S. baicalensis	Tomimori et al. (1984a)
101	5,7,2′6′-Tetrahydroxyflavonol-2′-O-D-glucopyranside	*S. amoena*	Zhou (1997)
102	(2R,3R)3,5,7,2′-Tetrahydroxyflavanone	*S. amoena*	Hu and Liu (1989)
		S. viscidula	Wang et al. (2003)
103	Pinocembrin	*S. altissima*	Tomimori et al. (1986)
104	Dihydrobaicalin	*S. baicalensis*	Tomimori et al. (1983)
		S. amoena	Zhou and Yang (2000)
105	Dihydrooroxylin A	*S. baicalensis*	Tomimori et al. (1983)
106	Dihydronorwogonin	*S. amoena*	Hu and Liu (1989)
107	Dihydroscutellarein	*S. scandens*	Miyaichi et al. (1989)
108	(2S)5,7,2′-Trihydroxyflavanone	*S. indica*	Miyaichi et al. (1987)
109	5,7,2′-Trihydroxy-6-methoxyflavanone-7-O-β-D-glucuronopyranoside	*S. amoena*	Zhou and Yang (2000)
110	Dihydroscutevurin	*S. indica*	Miyaichi et al. (1987)
111	Dihydrorehderianin I	*S. indica*	Miyaichi et al. (1987)
112	Carthamidin	*S. barbata*	Xiang et al. (1982)
		S. baicalensis	Ishimaru et al. (1995)

Table 2 (*Continued*)

No.	Compounds	Species	References
113	Carthamidin-7-O-D-glucuronide	*S. baicalensis*	Tomimori et al. (1984a)
114	Isocarthamidin	*S. barbata*	Xiang et al. (1982)
		S. baicalensis	Tomimori et al. (1984a)
115	Isocarthamidin-7-O-D-glucuronide	*S. baicalensis*	Tomimori et al. (1984a)
116	Dihydrohispidulin	*S. baicalensis*	Ishimaru et al. (1995)
117	(±)5,7,4′-Trihydroxy-8-methoxyflavanone	*S. barbata*	Liu (2005)
		S. baicalensis	Ishimaru et al. (1995)
		S. amoena	Xiao et al. (2003)
118	5,7,4′-Trihydroxy-6-methoxyflavanone	*S. baicalensis*	Tomimori et al. (1981)
119	(2S)5,7,2′,6′-Tetrahydroxyflavanone	*S. baicalensis*	Ishimaru et al. (1995)
		S. amoena	Hu and Liu (1989)
		S. viscidula	Wang et al. (2003)
120	Scuteamoenin	*S. amoena*	Hu and Liu (1989)
121	(2S)-5,2′,6′-Trihydroxy-7-methoxyflavanone	*S. amoena*	Hu and Liu (1989)
		S. viscidula	Wang et al. (2003)
122	(±)5,2′-Dihydroxy-6,7,6′-trimethoxyflavanone	*S. discolor*	Tomimori et al. (1985)
123	Dihydrorivularin	*S. discolor*	Tomimori et al. (1985)
124	Scuteamoenoside	*S. amoena*	Hu and Liu (1989)
125	(2S)5-Hydroxy-7,8,2′,6′-tetramethoxyflavanone	*S. grossa*	Kikuchi et al. (1991b)
126	(2S)5,7-Dihydroxy-8,2′-dimethoxyflavanone	*S. discolor*	Tomimori et al. (1985)
127	(2S)5,2-Dihydroxy-7,8,6′-trimethoxyflavanone-2-O-D-glucuronide	*S. indica*	Miyaichi et al. (1987)
128	(2S)5,7,2′,5′-Tetrahydroxy-6-methoxyflavanone	*S. scandens*	Miyaichi et al. (1988)
129	(2S)5,7,5′,2′-Tetrahydroxy-6-methoxyflavanone-2′-O-D-glucoside	*S. scandens*	Miyaichi et al. (1988)
130	(2S)5,7,5′,2′-Tetrahydroxy-6-methoxyflavanone-2′-O-D-(2-O-feruolyl)-glucoside	*S. scandens*	Miyaichi et al. (1988)
131	(2S)5,7,5′,2′-Tetrahydroxy-6-methoxyflavanone-2′-O-D-(2-O-sinapoly)-glucoside	*S. scandens*	Miyaichi et al. (1988)
132	(2S)5,7,5′,2′-Tetrahydroxy-6-methoxyflavanone-2′-O-D-(2-O-vanilloyl)-glucoside	*S. scandens*	Miyaichi et al. (1988)
133	(2S)7-Hydroxy-5,8,2′-trimethoxyflavanone	*S. discolor*	Tomimori et al. (1985)
134	(2S)7,2′,6′-Trihydroxy-5-methoxyflavanone	*S. baicalensis*	Tomimori et al. (1984a)
135	Alpinetin	*S. barbata*	Xiang et al. (1982)
136	(2S)5,6,7,2′,3′,4′,5′-Heptamethoxyflavonone	*S. indica*	Miyaichi et al. (1989)
137	(2R,3R)3,5,7-trihydroxyflavanone	*S. amoena*	Hu et al. (1990)
138	5,7,4′-trihydroxyflavanone (naringenin)	*S. barbata*	Xiang et al. (1982)
139	(2R,3R)-3,5,7,2′,6′-Pentahydroxyflavanone	*S. baicalensis*	Takagi et al. (1980)
		S. amoena	Hu et al. (1990)
		S. viscidula	Zhang et al. (2005)
		S. linearis	Hussain et al. (2008)
140	3,6,7,2′,6′-Pentahydroxyflavanone	*S. baicalensis*	Tomimori et al. (1981)
141	(*tans*)-5,7,2′,6′-Tetrahydroxyflavanonol	*S. baicalensis*	Takagi et al. (1980)
142	(*cis*)-5,7,2′-Trihydroxyflavanonol-3-O-β-D-glucopyranoside	*S. amoena*	Kikuchi et al. (1991b)
143	Amoenin D. [(*trans*)-5,7,2′,6′-tetrahydroxy flavanonol 3-O-β-D-glucopyranoside]	*S. amoena*	Zhou and Yang (2000)
144	Amoenin E. [(*cis*)-5,7,2′,6′-tetrahydroxy flavanonol 3-O-β-D-glucopyranoside]	*S. amoena*	Zhou and Yang (2000)
145	Amoenin B	*S. amoena*	Zhou and Yang (2000)
146	Amoenin C	*S. amoena*	Zhou and Yang (2000)
147	8,8′-Bibaiaclein	*S. discolor*	Tomimori et al. (1985)
148	Amentoflavone	*S. linearis*	Hussain et al. (2008)
149	Scutellaprostin A	*S. prostrata*	Kikuchi et al. (1991d)
150	Scutellaprostin B	*S. prostrata*	Kikuchi et al. (1991d)
151	Scutellaprostin C	*S. prostrata*	Kikuchi et al. (1991d)
152	Scutellaprostin D	*S. prostrata*	Kikuchi et al. (1991d)
153	Scutellaprostin E	*S. prostrata*	Kikuchi et al. (1991d)
154	Scutellaprostin F	*S. prostrata*	Kikuchi et al. (1991d)
155	2,2′-Dihydroxy-3,4,5,6′-tetramethoxy-4′,5′-Methylenedioxychalcone	*S. indica*	Miyaichi et al. (1989)
156	2,3,4,5,2′,4′,5′,6′-Octamethoxychalcone	*S. indica*	Miyaichi et al. (1989)
157	2,3,4,5,2′,6′-Hexamethoxy-4′,5′-Methylenedioxy	*S. indica*	Miyaichi et al. (1989)
158	2′-Hydroxy-2,3,4,5,4′,5′,6′-heptamethoxychalcone	*S. indica*	Miyaichi et al. (1989)
159	2′-Hydroxy-2,3,4,5,6′-pentamethoxy-4′,5′-Methylenedioxy	*S. indica*	Miyaichi et al. (1989)
160	Amoenin A.	*S. amoena*	Zhou and Yang (2000)
161	2′,4′-Dihydroxy-2,3,6′-trimethoxychalcone	*S. discolor*	Tomimori et al. (1985)
162	2,6,2′,4′-Tetrahydroxy-6′-methoxychalcone	*S. baicalensis*	Li and Wei (1994)
			Tomimori et al. (1984a)
Phenylethanoid glycosides			
163	2-(3′-Hydroxy-4′-methoxyphenyl)-ethy-1-O-β-D-glucoside	*S. prostrata*	Kikuchi et al. (1991a)
164	2-(3′-Hydroxy-4′-methoxyphenyl)-ethyl-1-O-β-D-(4-D-feruolyl)-glucoside	*S. prostrata*	Kikuchi et al. (1991a)
165	Acetoside	*S. prostrata*	Kikuchi et al. (1991a)
		S. albida	Gousiadou et al. (2007)
		S. baicalensis	Zhou et al. (1997)
166	Leucosceptoside A	*S. prostrata*	Kikuchi et al. (1991a)
		S. baicalensis	Zhou et al. (1997)

Table 2 (*Continued*)

No.	Compounds	Species	References
167	Martynoside	*S. prostrata*	Kikuchi et al. (1991a)
		S. albida	Gousiadou et al. (2007)
		S. baicalensis	Zhou et al. (1997)
168	2-(3-Hydroxy-4-methoxyphenyl)-ethyl-1-O-α-L-rhamnosyl (1 → 3)-β-(4-D-feruolyl)glucoside	*S. baicalensis*	Zhou et al. (1997)
169	Salidroside	*S. baicalensis*	Tomimori et al. (1982)
170	Darendoside A	*S. baicalensis*	Tomimori et al. (1983)
171	Darendoside B	*S. baicalensis*	Tomimori et al. (1983)
172	Isomartynoside	*S. albida*	Gousiadou et al. (2007)
173	4-Hydroxy-β-phenylethyl-β-D-glucopyranoside	*S. baicalensis*	Zhou et al. (1997)
Iridoid glycosides			
174	Catalpol	*S. albida*	Gousiadou et al. (2007)
		S. subvelutina	Franzyk et al. (1998)
175	Dihydrocatalpol	*S. albida*	Gousiadou et al. (2007)
176	Scutellarioside I	*S. altissima*	Wang et al. (1988)
177	Scutellarioside II	*S. altissima*	Wang et al. (1988)
178	6′-O-E-*p*-coumaroylgardoside	*S. albida*	Gousiadou et al. (2007)
179	6′-O-*p*-E-coumaroyl-8-*epi*-loganic acid	*S. albida*	Gousiadou et al. (2007)
180	Antirrhinoside	*S. subvelutina*	Franzyk et al. (1998)
181	Picroside III	*S. albida*	Gousiadou et al. (2007)
182	10-Descinnamoylglobularinin	*S. albida*	Gousiadou et al. (2007)
183	Globularin (scutellaroside-I)	*S. albida*	Gousiadou et al. (2007)
184	Gardoside	*S. albida*	Gousiadou et al. (2007)
185	8-*Epi*-loganic acid	*S. albida*	Gousiadou et al. (2007)
186	Macfadienoside	*S. albida*	Gousiadou et al. (2007)
Diterpenes			
187	Scutaltisin	*S. columnae var. columnae*	Malakov and Papanov (1998a)
		S. altissima	Malakov and Papanov (1996)
188	Ajugapitin	*S. lateriflora*	Bruno et al. (1998)
189	Scutellone D	*S. barbata*	Lin (1988a)
190	Scutellone E	*S. barbata*	Lin (1988a)
191	Scutellone F	*S. barbata*	Lin (1988b)
192	Scutellone H	*S. barbata*	Lin (1989)
193	Scutellone I	*S. barbata*	Lin (1989)
194	Scutellone A	*S. barbata*	Lin (1987a)
195	Scutellone B	*S. barbata*	Lin (1988a)
196	Scutellone C	*S. barbata*	Lin (1988b)
197	Scutellone G	*S. barbata*	Lin (1989)
198	Jodrellin A	*S. woronowii*	Lin (1988a)
		S. rubicunda subsp. *rubicunda*	Bruno et al. (2002)
		S. alpina subsp. *javalambrensis*	MuÑoz et al. (1997)
199	Jodrellin B	*S. strigillosa*	Miyaichi et al. (2006)
		S. rubicunda subsp. *rubicunda*	Bruno et al. (1999)
		S. alpina subsp. *javalambrensis*	MuÑoz et al. (1997)
200	Jodrellin T	*S. strigillosa*	Miyaichi et al. (2006)
201	14,15-Dihydrojodrellin T	*S. strigillosa*	Miyaichi et al. (2006)
202	Scutecolumnin A	*S. altissima*	Malakov and Papanov (1996)
		S. albida	Bruno et al. (1996a)
203	Scutecolumnin B	*S. altissima*	Malakov and Papanov (1996)
		S. albida	Bruno et al. (1996a)
204	Scutecolumnin C	*S. columnae var. columnae*	Malakov and Papanov (1998a)
		S. alpina	MarÍa et al. (1995)
		S. alpina subsp. *javalambrensis*	MuÑoz et al. (1997)
		S. altissima	Malakov and Papanov (1998a)
		S. albida	Bruno et al. (1996a)
205	11-Episcutecolumnin C	*S. columnae var. columnae*	Malakov and Papanov (1998a)
206	Clerodin	*S. altissima*	Malakov and Papanov (1996)
		S. albida	Bruno et al. (1996a)
207	Galericulin	*S. galericulata*	RodrÍguez et al. (1996)
208	Scutenisin	*S. orientalis* subsp. *sintenisii*	Ezer et al. (1998)
209	Neoandrographolide	*S. barbata*	Zhu and Liu (1993)
210	Scutedrummonin	*S. drummondii*	Esquivel et al. (1995)
211	Barbatin A	*S. barbata*	Dai et al. (2006b)
212	Barbatin B	*S. barbata*	Dai et al. (2006b)
213	Barbatin C	*S. barbata*	Dai et al. (2006b)
214	Scuterivulactone A/D	*S. barbata*	Kizu et al. (1987)
215	Scuterivulactone C_2	*S. barbata*	Dai et al. (2006b)
216	Scutelaterin A	*S. lateriflora*	Bruno et al. (1998)
217	Scutelaterin B	*S. lateriflora*	Bruno et al. (1998)

Table 2 (*Continued*)

No.	Compounds	Species	References
218	Scutelaterin C	*S. lateriflora*	Bruno et al. (1998)
219	Lupulin A	*S. linearis*	Hussain et al. (2008)
220	Lupulin B	*S. linearis*	Hussain et al. (2008)
221	Lupulin C	*S. linearis*	Hussain et al. (2008)
222	Lupulin D	*S. linearis*	Hussain et al. (2008)
223	11-Deacetylscutalpin	*S. alpina* subsp. *javalambrensis*	MuÑoz et al. (1997)
224	Scutalsin	*S. rubicunda* subsp. *rubicunda*	Bruno et al. (2002)
		S. altissima	Malakov and Papanov (1996)
		S. albida	Bruno et al. (1996a)
225	Scutecyprol A	*S. rubicunda* subsp. *rubicunda*	Bruno et al. (2002)
		S. columnae subsp. *gussonei*	Bruno et al. (2002)
		S. cypria subsp. *cypria*	Bruno et al. (1996b)
226	Scutecyprol B	*S. rubicunda* subsp. *rubicunda*	Bruno et al. (2002)
		S. rubicunda subsp linneana	Bruno et al. (1999)
		S. columnae var. columnae	Malakov and Papanov (1998a)
		S. cypria subsp. *cypria*	Bruno et al. (1996b)
227	Scutegrossin A	*S. rubicunda* subsp. *rubicunda*	Bruno et al. (2002)
228	Scutalbin A	*S. rubicunda* subsp. *rubicunda*	Bruno et al. (2002)
		S. altissima	Malakov and Papanov (1996)
		S. albida	Bruno et al. (1996a)
229	Scutalbin C	*S. rubicunda* subsp. *linneana*	Bruno et al. (2002)
		S. altissima	Malakov and Papanov (1996)
		S. albida	Bruno et al. (1996a)
230	Scutalbin B	*S. altissima*	Malakov and Papanov (1996)
		S. albida	Bruno et al. (1996a)
231	Ajugarin V	*S. parvula*	Bruno et al. (2004)
		S. drummondii	Esquivel et al. (1995)
232	2α-Hydroxyajugarin V	*S. drummondii*	Esquivel et al. (1995)
233	2α-Hydroxy-deacetylajugarin V	*S. drummondii*	Esquivel et al. (1995)
234	Scuteparvin	*S. parvula*	Bruno et al. (2004)
235	11-Episcutecyprin,	*S. columnae var. columnae*	Malakov and Papanov (1997a)
236	Scuteselerin	*S. seleriana*	Esquivel et al. (1998)
237	Scutebaicalin	*S. baicalensis*	Ahmed et al. (1996)
238	Scutalpin L	*S. orientalis subsp pinnatifida*	Malakov and Papanov (1997b)
		S. alpina	MarÍa et al. (1995)
		S. baicalensis	Ahmed et al. (1996)
239	Scutalpin B	*S. alpina*	MarÍa et al. (1995)
		S. alpina subsp javalambrensis	MuÑoz et al. (1997)
240	Scutalpin D	*S. alpina*	MarÍa et al. (1995)
		S. alpina subsp javalambrensis	MuÑoz et al. (1997)
241	Scutalpin G	*S. alpina*	MarÍa et al. (1995)
		S. alpina subsp javalambrensis	MuÑoz et al. (1997)
242	Scutalpin H	*S. alpina*	MarÍa et al. (1995)
243	Scutalpin I,	*S. alpina*	MarÍa et al. (1995)
		S. alpina subsp javalambrensis	MuÑoz et al. (1997)
244	Scutalpin J	*S. alpina*	MarÍa et al. (1995)
		S. alpina subsp javalambrensis	MuÑoz et al. (1997)
		S. orientalis subsp. *sintenisii*	Ezer et al. (1998)
245	Scutalpin K	*S. alpina*	MarÍa et al. (1995)
246	Scutalpin M	*S. alpina*	MarÍa et al. (1995)
247	Scutalpin O	*S. alpina*	Malakov and Papanov (1998b)
248	Scutalpin N	*S. alpina*	Malakov and Papanov (1998b)
249	Scutalpin E	*S. orientalis* subsp. *sintenisii*	Ezer et al. (1998)
250	Scutalpin C	*S. alpina* subsp. *javalambrensis*	MuÑoz et al. (1997)
251	Scutorientalin A	*S. orientalis* subsp. *pinnatifida*	Malakov and Papanov (1997b)
252	Scutorientalin B	*S. orientalis* subsp. *pinnatifida*	Malakov and Papanov (1997c)
253	Scutorientalin C	*S. orientalis* subsp. *pinnatifida*	Malakov and Papanov (1997c)
254	Scutorientalin D	*S. orientalis* subsp. *pinnatifula*	Malakov and Papanov (1997c)
255	Scutorientalin E	*S. orientalis* subsp. *pinnatifida*	Malakov and Papanov (1997c)
256	Scutegalin B	*S. galericulata*	RodrÍguez et al. (1996)
257	Scutegalin C	*S. galericulata*	RodrÍguez et al. (1996)
258	Scutegalin D	*S. columnae var. columnae*	RodrÍguez et al. (1996)
		S. galericulata	Malakov and Papanov (1998a)

Table 2 (*Continued*)

No.	Compounds	Species	References
Triterpenoids			
259	Scutellaric acid	*S. barbata*	Zhu and Liu (1993)
260	Ursolic acid	*S. strigillosa*	Miyaichi et al. (2006)
Neo-Clerodane Diterpenoid Alkaloids			
261	Scutebarbatine A	*S. barbata*	Wang and Li (1996)
262	Scutebarbatine B	*S. barbata*	Dai et al. (2006a)
263	Scutebarbatine C	*S. barbata*	Dai et al. (2006a)
264	Scutebarbatine D	*S. barbata*	Dai et al. (2006a)
265	Scutebarbatine E	*S. barbata*	Dai et al. (2006a)
266	Scutebarbatine F	*S. barbata*	Dai et al. (2006a)
267	Scutebarbatine G	*S. barbata*	Dai et al. (2007)
268	6,7-Di-O-nicotinoylscutebarbatine G	*S. barbata*	Dai et al. (2007)
269	6-O-nicotinoyl-7-O-acetylscutebarbatine G	*S. barbata*	Dai et al. (2007)
270	Scutebarbatine H	*S. barbata*	Dai et al. (2007)
271	7-O-nicotinoylscutebarbatine H	*S. barbata*	Dai et al. (2007)
Alkaloids			
272	Sophoranol	*S. flavescens*	Ma et al. (2002)
273	Sophoridine	*S. flavescens*	Ma et al. (2002)
274	Allmatrine	*S. flavescens*	Ma et al. (2002)
275	Anagyrine;	*S. flavescens*	Ma et al. (2002)
276	Cytosine	*S. flavescens*	Ma et al. (2002)
277	Isomatrine	*S. flavescens*	Ma et al. (2002)
278	Matrine	*S. flavescens*	Ma et al. (2002)
279	*N*-methylcytisine	*S. flavescens*	Ma et al. (2002)
280	Oxymatrine	*S. flavescens*	Ma et al. (2002)
281	Osysophocarpine	*S. flavescens*	Ma et al. (2002)
282	Sophocarpine	*S. flavescens*	Ma et al. (2002)
Others compounds			
283	Aurantiamide acetate	*S. barbata*	Lin (1987b)
284	Daucosterol	*S. barbata*	Liu (2005)
Phytosterols			
285	6β-Hydroxy-4-stigmasten-3-one	*S. strigillosa*	Miyaichi et al. (2006)
286	6-β-Hydroxy-4,22-stigmastadien-3-one	*S. strigillosa*	Miyaichi et al. (2006)
Tocopherols			
287	2 R, 4′R, 8′R-γ-tocopherol	*S. strigillosa*	Miyaichi et al. (2006)
288	(S)-5,5′-Bi-γ-tocopheryl	*S. strigillosa*	Miyaichi et al. (2006)
289	(R)-5,5′-Bi-γ-tocopheryl	*S. strigillosa*	Miyaichi et al. (2006)
290	Solanachromene	*S. strigillosa*	Miyaichi et al. (2006)
291	Tocopherylquinone	*S. strigillosa*	Miyaichi et al. (2006)
292	Pinosylvin	*S. scandens*	Li and Wei (1994)
293	Pinosylvin-2-carboxylic acid	*S. scandens*	Li and Wei (1994)
294	Pinosylvin-3-O-β-D-glucoside	*S. scandens*	Li and Wei (1994)
295	Gaylussacin	*S. scandens*	Li and Wei (1994)

The leaves of *S. scandens* are used to treat wounds and swelling by insects in Nepal (Li and Wei, 1994). *S. albida*. ssp. *albida* is a herbaceous perennial plant and has a general distribution from N. Italy to the Balkan Peninsula and Crimea (Bothmer, 1985). It presents antispasmodic, diaphoretic and febrifuge properties and was used in local medicine (Duke, 1986). The aerial parts of *S. rubicunda* subsp. *Linneana* an endemic species growing in the central part of Sicily has antifeedant and anti-fungal activities (Bruno et al., 1999).

3. Phytochemistry

From the genus *Scutellaria*, **295** compounds were isolated, including flavonoids, phenylethanoid glycosides, iridoid glycosides, diterpenes, triterpenoids, alkaloids, phytosterols, polysaccharides and other compounds (Table 2). Some of them displayed many bioactivities *in vivo* or *in vitro* (Table 3).

3.1. Flavonoids

Flavonoids and their derivatives are the main components of the *Scutellaria* genus. More than **160** compounds, including flavones (**1**–**99**) and flavonols (**100**–**101**), flavanones (**102**–**136**) and flavanonols (**137**–**146**), biflavonoids (**147**–**148**), flavonolignans (**149**–**154**), chalcones (**155**–**162**), have been isolated. Most of them have methoxyl or hydroxyl groups at various positions on their aromatic rings.

3.1.1. Flavones and flavonols

Compounds **1**–**101** isolated from the *Scutellaria* genus are flavones and flavonols. Among these compounds, baicalin (**7**), baicalein (**8**), oroxylin A (**16**), wogonin (**20**), wogonoside (**21**), apigenin (**36**), scutellarein (**39**), 5,7,4′-trihydroxy-8-methoxyflavone (**45**), luteolin (**46**), viscidulin III (**70**), 2′,3′,5,7-tetrahydroxyflavone (**81**) and ganhuangenin (**85**) from *S. baicalensis*, *S. barbata* or *S. laterifolia*, have been confirmed to have antitumor, hepatoprotective, antioxidant, anti-inflammatory, anti-RSV, antimutagenic, neuroprotective, anxiolytic, and other activities. The relationship between compound structures and their activities have been elucidated. For example, the methoxyl group on C(8), wogonin (**20**) and wogonoside (**21**) shows stronger inhibition toward histamine and IgE production than 3,5,7,2′,6′-pentahydroxyflavanone (**139**). On the other hand, 3,5,7,2′,6′-pentahydroxyflavanone (**139**) with two hydroxyl groups in the B ring shows stronger activity than wogonin (**20**) and wogonoside (**21**) against lipid peroxidation (Lim, 2003).

3.1.2. Flavanones and flavanonols

Flavanones and flavanonols **102**–**146** with various substitutions have been isolated from *S. baicalensis*, *S. amoena*, *S.*

Table 3
The activities of some compounds from *S. baicalensis*, *S. barbata*, *S. laterifolia*, *S. rubicunda*.

Compounds	Species	Effects	*In vivo*	*In vitro*	Ref.
Baicalein	*S. baicalensis*	Antitumor		100 μM Inhibited TGF-β1-induced apoptosis via increase in cellular H2O2 formation and NF-κB activation in human hepatoma Hep3B cells ($p<0.01$)	Chou et al. (2003)
				12.5 μM Prevented cisplatin-induced apoptosis through inhibition of the mitochondrial depolarization in human glioma cells	Lee et al. (2005)
				50 μM Prevented carcinogen-DNA adduct formation ($p<0.01$)	Chan et al. (2002)
		Hepatoprotective	Inhibited protein nitration and lipid peroxidation in liver homogenate and the oxidation of protein in liver microsome	Inhibited the decrease of cell viability and the contents of GSH in HepG2 cells, the inhibition order was baicalein > baicalin ≫ wogonin	Tan et al. (2006)
		Antioxidant		400 μM Scavenged hydroxyl radical, DPPH radical and alkyl radical in a dose-dependent manner	Gao et al. (1999)
		Anti-inflammatory effects		75 μM Inhibited inflammation through inhibition of COX-2 gene expression through blockade of C/EBP β DNA binding activity	Woo et al. (2006)
				Bond a variety of chemokines and limit their biological function.	Li et al. (2000a)
		Anti-RSV		50% inhibition concentration (IC50) 20.8 μg/ml	Ma et al. (2002)
		Antimutagensis		**Baicalin, baicalein, wogonin** (at 250 μg/plate) suppressed 47%, 93%, 41% of NQNO mutagenic activity with TA98 strain and 72%, 62%, 57% of NQNO mutagenic activity with TA100 strain, respectively. And suppressed 64%, 99%, 79%, 95% of the 2-aminofluorene mutagenic activity with TA98 and 94%, 100%, 85% and 100% at the same concentration with TA100, respectively. So they inhibited both direct and indirect the types of mutagens and clearly in the Ames test	Woz'niak et al. (2004)
				Possessed strong antiradical properties in the DPPH assay	Johan et al. (2005)
		Neuroprotective effect and memory improvement		Prevented neurotoxicity induced by both glutamate and glucose deprivation in primary cultured rat brain neurons by protecting PC12 cells from hydrogen peroxide-induced toxicity	Lee et al. (2003)
				Protected neurons from the deleterious effects of 6-hydroxydopamine via the attenuation of oxidative stress, mitochondrial dysfunction, caspase activity, and JNK activation	Lee et al. (2005)
	S. laterifolia	Anxiolytic	Displayed anxiolytic effect in rats through bind to the benzodiazepine site of the $GABA_A$ receptor		Awad et al. (2003)

Baicalin	*S. baicalensis*	Antitumor		20 μM Inhibited EROD activities and reduced CYP1A1/1B1 mRNA expression induced by DMBA. At the same time it could reduce DMBA–DNA adduct formation in MCF-7 cells.($p < 0.01$). So it could inhibit the proliferation of prostate cancer cells	Chan et al. (2000)
		Hepatoprotective	Exhibited the best hepatoprotective effect on CC14-induced liver injuries at the 10 mg/kg concentration		Lin and Shieh (1996)
		Anti-oxidative	20 mg/kg Played the key role of the anti-oxidative properties in the regulation of age-related alterations ($p < 0.01$).		Kim et al. (2006)
		Anti-RSV		With 50% inhibition concentration 20.8 μg/ml	Ma et al. (2002)
				Inhibited superantigenic staphylococcal exotoxins-stimulated T-cell proliferation, decressed the production of IL-1, IL-6, TNF, interferonγ, monocyte chemotactic protein 1, MIP-1α, and MIP-1β mRNA and protein by human peripheral blood mononuclear cells.	Krakauer et al. (2001)
				Mitigated the pathogenic effects of staphylococcal exotoxins by inhibiting the signaling pathways activated by superantigens.	Liu et al. (2000)
		Antimutagenic		Possessed strong antiradical properties in the DPPH assay	Johan et al. (2005)
		Neuroprotective effect and memory improvement		Prevented neurotoxicity induced by glutamate deprivation by protecting PC12 cells from hydrogen peroxide-induced toxicity	Lee et al. (2003)
		Anti-HIV-1		At the noncytotoxic concentrations, inhibited both T cell tropic (X4) and monocyte tropic (R5) HIV-1 Env protein mediated fusion with cells expressing CD4/CXCR4 or CD4/CCR5. and blocked the replication of HIV-1 early strong stop DNA in cells at the initial stage of HIV-1 viral adsorption	Li et al. (2000b)
				In the T cell strain CEM infected by HIV virus, it displayed the marked cytotoxic, made DNA damage, especially for the CEM-HIV cell which released massive HIV virus.	Wu et al. (2001)
	S. laterifolia	Anxiolytic	Performed anxiolytic effect in rats throght bind to the benzodiazepine site of the GABAA receptor		Awad et al. (2003)

Table 3 (*Continued*)

Compounds	Species	Effects	*In vivo*	*In vitro*	Ref.
Wogonin	*S. baicalensi*	Antitumor		As a potential adjuvant therapy for drug-resistant human non-small lung cancer, especially for those with the aldo-keto reductases superfamily overexpression. 10 μM inhibited IL-6-induced AKR1C1/1C2 expression and drug resistance	Wang et al. (2007)
				200 μM 72 h Did not affect the proliferation of normal fetal lung diproid cells but did inhibit the proliferation of monocytic leukemia cells and osteogenic sarcoma cells. Had a cancer-specific apoptosis-inducing activity	Himeji et al. (2007)
	S. barbata			Inhibited the proliferation of HL-60, IC50 17.4 μM	Sonoda et al. (2004)
	S. baicalensis	Hepatoprotective	5, 10 mg/kg Decreased the toxicity produced by D-GalN ($p < 0.01$) and APAP-induced hepatotoxicity		Lin and Shieh (1996)
		Anti-HBV	Inhibited the Duck hepatitis B virus DNA polymerase with an IC50 of 0.57 μg/ml. wogonin dosed i.v. once a day for 10 days reduced plasma DHBV DNA level with an ED50 of 5mg/kg in DHBV-infected ducks and reduced plasma HBsAg level in human HBV-transgenic mice.	Suppressed the secretion of the HBV antigens with an IC50 of 4 μg/ml at day 9 for both HBsAg and HbeAg and reduced HBV DNA level in a dose-dependent manner in the human HBV-transfected liver cell line HepG2.2.15.	Guo et al. (2007)
		Antioxidant	Inhibited histamine release in cells stimulated with calcium ionophore A23187 or compound 48/80, and alleviated the increase in the IgE content induced by concanavalin A		Lim et al. (1999), Lim, 2003
		Anti-inflammatory	As a direct COX-2 inhibitor.		Chi et al. (2000)
			Cured skin inflammatory diseases by modulating of the expression of proinflammatory molecules. **Wogonin** (1000 mg/ear/3 days) slightly increased COX-1 and fibronectin mRNA. On the other hand, wogonin (250–1000 mg/ear/3 days) potently lowered mRNA levels of COX-2 and TNF-a with less effect on intercellular adhesion molecule-1 and interleukin-1b in a sub-chronic skin inflammation model of tetradecanoylphorbol-13-acetate-induced ear edema		Chi et al. (2003)
			At 200 mg/site/treatment, wogonin caused a 55.3% reduction of prostaglandin E2 production on the dorsal skin compared with an increased production in the TPA-treated control group. And inhibited mouse ear edema induced by TPA in both preventive (58.1% inhibition) as well as curative treatment (31.3% inhibition). So it might be beneficial for COX-2-related skin disorders		Park et al. (2001)
				Controlled the expression COX-2 down regulation of skin fibroblast from skin fibroblasts in culture against skin inflammation	Chi and Kim (2005)

		Anticonvulsant	10 mg/kg Displayed the anticonvulsant by mediating the GABA ergic neuron ($p < 0.01$)		Park et al. (2007)
		Anti-RSV		With 50% inhibition concentration 7.4 μg/ml	Ma et al. (2002)
		Neuroprotective effect and memory improvement		Had a protective effect on neuronal cells damaged by oxygen and glucose deprivation in rat hippocampal slices in culture	Son et al. (2004)
				Might have a neurotoxic effect on the brain	Lee et al. (2003)
		Anxiolytic		Exerted the anxiolytic effect through positive allosteric modulation of the GABAA receptor complex via interaction at the BZD-S.	Hui et al. (2002)
Barbatins A-C, and Scutebarbtine B	*S. barbata*	Antitumor		Showed significant cytotoxic activities against HONE-1 nasopharyngeal, KB oral epidermoid carcinoma, and HT 29 colorectal carcinoma cells, with IC50 values in the range 3.5-8.1 μM	Dai et al. (2006a,b)
2′,3′,5,7-tetrahydroxy flavone	*S. barbata*	Antitumor		Inhibited the proliferation of HL-60, IC50 = 9.5 μM.	Sonoda et al. (2004)
Apigenin	*S. barbata*	Antitumor		Inhibited the proliferation of HL-60, IC50 = 15.0 μM	Sonoda et al. (2004)
Viscidulin III	*S. barbata*	Antitumor		Inhibited the proliferation of HL-60, IC50 = 17.4 μM	Sonoda et al. (2004)
Luteolin	*S. barbata*	Antitumor		Inhibited the proliferation of HL-60, IC50 = 18.4 μM,	Sonoda et al. (2004)
Ganhuangenin	*S. baicalensis*	Antioxidant	Inhibited histamine release in cells stimulated with calcium ionophore A23187 or compound 48/80, and alleviated the increase in the IgE content induced by concanavalin A in the amounts of 10 and 100 mM		Lim et al. (1999)
		Anti-RSV		With 50% inhibition concentration 83.3 μg/m	Ma et al. (2002)
3,5,7,2′,6′-pentahydroxyl flavanone	*S. baicalensis*	Antioxidant	Inhibited histamine release in cells stimulated with calcium ionophore A23187 or compound 48/80 and inhibited LTB4 production and inhibited the release of lipid peroxidation induced by ConA was in order of PHF > WG > WGS		Lim, 2003
Oroxylin A	*S. baicalensis*	Anti-RSV		With 50% inhibition concentration 14.5 μg/m	Ma et al. (2002)
		Neuroprotective effect and memory improvement		Protected cognitive impairments induced by cholinergic dysfunction via the GABAergic nervous system.	Kim et al. (2007)
Scutellarein	*S. baicalensis*	Anti-RSV		With 50% inhibition concentration 20.8 μg/m	Ma et al. (2002)
5,7,4′-trihydroxy-8-methoxyflavone	*S. baicalensis*	Anti-RSV		Reduced the single-cycle replication of A/PR8 from 4 h to 12 h after incubation and the dose which decrease the virus titer one tenth was 11 μM.	Nagai et al. (1995)
Scutecyprol B	*S. rubicunda*	Antifeedant		Showed significant activity against larvae from all the five species tested at 100 ppm.	Bruno et al. (1999)
Jodrellin A, Jodrellin B, Scutalbin A and Scutecyprol B	*S. rubicunda*	Antifeedant		Had potent antifeedant activity against all five species of *Lepidoptera*.	Bruno et al. (2002)

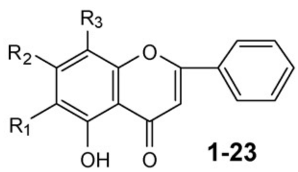
indica, *S. barbata*, *S. scandens* and other species. 3,5,7,2′,6′-Pentahydroxyflavanone (**139**) can markedly inhibit histamine release and inhibit LTB4 production in cells stimulated with calcium ionophore A23187 or compound 48/80 at a concentration of 100 mM. At the same time, the inhibitory effects on the content of lipid peroxidation induced by ConA was in the order of 3,5,7,2′,6′-pentahydroxyl flavanone > Wogonin > Wogonoside (Lim, 2003).

3.1.3. Biflavonoids

There are two biflavonoids (**147**,**148**) reported. 8,8′-Bibaiaclein (**147**) was reported from *S. discolor*, and compounds with this structure have two baicalein molecules connected at C (8) (Tomimori et al., 1985). Amentoflavone (**148**) was obtained from *S. linearis*, and the structure was two different flavones connected by C (5′)-C (8) (Hussain et al., 2008). The biflavonoids usually exist in Gymnospermaes. In the *Scutellaria* genus, only these two compounds have been isolated.

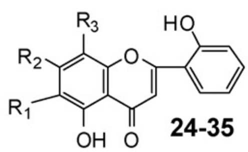
3.1.4. Flavonolignans

Up to now, only six flavonolignans have been isolated from the genus *Scutellaria.* In 1991, Kikuchi et al obtained scutellaprostins (A–F) (**149**–**154**) from *S. prostrata* for the first time, and the structure of these compounds were determined to be formed by the polymerization between the A ring of flavonoids and lignans (Kikuchi et al., 1991d).



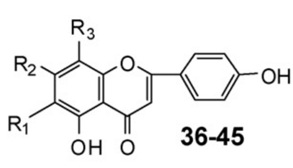
1-23

	R_1	R_2	R_3
1	H	OH	H
2	H	O-GluA	H
3	Glu	OH	Ara
4	Ara	OH	Glu
5	H	OH	Glu
6	OH	H	H
7	OH	O-GluA	H
8	OH	OH	H
9	O-GluA	OH	H
10	OH	O-Glu	H
11	OH	O-rha	H
12	H	OH	OH
13	H	O-GluA	OH
14	H	OH	O-GluA
15	H	OCH_3	OCH_3
16	OCH_3	OH	H
17	OCH_3	O-GluA	H
18	OCH_3	O-Glu	H
19	OCH_3	O-GluA Et ester	H
20	H	OH	OCH_3
21	H	O-GluA	OCH_3
22	OCH_3	OCH_3	OH
23	OH	O-Glu	H



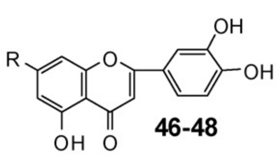
24-35

No.	R_1	R_2	R_3
24	H	OH	H
25	H	GluA	H
26	OCH_3	OH	H
27	OCH_3	O-Glu A Et ester	H
28	OCH_3	O-Glu A	H
29	OCH_3	O-Glu	H
30	OCH_3	OCH_3	OCH_3
31	OCH_3	OH	H
32	H	OH	OCH_3
33	H	O-D-GluA	OCH_3
34	OH	O-Glu A	H
35	OCH_3	OCH_3	OCH_3



36-45

	R1	R2	R3
36	H	OH	H
37	H	O-Glu	H
38	H	O-GluA	H
39	OH	OH	H
40	OH	O-Glu	H
41	OH	O-GluA	H
42	H	OH	OCH_3
43	OCH_3	OH	H
44	OCH_3	O-GluA	H
45	H	OH	OCH_3



46-48

	R
46	OH
47	O-GluA
48	O-Glu

Fig. 2. The chemical structure of isolated compounds from the genus *Scutellaria* (the name of chemical compound listed in Table 2).

3.1.5. Chalcones

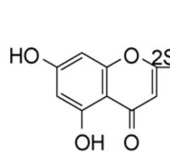
Due to the breakage of chemical bond between C1 and C2, compounds **155**–**162** belong to the Chalcones. **155**–**159** are five simple chalcones isolated from *S. indica* (Miyaichi et al., 1989). Amoenin A (**160**) was obtained from *S. amoena* in 2000 (Zhou and Yang, 2000). 2′,4′-dihydroxy-2,3,6′-trimethoxy-chalcone (**161**), 2,6,2′,4′-tetrahydroxy-6′-methoxychalcone (**162**) were isolated from *S. discolor* and *S. baicalensis* (Li and Wei, 1994; Tomimori et al., 1984a).

3.2. Phenylethanoid glycosides

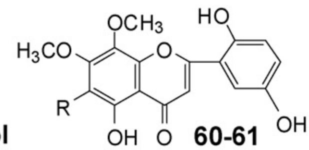
10 Phenylethanoid glycosides identified from the genus *Scutellaria*. 2-(3′-hydroxy-4′-methoxyphenyl)-ethyl-1-O-α-L-rhamnosyl (1 → 3)-β-(4-D-feruolyl)glucoside (**163**) and 2-(3′-hydroxy-4′-methoxyphenyl)-ethyl-1-O-β-D-(4-D-feruolyl)-glucoside (**164**) obtained from *S. prostrata* (Kikuchi et al., 1991a). Acetoside (**165**), Leucosceptoside A (**166**), Martynoside (**167**) were isolated from *S. prostrata*, *S. albida* ssp. *albida*, *S. baicalensis*, respectively (Kikuchi et al., 1991a; Gousiadou et al., 2007; Zhou et al., 1997). Moreover, 2-(3-hydroxy-4-methoxyphenyl)-ethyl-1-O-α-L-rhamnosyl (1 → 3)-β-(4-D-feruolyl)glucoside (**168**), salidroside (**169**), darendoside A (**170**), darendoside B (**171**), 4-hydroxy-β-phenylethyl-β-D-glucopyranoside (**173**) were isolated from *S. baicalensis* (Zhou, 1997; Tomimori et al., 1982, 1983). Gousiadou et al. (2007) isolated one known phenylethanoid glycosides from *S. albida*, isomartynoside (**172**).

3.3. Iridoid glycosides

After successful chromatography on silica gel columns and RP-HPLC, **13** iridoid glycosides were isolated from the methanol extract of the aerial parts of *S. albida* ssp. *albida* (Gousiadou et al., 2007).

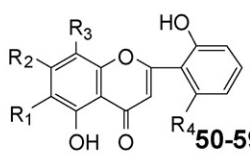


49 eriodictyol

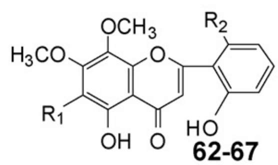


60-61

	R
60	H
61	OCH_3



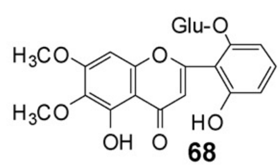
50-59



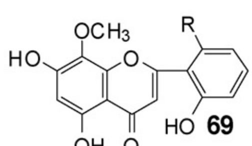
62-67

	R_1	R_2	R_3	R_4
50	H	OH	OCH_3	OCH_3
51	H	OCH_3	OH	H
52	H	O-Glu	OH	H
53	OCH_3	OCH_3	OH	H
54	OH	OCH_3	OCH_3	H
55	OH	OCH_3	OCH_3	OCH_3
56	H	OH	H	OCH_3
57	OCH_3	OCH_3	OCH_3	OCH_3
58	H	OCH_3	OCH_3	OCH_3
59	H	OCH_3	OCH_3	H

	R_1	R_2
62	H	OH
63	H	O-GluA
64	OCH_3	OH
65	OCH_3	O-Glu
66	OH	OH
67	OCH_3	OCH_3

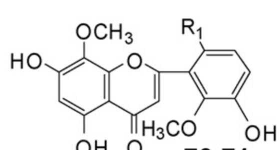


68



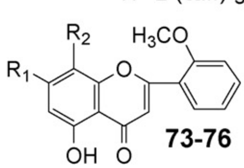
69

R=-2-(caff)-glu

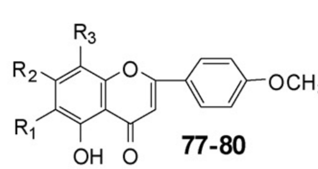


70-71

	R_1
70	OH
71	O-Glu



73-76



77-80

	R_1	R_2
73	OH	H
74	O-D-GluA	H
75	OH	OCH_3
76	O-D-GluA	OCH_3

	R_1	R_2	R_3
77	OCH_3	OCH_3	H
78	H	OH	H
79	H	O-D-Glu	H
80	OCH_3	OH	H

Fig. 2. (*Continued*)

Other iridoid glycosides were isolated from the aerial parts of *S. subvelutina* (Franzyk et al., 1998).

3.4. Diterpenes

The genus is rich in neoclerodane diterpenoids (**187**–**258**), which usually show some heterocyclic function. These include the epoxides, lactones, hydrofurans groups. Many of these products have remarkable antifeedant activity against pest insects. Especially, jodrellin A (**198**), jodrellin B (**199**), scutalbin A (**228**) and scutecyprol B (**230**) from *S. rubicunda* subsp. *rubicunda* have been found to have potent antifeedant activity against all five species of *Lepidoptera* (Bruno et al., 1999). At the same time, barbatins A–C (**211**–**213**), show significant cytotoxic activity against HONE-1 nasopharyngeal (IC_{50} = 4.7 μM, 5.0 μM, 4.1 μM), KB oral epidermoid carcinoma (IC_{50} = 7.7 μM, 8.1 μM, 7.1 μM) and HT 29

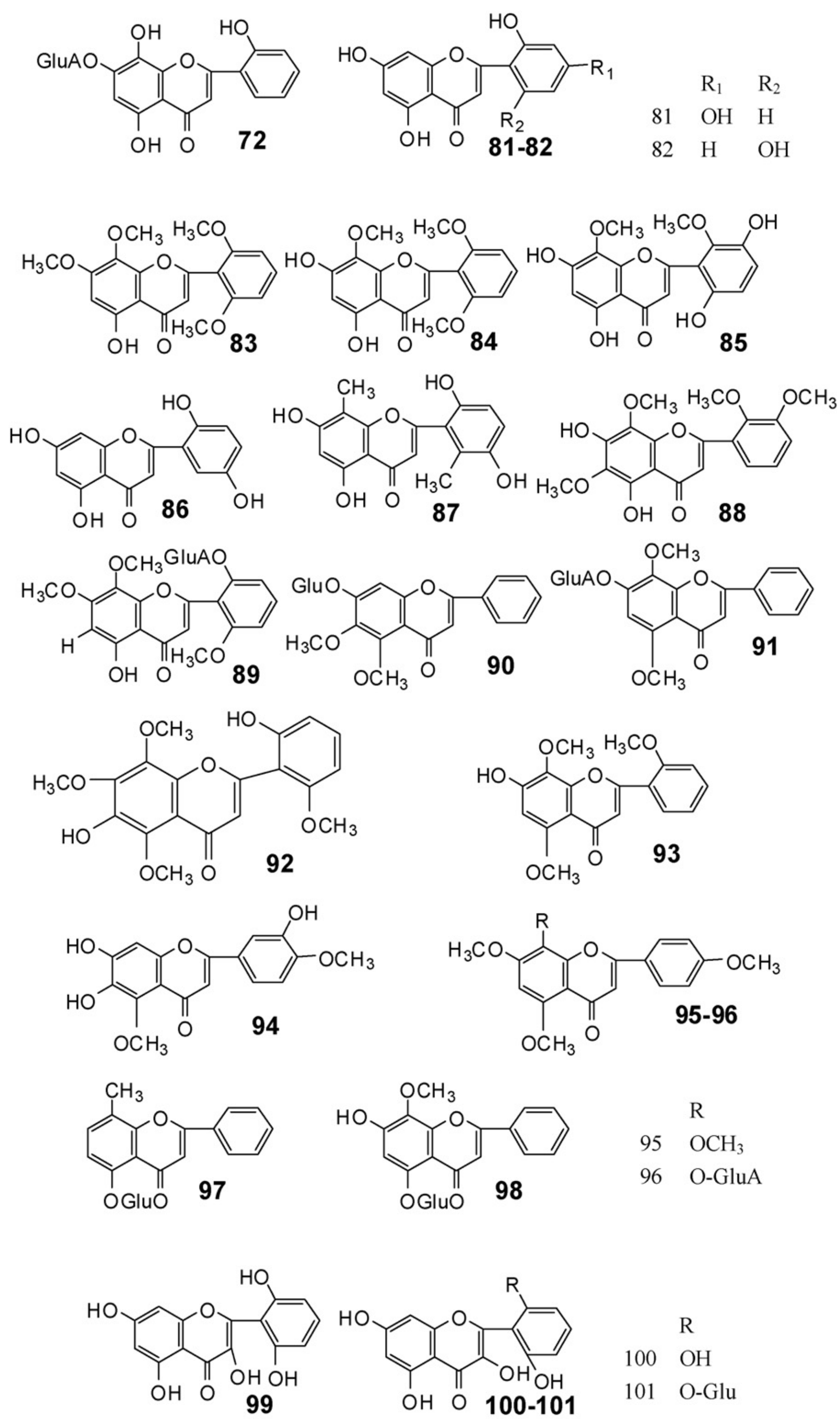


Fig. 2. (*Continued*)

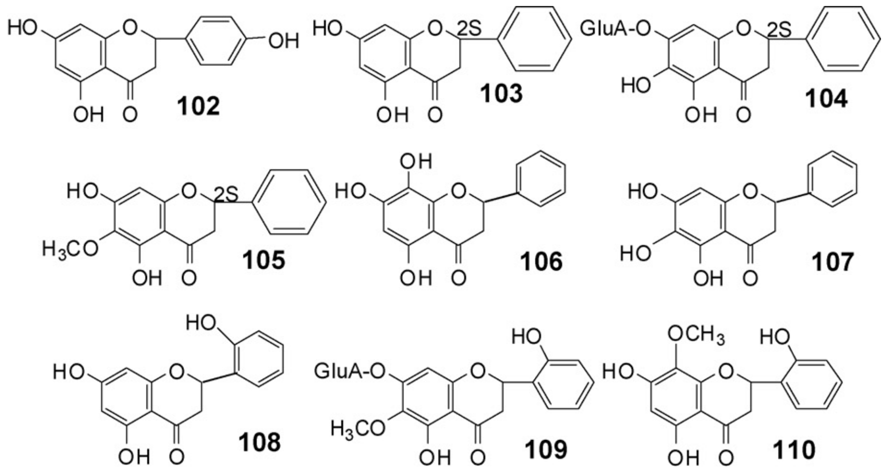
colorectal carcinoma cells (IC_{50} = 5.9 μM, 6.6 μM, 4.3 μM) (Dai et al., 2006a,b).

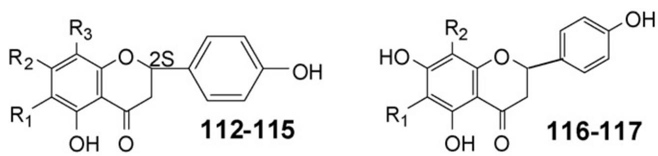
3.5. Triterpenoids

In 1993, Zhu et al. isolated an oleanane-type triterpenoid acid, scutellaric acid (**259**) from *S. barbata* for the first time (Zhu and Liu, 1993). In 2006, Miyaichi et al. isolated one known triterpenoid, ursolic acid (**260**) from the leaves of *S. strigillosa* (Miyaichi et al., 2006).

3.6. Neo-clerodane diterpenoid alkaloids

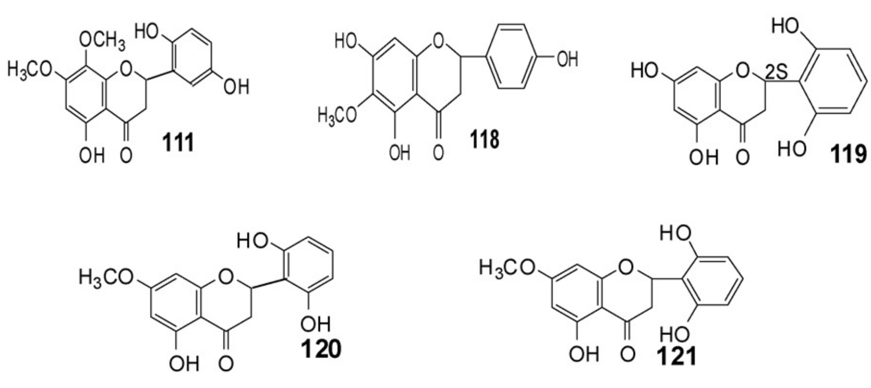
In 1996, scutebarbatine A (**261**), a new neoclerodane-type diterpenoid alkaloid was isolated from *S. barbata* for the first time (Wang and Li, 1996). In 2006, 2007, Dai et al. (2006a,b, 2007) obtained scutebarbatines and its derivates (**262**–**2271**) from *S. barbata*. Scutebarbatine B (**262**) showed significant cytotoxic activities against HONE-1 nasopharyngeal (IC_{50} = 4.4 μM), KB oral epidermoid carcinoma (IC_{50} = 6.1 μM) and HT 29 colorectal carcinoma cells (IC_{50} = 3.5 μM) (Dai et al., 2006a,b).

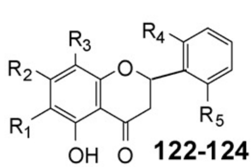




	R_1	R_2	R_3
112	H	OH	OH
113	H	O-GluA	OH
114	OH	OH	H
115	OH	O-GluA	H

	R_1	R_2
116	OCH_3	H
117	H	OCH_3





	R_1	R_2	R_3	R_4	R_5
122	OCH_3	OCH_3	H	OH	OCH_3
123	H	OCH_3	OCH_3	OH	OCH_3
124	H	OCH_3	H	O-Glu	OH

Fig. 2. (*Continued*)

3.7. Alkaloids

Only eleven alkaloids (**272**–**282**) were isolated from *S. flavescens* by column chromatography using silica gel and aluminum oxide in 2002 (Ma et al., 2002). Among these compounds, sophoranol (**272**), anagyrine (**275**), oxymatrine (**280**) showed potent antiviral activities against RSV with IC_{50} values of 10.4 μg/ml and SI values of 24.0, 24.0 and 12.0.

3.8. Essential oils

The essential oils of only a few species of *Scutellaria* have been investigated. The oil of *S. albida* ssp. *albida* from Greece was characterized by the presence of high concentrations of linalool (52.6%) and *trans*-nerolidol (9.0%) (Skaltsa et al., 2000). Other species from Greece, *S. sieberi* and *S. rupestris* ssp. *adenotricha* also contain high amounts of linalool, 22.7% and 38.8%, respectively (Skaltsa et al., 2005). The main components in the oil from aerial parts of *S. barbata* from China are hexahydrofarnesyl acetone (11.0%), 3,7,11,15-tetramethyl-2-hexadecen-1-ol (7.8%), menthol (7.7%) and 1-octen-3-ol (7.1%) (Yu et al., 2004). The oil of *S. lateriflora* from Iran is composed of sesquiterpenes (78.3%) of which β-cadinene (27.0%) and calamenene (15.2%) are major components along with β-elemene (9.2%), α-cubebene (4.1%) and α-humulene (4.2%) (Yaghmai, 1988). Lawrence et al. (1972) described sesquiterpenes in the oils of *S. galericulata* and *S. parvula*. The former was characterized by high content of sesquiterpene hydrocarbons with caryophyllene (29.4%) and *trans*-β-farnesene (17.0%) as the main components, while the latter showed α-bisabolol (20.6%) as the main compound accompanied by *trans*-α-bergamotene (13.4%). The main components of the oil from roots of *S. baicalensis* are acetophenone, (E)-4-phenyl-3-buten-2-one, 1-phenyl-1, 3-butandione, palmitic and oleic acids (Katsuya et al., 1987). Linalool (27.8%), Caryophyllene (28.7%) are the main compounds from *S. rubicunda* subsp. *linnaeana* endemic in Sicily (Rosselli et al., 2007).

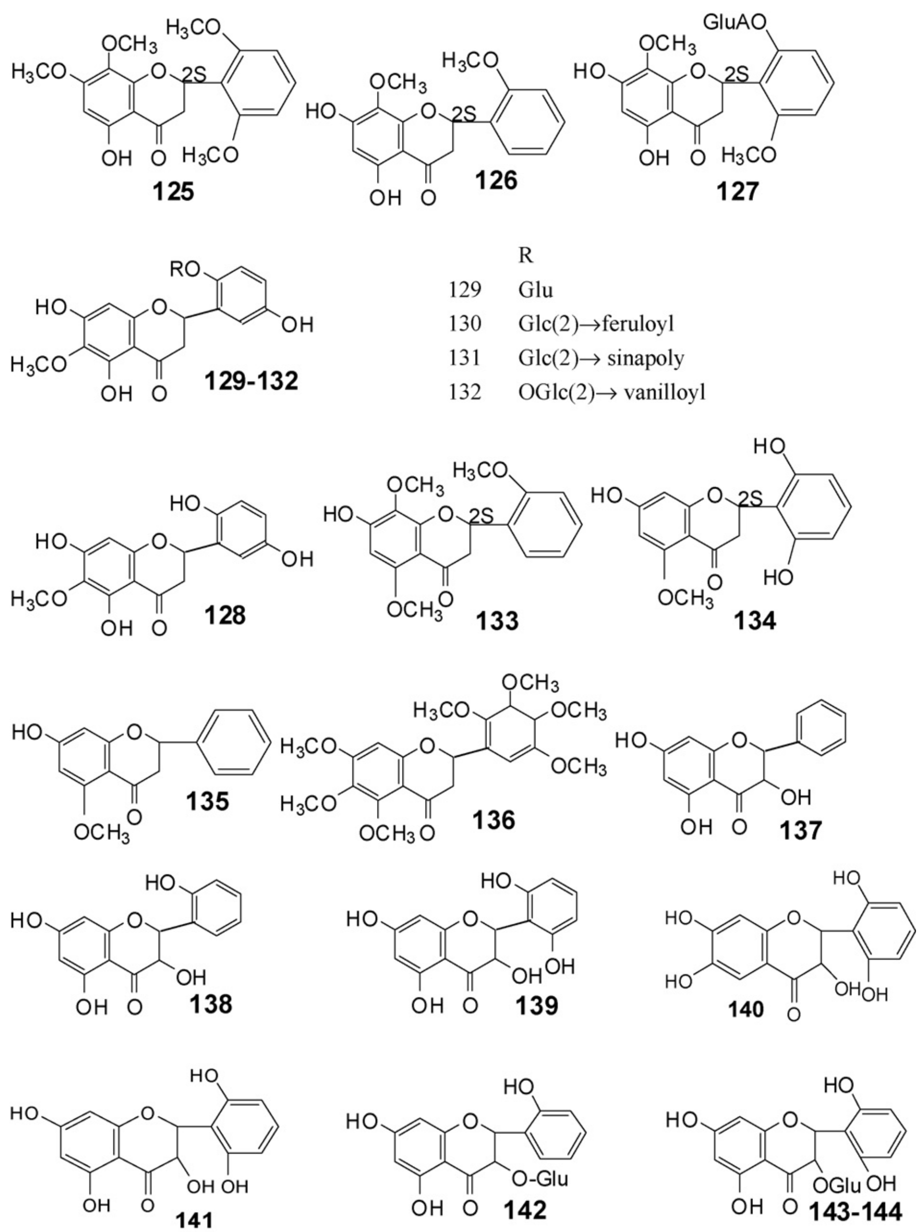
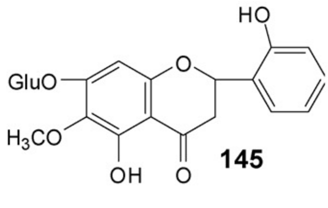


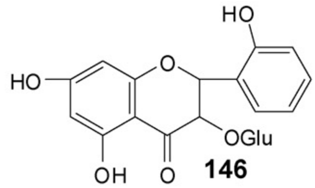
Fig. 2. (*Continued*)

3.9. Other compounds

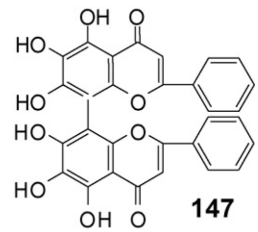
Aurantiamide acetate (**283**) was isolated from *S. barbata* (Lin, 1987b). In 2007, from the *S. albida* ssp. *albida*, Gousiadou et al. (2007) isolated six known phenolic derivatives, E-*p*-coumaric acid, E-caffeic acid, E-ferulic acid, E-*p*-coumaroylgluco side, vanilloloside and benzyl-β-glucopyranoside. Moreover, *p*-coumaric acid acetata, *p*-hydroxybenzaldehyde and *p*-hyroxybenzylacetone were also obtained from *S. barbata* (Xiang et al., 1982). Miyaichi et al. (2006) obtained two phytosterols (**285**, **286**) and five tocopherols (**297**–**291**) from the leaves of *S. strigillosa*. From *S. linearis* β-sitosterol and β-sitosterol glucopyrano was obtained (Hussain et al., 2008). Daucosterol (**284**) and dibutyl phthalate were isolated from the *S. amoena* (Zhou and Yang, 2000). In 1938, pinosylvin and its derivatives (**292**–**294**), gaylussacin (**295**) were isolated *S. scandens* endemic in Nepal (Li et al., 1994), and



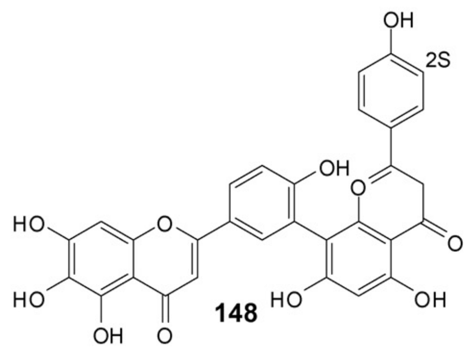
145



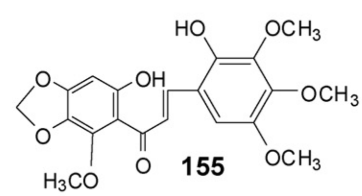
146



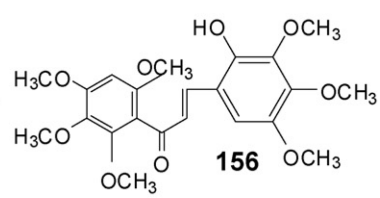
147



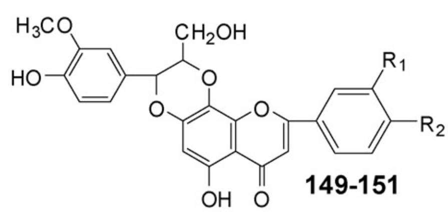
148



155

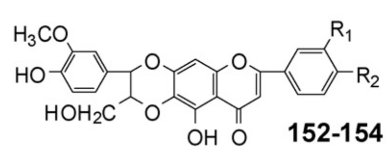


156



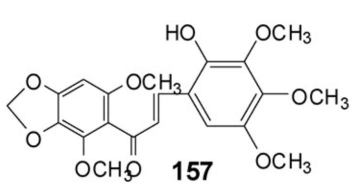
149-151

	R_1	R_2
149	H	H
150	H	OH
151	OH	OH

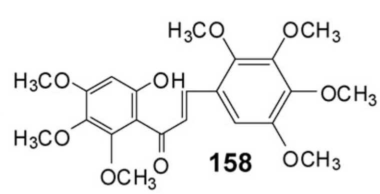


152-154

	R_1	R_2
152	H	H
153	H	OH
154	OH	OH



157



158

Fig. 2. (*Continued*)

polysaccharides, SBP, SPS4 obtained from *S. barbata* (Xu et al., 1992).

4. Qualitative and quantitative analysis

Obviously, flavonoids are the main and effective components of the genus *Scutellaria*. One or more flavonoids are usually adopted for qualitative and quantitative analysis for *Scutellaria*. Baicalin (**7**), the main flavonoid with the highest content, is employed by many countries and peoples to control the quality of medical materials and preparations. For example, the pharmacopeia of China suggests that the content of baicalin in the Radix *Scutellaria* should more than 9%. Today, it is widely accepted that the quality cannot be measured by mono-content. In 2002, six flavones in twenty-five samples of *S. baicalensis*, from the southeast of Russia to the northeast of China, were analyzed by HPLC to describe the differences between native and no-native herbs (Yang et al., 2002). In this study, flavonoid glycosides and aglycones were determined with a mobile phase of MeOH-H_2O-CH_3COOH (41:59:0.2) and MeOH-H_2O-CH_3COOH (50:50:0.2), respectively. The detection wavelength was 275 nm.

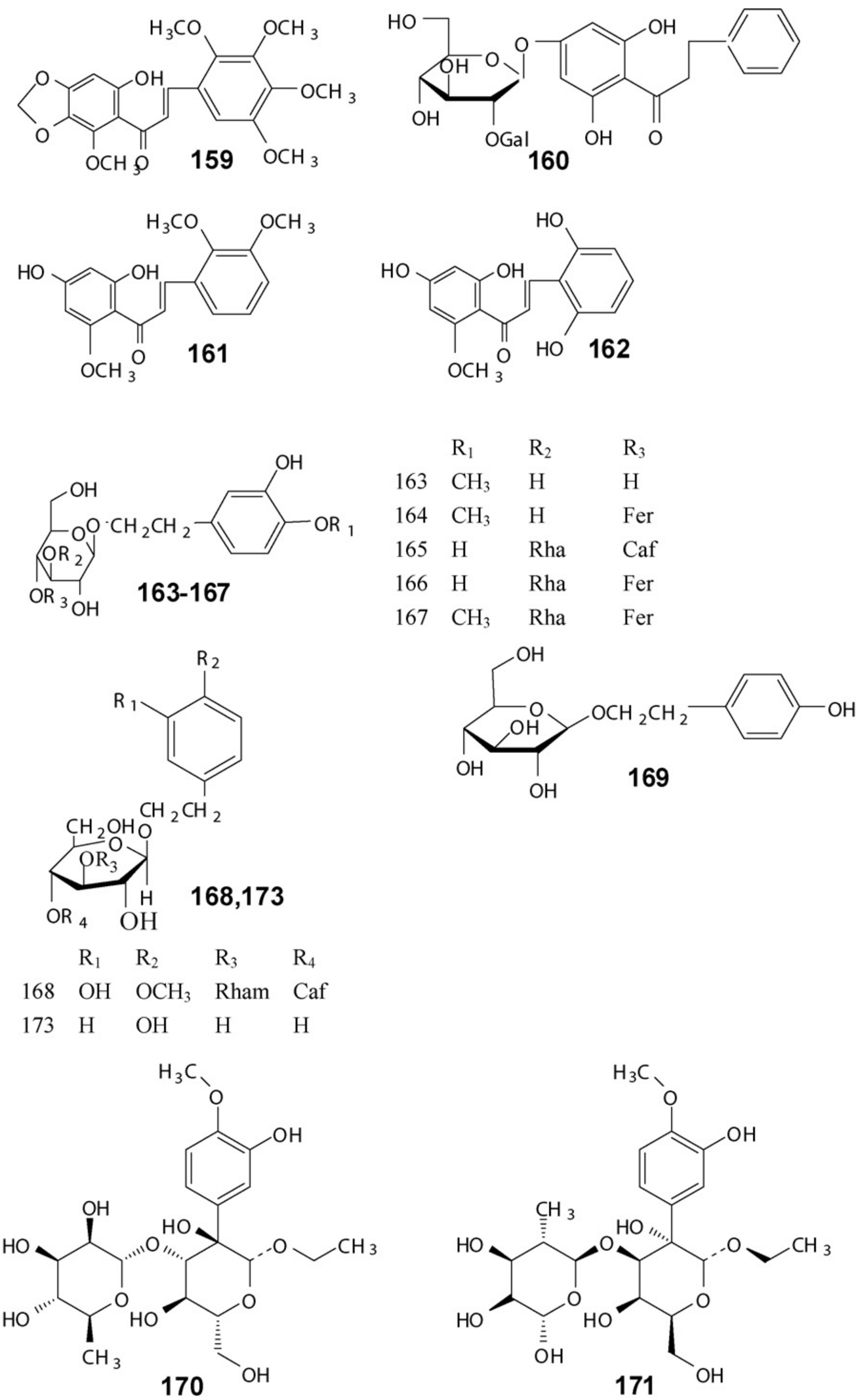


Fig. 2. (*Continued*)

The results showed that the contents of baicalin (**7**) are 6–9%, wogonin (**20**) are 2–8%, baicalein (**8**) are 0.1–1.6%, wogonoside (**21**) are 0.01–0.3%, viscidulin I (**100**) and trace amounts of oroxylin A (**16**). The native and no-native herbs had no distinct differences in absolute component ratios. The ratio of baicalin and wogonoside was under three. The ratio of baicalin and baicalein, baicalin and wogonin was between twenty and fifty. Finally, these ratios were suggested for the assessment of the quality of *S. baicalensis*.

Chemical fingerprint analysis has been introduced and accepted by WHO (1991), SFDAC (2000) and other authorities as a strategy for quality assessment of herbal medicines. It has been recognized as a rapid and reliable means for the identification and qualification of herbal medicines (Liang et al., 2004). Song et al. (2006) applied the gradient mobile system to compare *S. baicalensis* from 30 different cultivating areas in China. The results showed that similarity is correlated with the habitat of the herb. All samples tested contained the same eight peaks, which was identified as the characteristic fingerprints. However, the content of each peak showed large differences among samples. Similar degrees of HPLC fingerprints could be used to compare crude drugs from different habitats.

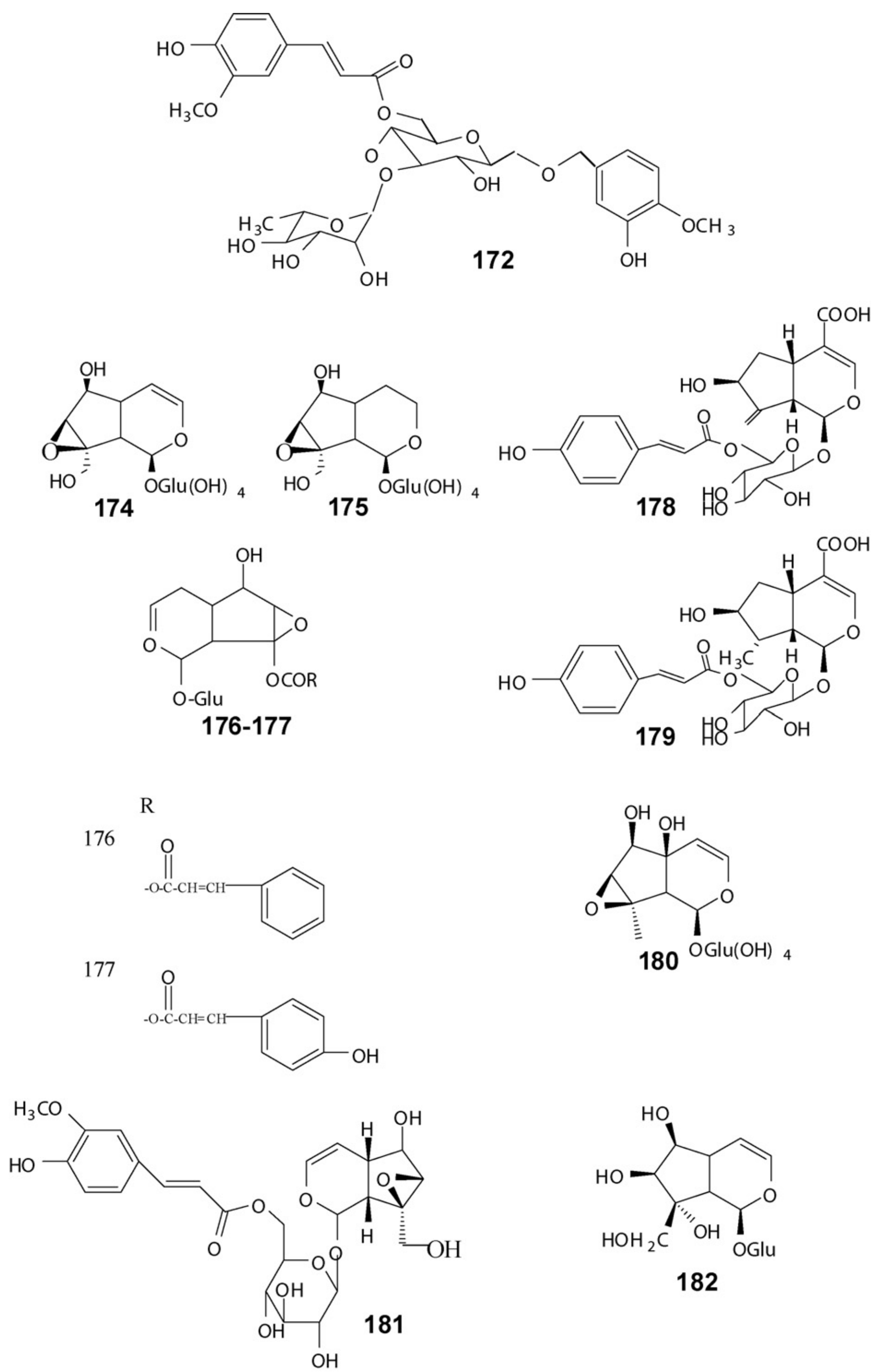


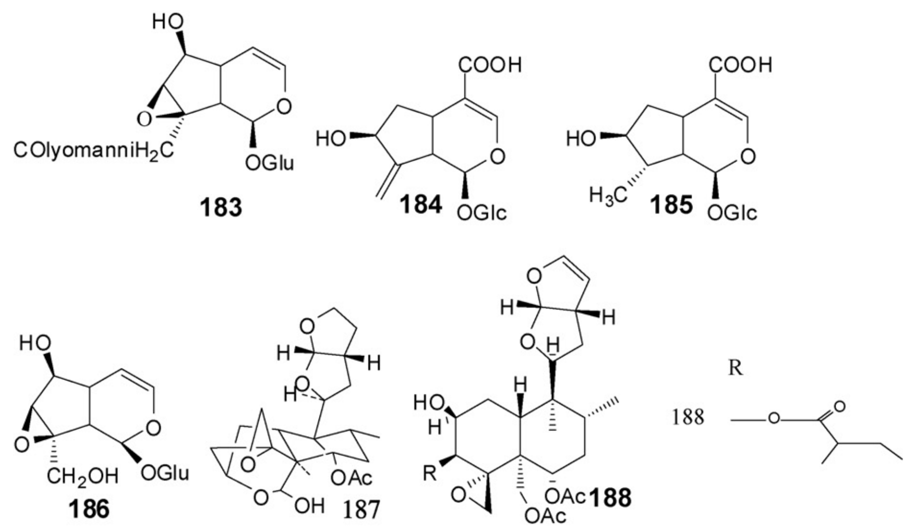
Fig. 2. (*Continued*)

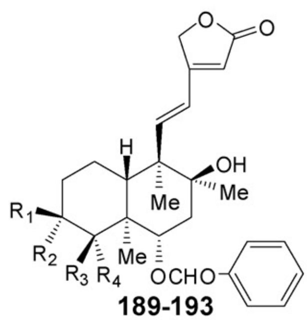
By combining HPLC, DAD and MS for medicinal plant analysis, the identification and quantification of bioactive and marker compounds in complex matrices can be realized even with structurally similar natural products (He, 2000). In 2005, Horvath et al. developed this method to analyze eight flavones (wogonin, baicalin, baicalein, scutellarein, apigenin-7-glucuronide, scutellarin, apigenin, chrysin and 6-hydroxyflavone) in root and aerial tissues of *S. baicalensis.* The identity of the analytes was confirmed using retention time, UV-vis and mass spectral comparisons to commercial standards. Both UV-vis and mass spectral patterns were characterized for glycosylated flavones. At the same time, two additional flavone glycosides were tentatively identified as chrysin-7-glucuronide and wogonoside, but not quantified.

5. Effects of crude extract

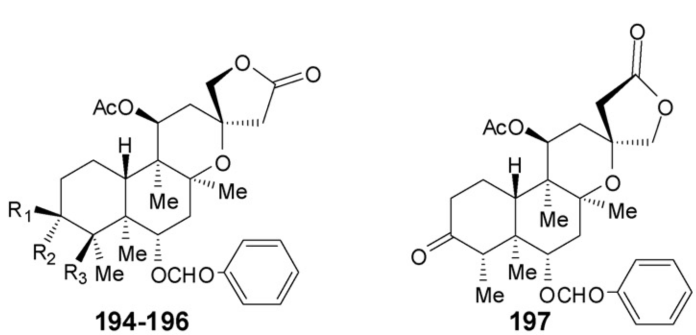
5.1. Antitumor

S. barbata, a traditional Chinese herbal medicine is native to southern China. The ethanol extracts show growth inhibitory effects on A549 cell with IC_{50} of 0.21 mg/ml (Yin et al., 2004).





	R_1	R_2	R_3	R_4
189	H	OH	CH_3	OH
190	=O		CH_3	H
191	H	=O		CH_3
192	H	OH	CH_3	OEt
193	H	OH	CH_3	OMe

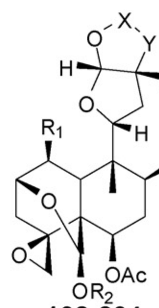


	R_1	R_2	R_3
194	H	OH	OH
195	=O		H
196	OH	H	OH

Fig. 2. (*Continued*)

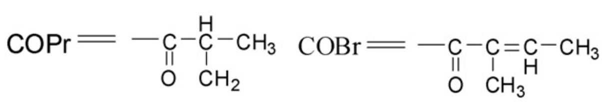
At the same time, it exhibits cancer chemo preventive activity in assays representing three major stages of carcinogenesis, especially in gynecological cancers (Suh et al., 2007). The aqueous extracts demonstrate growth inhibitory activity on A549, PC-3, Panc-1, LNCaP, MCF-7 (human) and Panc02, LLC, MCNeuA (murine) on eight cancer cell lines (Shoemaker et al., 2005). Cha et al. (2004) investigated the antitumor mechanism of the methylene chloride fraction of *S. barbata* (MCSB) in human U937 leukemia cells. It was confirmed that MCSB could induce apoptosis via the mitochondria-mediated pathway. The apoptosis of leiomyomal cells induced by *S. barbata* was associated with the release of Cytochrome *C* from the mitochondria, followed by an increase in Caspase 3-like activity (Lee et al., 2006). Yu et al. (2007) confirmed that non-polar and low-polar solvent fractions of *S. barbata* have dose-dependent cytotoxicities on six cancer cell lines. Among them, the chloroform fraction had the strongest cytotoxicity on cancer cell lines with a lower cytotoxic effect on a normal liver cell line, and significantly inhibited solid tumor proliferation. Furthermore, treatment with extracts could increase the life span of ascites tumor bearing mice.

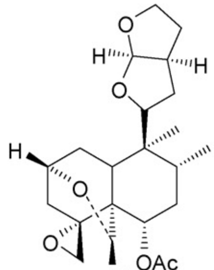
The aqueous extract of roots of *S. baicalensis* (*Scutelleria* Radix) displays significant inhibition against MMP-2 and -9 activities and invasion of SK-Hep1 cells, with IC_{50} of 85, 145 and 150 μg/ml, respectively (Ha et al., 2004). This extract also inhibits the growth of lymphoma and myeloma cell lines by inducing apoptosis and cell cycle arrest at clinically achievable concentrations. This anti-proliferative effect is associated with mitochondrial damage, modulation of the Bcl family of genes, increased level of the CDK inhibitor p27[KIP1] and decreased level of c-myc oncogene (Kumagai et al., 2007).



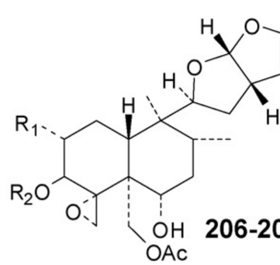
198-204

	R_1	R_2	X-Y
198	H	Ac	CH=CH
199	H	COPr	CH=CH
200	OCOBr	Ac	CH=CH
201	OCOBr	Ac	CH_2-CH_2
202	H	COBr	CH=CH
203	H	COBr	CH_2-CH_2
204	H	H	CH_2-CH_2



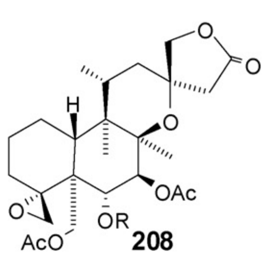


205

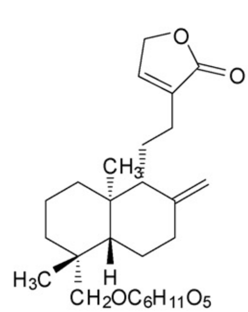


206-207

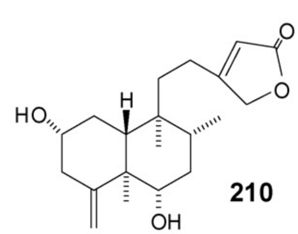
	R_1	R_2
206	H	H
207	OH	COBr



208



209



210

R

208

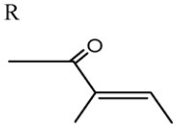


Fig. 2. (*Continued*)

Zhang et al. (1998) compared the four flavonoids of *S. planipes* to *S. baicalensis*, and the results showed that their contents are similar in both plant roots. *S. planipes* may be considered as a new medicinal plant because the contents of its main components, and their antiallergenic, antibacterial activities and the acute toxicity, *in vitro*, do not differ significantly from those of *S. baicalensis*.

In 2009, Min reviewed the anticancer properties of *Scutellaria* and its main active constituents baicalin (**7**), baicalein (**8**) and wogenin (**21**). This paper demonstrated that *Scutellaria* possesses potent anticancer activity and its bioactive components are flavones. Its extracts were not only cytostatic but also cytotoxic to various human tumor cell lines *in vitro* and it inhibited tumor growth *in vivo*. The antitumor functions of these flavones are largely

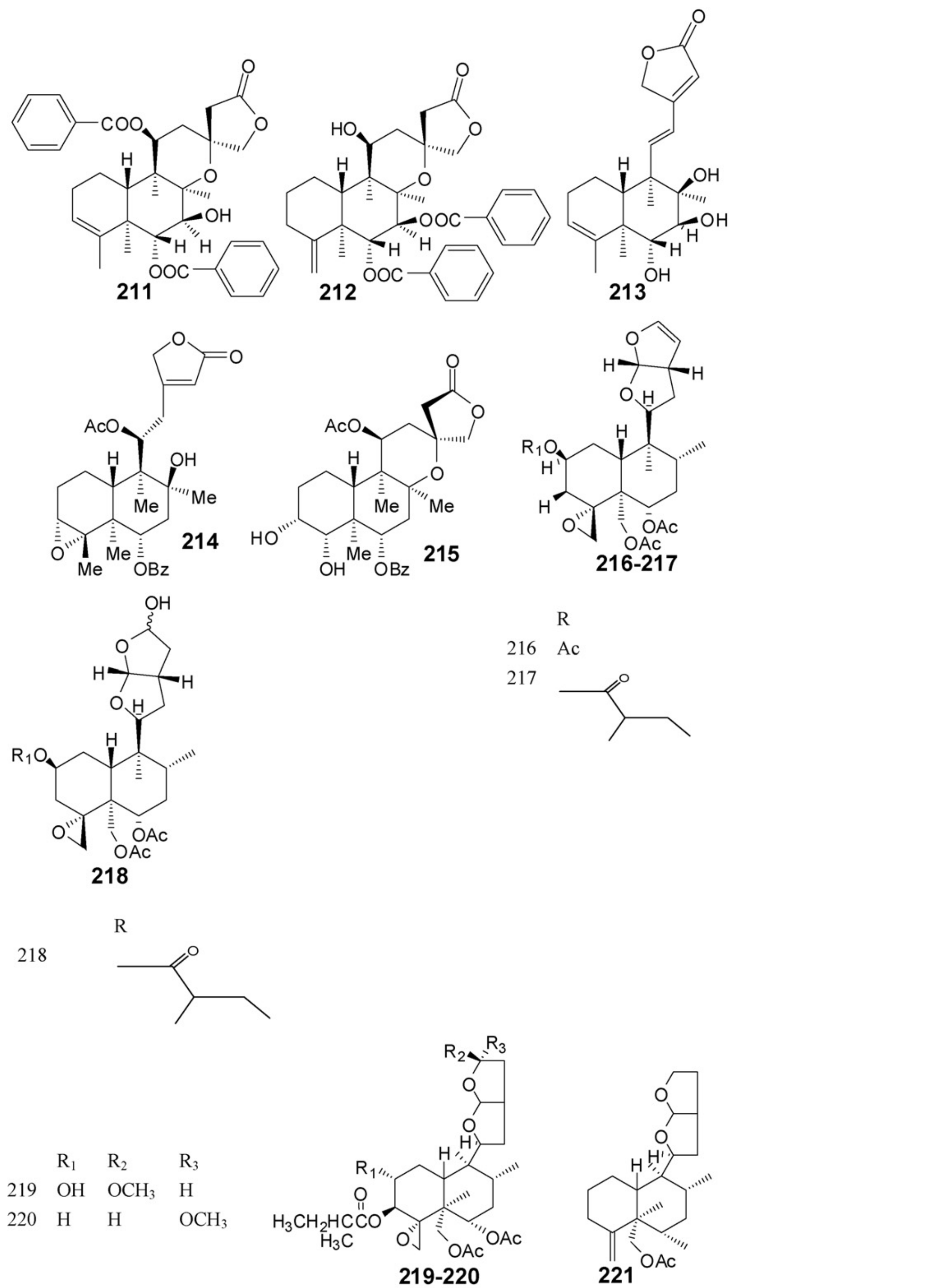


Fig. 2. (*Continued*)

due to their ability to scavenge oxidative radicals, attenuate NF-κB activity, inhibit several genes important for regulation of the cell cycle, suppress COX-2 gene expression and prevent viral infections. The tumor-selectivity of wogonin has been attributed to its ability to differentially modulate the oxidation–reduction status of malignant vs. normal lymphocytic cells and to preferentially induce phospholipase Cγ1, a key enzyme involved in Ca^{2+} signaling, through H_2O_2 signaling in malignant lymphocytes (Min, 2009).

5.2. Anti-angiogenesis

Wang et al. (2004) determined angiogenic activity in vessels from the chick embryo chorioallantoic membrane (CAM) and cultured bovine aortic endothelial cells (BAECs). The results indicated that the aqueous extract of *S. baicalensis* has strong anti-angiogenesis activity *in vitro*.

5.3. Hepatoprotective

Lin et al. (1997) investigated the hepatoprotective effect of various fractions (*n*-hexane, $CHCl_3$, EtOAc, *n*-BuOH and H_2O) from *S. barbata* in three experimental models *in vivo*. The results indicated that the $CHCl_3$ fraction and *n*-hexane fraction re most potent against D-galactosamine (D-GlaN)-induced intoxication, and the $CHCl_3$ fraction represents the greatest liver-protective effect on acetaminophen (APAP)-induced hepatotoxicity. The pathological changes of hepatic lesions were improved by treatment with the fraction mentioned.

Tan et al. (2006) hypothesized that the anti-fibrosis activity of *S. baicalensis* root may be involved in up-regulation of cAMP response element binding protein phosphorylation. The roots and shoots of *S. baicalensis* also inhibited the mutagenicity of the mycotoxin aflatoxin-B_1 in the liver of the rat (Johan et al., 2005).

5.4. Antioxidant

Methanol extracts of *S. baicalensis* can inhibit lipid peroxidation in rat liver microsomes and red blood cells, and inhibit aminopyrine N-demethylase and xanthine oxidase activities as well as have a pro-oxidant effect as observed in the Fe^{3+}-EDTA-H_2O_2 system (Schinella et al., 2002). In a cardiomyocyte model of ischemia and reperfusion, 1.0 mg/ml *S. baicalensis* extract quickly

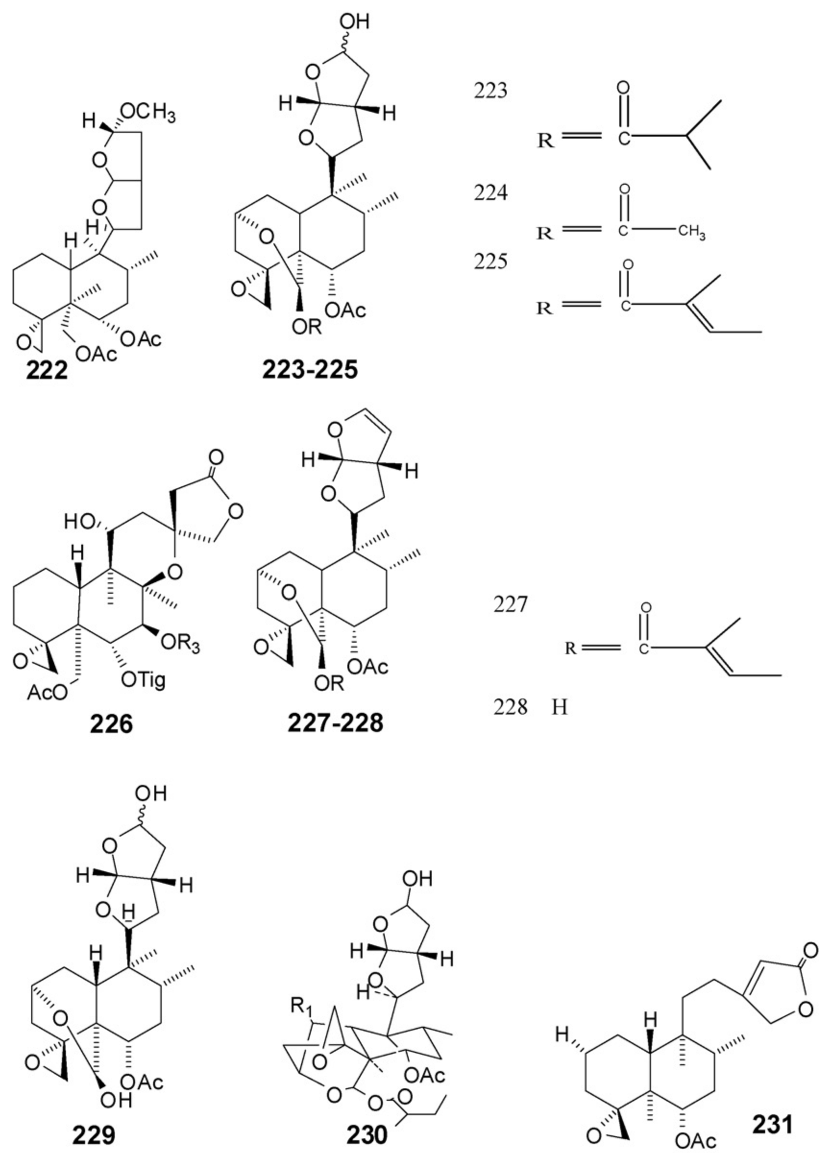


Fig. 2. (*Continued*)

attenuated levels of oxidants generated during transient hypoxia and exposure to the mitochondrial site III inhibitor antimycin A. Cell death after ischemia/reperfusion decreased from 47 ± 3% in untreated to 26 ± 2% in *S. baicalensis* treated cells. After antimycin exposure, *S. baicalensis* decreased cell death from 49 ± 6% in untreated to 23 ± 4% in treated cells ($p < 0.001$) (Shao et al., 1999).

Neuronal cells exposed to oxidative stress and treated with flavones from aqueous extracts of *S. baicalensis* were also observed. It was confirmed that flavone extracts (50 μg/ml) protect cells and increase viability to 85 ± 5%, and increase the content of Bcl-2 in cells. Furthermore, oxidative-stress-induced protein carbonyl formation was reduced nearly two-fold when cells were pretreated with the flavone extract (Choi et al., 2002).

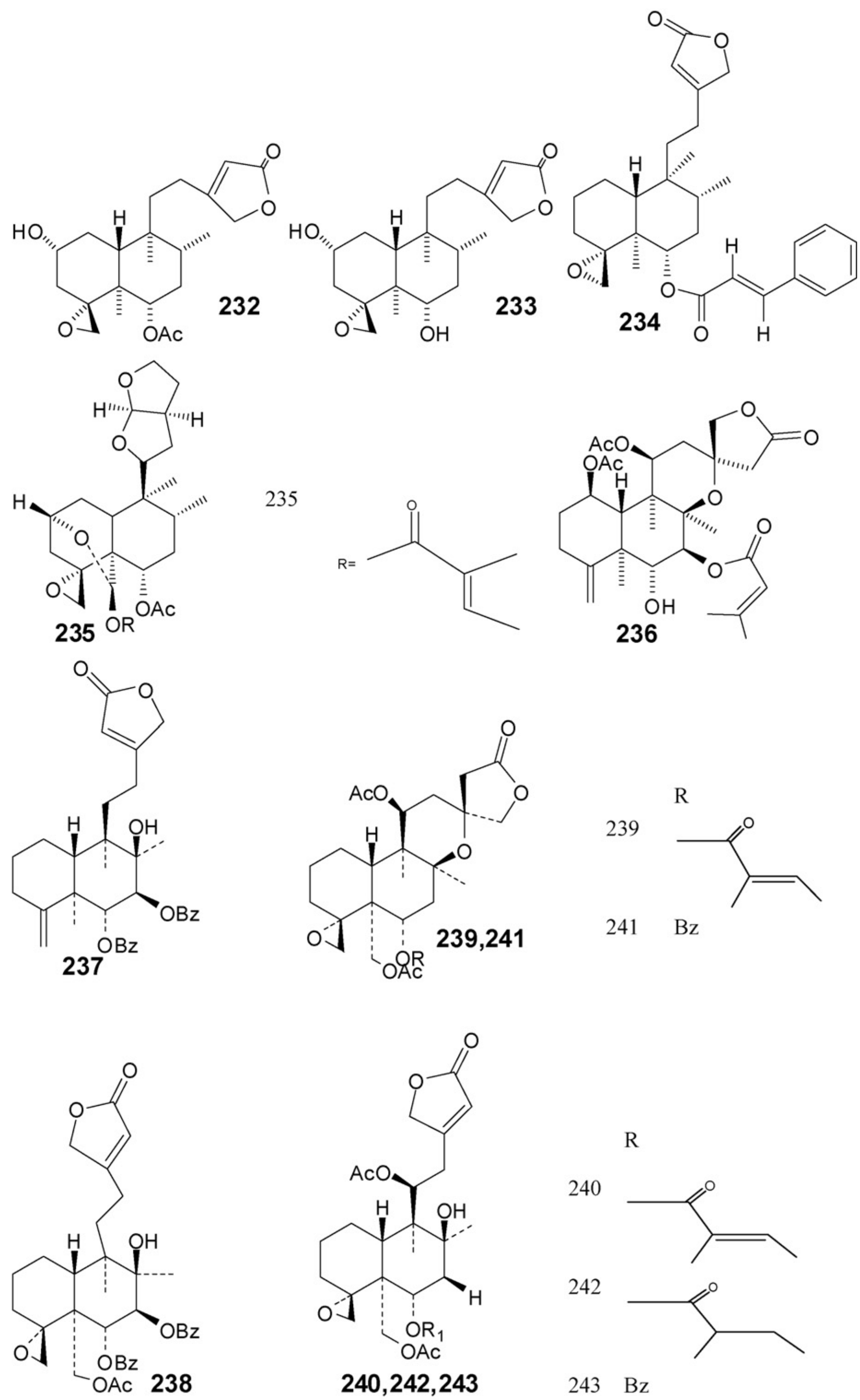


Fig. 2. (*Continued*)

5.5. Anticonvulsant

Wang et al. (2000) examined the anticonvulsant effect of *S. baicalensis* aqueous extracts (ED_{50} 3.6 g/kg) *in vivo* and its enhancing effect on γ-amino-*n*-butyric acid (GABA)-stimulated uptake of $^{36}Cl^-$ in *in vitro* cortex preparation. The results showed that aqueous extracts have anticonvulsant activity against maximal electroshock-induced tonic seizures, and this anticonvulsant effect is not due to the activation of the benzodiazepine binding site of $GABA_A$ receptors, but probably via the prevention of seizure spread.

The study of Zhang et al. (2009) showed that the whole extract (ethanol and water solution) of *S. lateriflora* has modest anticonvulsant activity in two rodent models of acute seizures as an anticonvulsant.

5.6. Antibacterial and antiviral

10% aqueous extracts of *S. baicalensis* have antimycotic properties against pathological phyla of *Aspergillus fumigatus*, *Candida albicans*, *Geotrichum candidum* and *Rhodotorula rubra* had the highest activity against *Candida albicans* (Blaszczyk et al., 2000). Ethanol extracts of *S. baicalensis* can improve the antimicrobial activity of four antibiotics (penicillin G, gentamicin, ciprofloxacin, ceftriaxone) on the resistance of *Staphylococcus aureus in vitro* (Yang et al., 2005).

Antiviral activities against human respiratory syncytial virus (RSV) of aqueous extracts from *S. indica*, *S. barbata* were screened using a cytopathic effect (CPE) reduction assay. The results exhibited anti-RSV activity and the 50% inhibitory (IC_{50}) concentrations were 31.3 and 62.5 μg/ml, and the selective indices (SI) were 11.2,

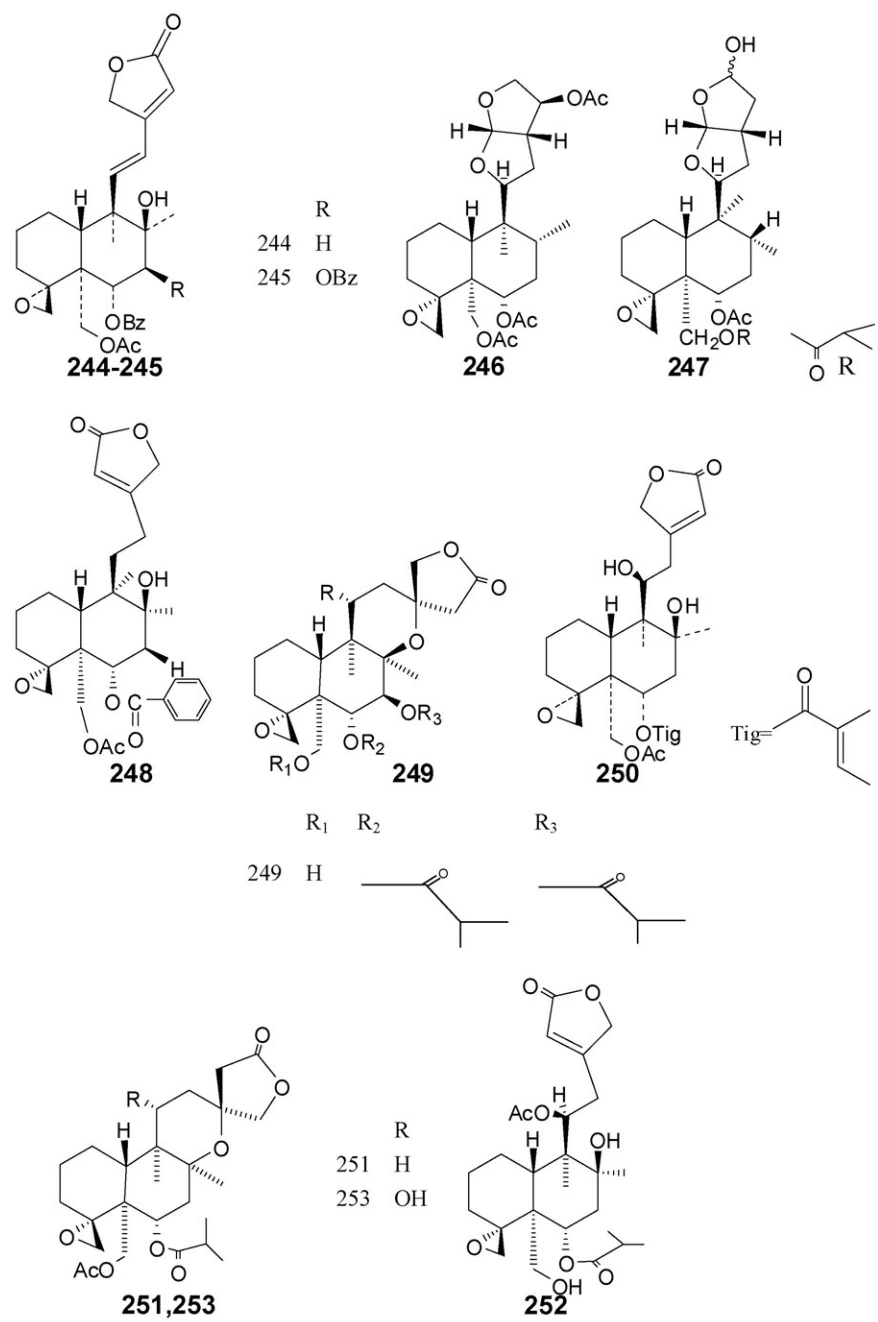


Fig. 2. (*Continued*)

8.0, respectively (Li et al., 2004). In addition, the aqueous extracts of *S. baicalensis* elicited significant inhibition (90%) at a concentration of 200 mg/ml against HIV-1 protease activity (Lam et al., 2000).

5.7. Neuroprotective effects and memory improvement

Flavonoids, isolated from aerial parts of *S. baicalensis* and administrated orally (35 mg/kg, 19–20 days) can dramatically reduce the decrease in learning and memory, attenuate neuronal injury and improve abnormality of energy metabolites in rats induced by global ischemia. These results suggest that flavonoids of *S. baicalensis* may be beneficial for the treatment of vascular dementia (Shang et al., 2005). At the same time they have a significant protective effect on cerebral ischemia and ischemia-reperfusion induced brain injury (Zhang et al., 2006).

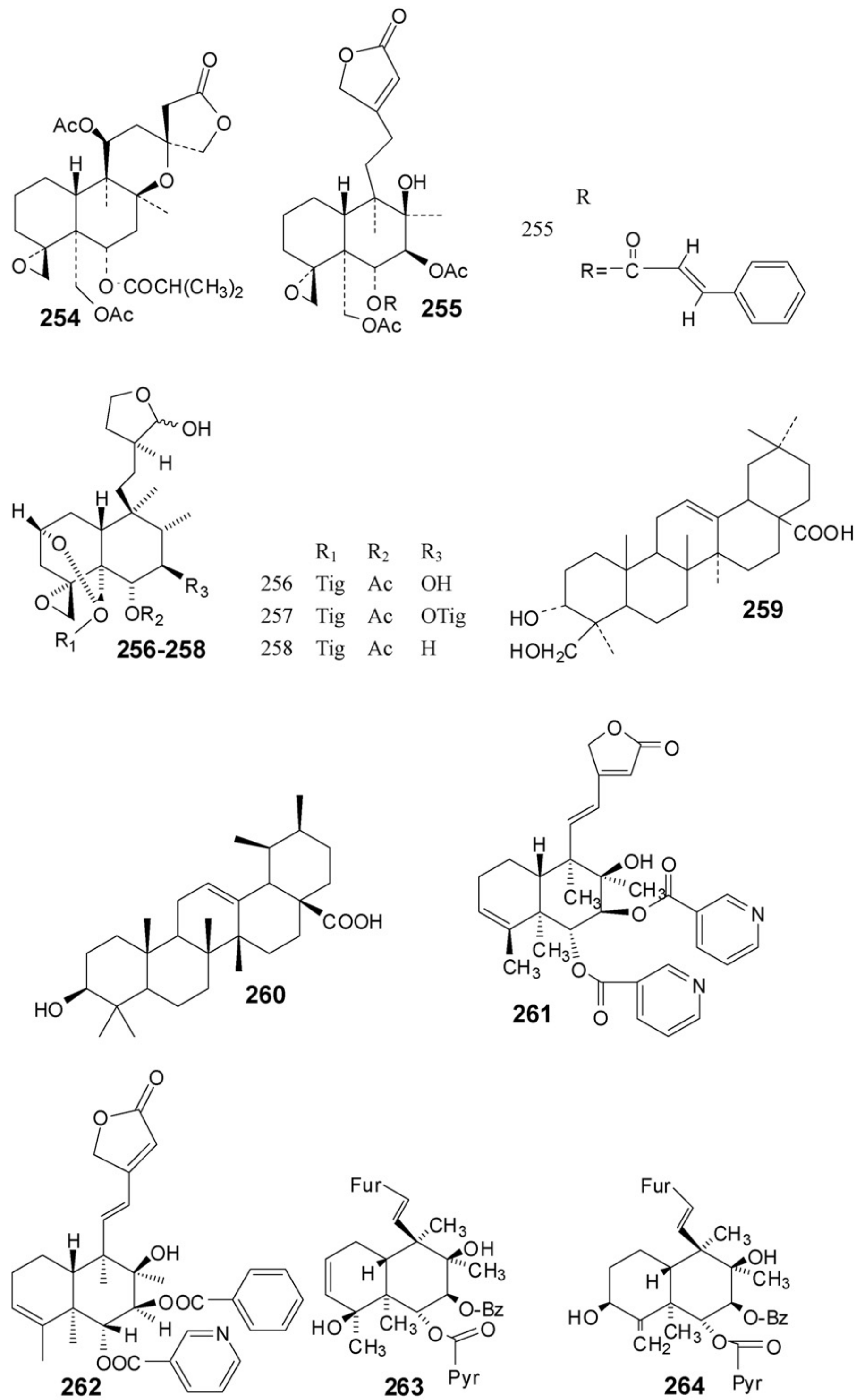


Fig. 2. (*Continued*)

Heo et al. (2009) proposed that *S. baicalensis* has significant neuroprotective effects in the Ibo model. After administration of 30 mg/kg 70% ethanol extract of *S. baicalensis*, the number of neuronal cells immunoreactive for choline acetyltransferase (ChAT) increased in the hippocampus, while cells producing GABA and glutamate did not increase. Furthermore, the extracts enhanced the survival of a hippocampal progenitor cell line, HiB5 and its differentiation to ChAT immunoreactive cells. At the same time the increased expression of NMDA receptors and a reduction of activated microglia in the hippocampus were also observed in the Ibo model.

Kim et al. (2001) proposed that the methanol extract of *S. baicalensis* inhibits microglial TNF-α and NO production, and protects PC12 cells from hydrogen peroxide-induced toxicity *in vitro*.

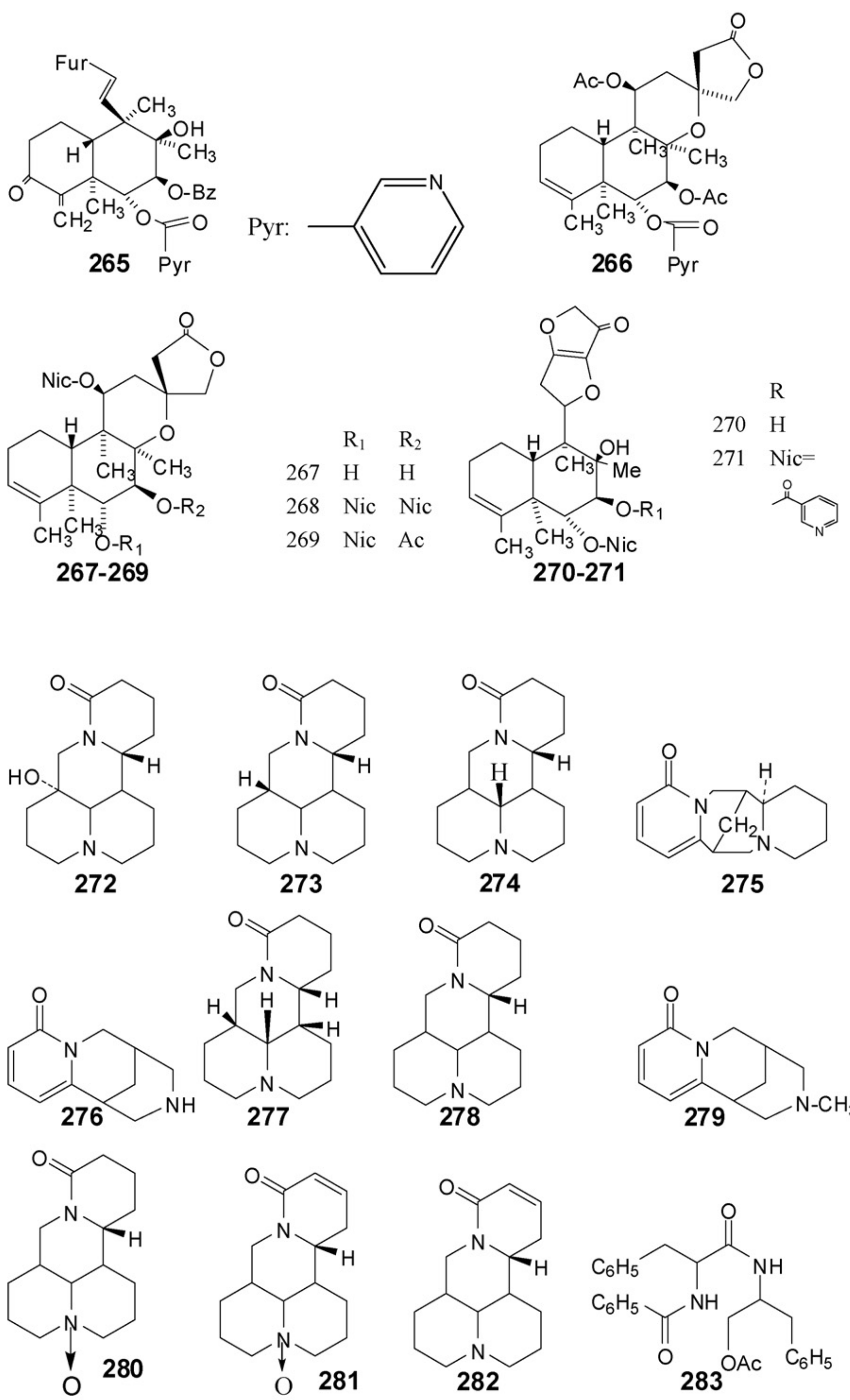
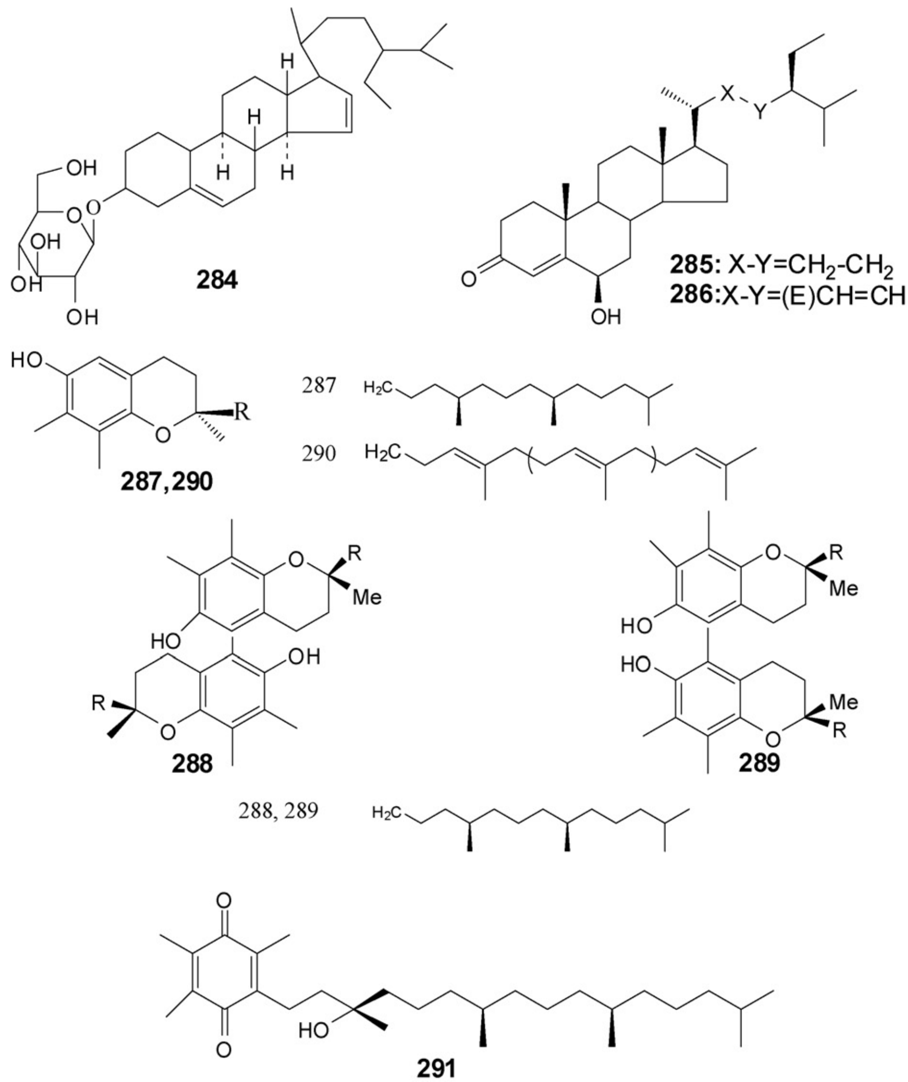
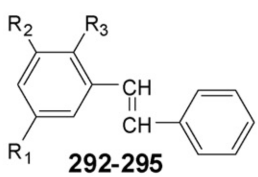


Fig. 2. (*Continued*)





	R_1	R_2	R_3
292	H	OH	OH
293	COOH	OH	OH
294	H	-O-Glu	OH
295	COOH	OH	-O-Glu

Fig. 2. (*Continued*).

6. Conclusion

The interest in the relationship between pharmacological effects and traditional uses of *Scutellaria* has increased considerably in recent years. More and more extracts and individual compounds have been used to treat cancer, hepatitis, pain, HIV-1 and pyogenic infection. According to the literatures reviewed in this paper, several reasons could be contributed to this including: (1) some of species have been used as a local medicine for thousands years in the world, especially in Asia and the effects and safety of these species have been confirmed. Thus, these plants have generated much interest and new medicine may be more easily found in some species. (2) Phenols and terpenes have been identified as the two main chemical compositions of *Scutellaria*. Among of them, baicalin, baicalein, barbatins A–C and scutebarbatine B have been proven to be potential drug leads most notably with anti-cancer and anti-HIV effects. These compounds will be the main anchors for further studies on this genus and have great potential as new medicines. (3) Only **35** of the approx. 350 species have been studied in some detail. Considering that they have many bioactive compounds, the development of new substitutes and the discovery of new activities in related species are very important. (4) In China, some species have been used in TCM for thousands of years, and the roots of these species are used as one composition with other Chinese medicinal plants. The effects of *Scutellaria* in the interaction between *Scutellaria* and other TCM have been not explored in great detail.

Phytochemical and pharmacological studies of the genus *Scutellaria* have received much interest in recent years. Further studies are required for the development of new drugs and therapeutics for the treatment of various diseases, especially for antitumor and antivirus.

References

Ahmed, A., Hussein, M.C., Torre, D.L., Jimeno, M.L., RodrÍguez, B., Bruno, M., Piozzi, F., Servettaz, O., 1996. A Neo-Clerodane diterpenoids from *Scutellaria baicalensis*. Phytochemistry 43, 835–837.

Awad, R., Arnason, J.T., Trudeau, V., Bergeron, C., Budzinski, J.W., Foster, B.C., Merali, Z., 2003. Phytochemical and biological analysis of Skullcap (*Scutellaria lateriflora* L.): a medicinal plant with anxiolytic properties. Phytomedicine 10, 640–649.

Blaszczyk, T., Krzyzanowska, J., Lamer-Zarawska, E., 2000. Screening for antimycotic properties of 56 traditional Chinese drugs. Phytotherapy Research 14, 210–212.

Bothmer, R., 1985. Differentiation patterns in the *Scutellaria albida* group (Lamiaceae) in the Aegean area. Nordic Journal of Botany 5, 421–439.

Bruno, M., Ckuciata, M., Bondi, M.L., Piozzi, F., et al., 1998. Neo-Clerodane diterpenoids from *Scutellaria lateriflora*. Phytochemistry 48, 687–691.

Bruno, M., Piozzi, F., RodrÍguez, B., MarÍa, C., De La Torre, Vassallo, N., Servettaz, O., 1996a. Neo-Clerodane diterpenoids from *Scutellaria altissima and S. albida*. Phytochemistry 42, 1059–1064.

Bruno, M., Fazio, C., Arnold, N.A., 1996b. Neo-clerodane diterpenoid from *Scutellaria cypria*. Phytochemistry 42, 555.

Bruno, M., Vassallo, N., Simmonds, M.S.J., 1999. A diterpenoid with antifeedant activity from *Scutellaria rubicunda*. Phytochemistry 50, 973–976.

Bruno, M., Piozzi, F., Maggio, A.M., Simmonds, M.S.J., 2002. Antifeedant activity of neoclerodane diterpenoids from two Sicilian species of *Scutellaria*. Biochemical Systematics and Ecology 30, 793–799.

Bruno, M., Rosselli, S., Maggio, A., Piozzi, F., Scaglioni, L., Servettaz, O., 2004. Scuteparvin, a new neoclerodane diterpenoid from *Scutellaria parvula*. Biochemical Systematics and Ecology 32, 755–759.

Cha, Y.Y., Lee, E.O., Lee, H.J., Park, Y.D., Ko, S.G., Kim, D.H., Kim, H.M., Kang, I.C., Kim, S.H., 2004. Methylene chloride fraction of *Scutellaria barbata* induces apoptosis in human U937 leukemia cells via the mitochondrial signaling pathway. Clinica Chimica Acta 348, 41–48.

Chan, H.Y., Chen, Z.Y., Tsang, D.S.C., Leung, L.K., 2002. Baicalein inhibits DMBA-DNA adduct formation by modulating CYP1A1 and CYP1B1 activities. Biomedicine Pharmacotherapy 56, 269–275.

Chan, F.L., Choi, H.L., Chen, Z.Y., Chan, P.S.F., Huang, Y., 2000. Induction of apoptosis in prostate cancer cell lines by flavonoid, baicalin. Cancer Letters 160, 219–228.

Chi, Y.S., Cheon, B.S., Kim, H.P., 2000. Effect of wogonin, a plant flavone from *Scutellaria radix*, on the suppression of cyclooxygenase-2 and the induction of inducible nitric oxide synthase in lipopolysaccharide-treated RAW 264.7 cells. Biochemical Pharmacology 61, 1195–1203.

Chi, Y.S., Lim, H., Park, H., Kim, H.P., 2003. Effects of wogonin, a plant flavone from *Scutellaria radix*, on skin inflammation: *in vivo* regulation of inflammation-associated gene expression. Biochemical Pharmacology 66, 1271–1278.

Chi, Y.S., Kim, H.P., 2005. Suppression of cyclooxygenase-2 expression of skin fibroblasts by wogonin, a plant flavone from *Scutellaria radix*. Prostaglandins, Leukotrienes and Essential Fatty Acids 72, 59–66.

Choi, J., Conrad, C.C., Malakowsky, C.A., Talent, J.M., Yuan, C.S., Gracy, R.W., 2002. Flavones from *Scutellaria baicalensis* Georgi attenuate apoptosis and protein oxidation in neuronal cell lines. Biochimica et Biophysica Acta General Subjects 1571, 201–210.

Chou, C.C., Pan, S.L., Teng, C.M., Guh, J.H., 2003. Pharmacological evaluation of several major ingredients of Chinese herbal medicines in human hepatoma Hep3B cells. European Journal of Pharmaceutical Sciences 19, 403–412.

Dai, S.J., Chen, M., Liu, K., Jiang, Y.T., Shen, L., 2006a. Four new neo-clerodane diterpenoid alkaloids from *Scutellaria barbata* with cytotoxic activities. Chemical & Pharmaceutical Bulletin 54, 869–872.

Dai, S.J., Tao, J.Y., Liu, K., Jiang, Y.T., Shen, L., 2006b. *Neo*-Clerodane diterpenoids from *Scutellaria barbata* with cytotoxic activities. Phytochemistry 67, 1326–1330.

Dai, S.J., Wang, G.F., Chen, M., Liu, K., Shen, L., 2007. Five new neo-clerodane diterpenoid alkaloids from *Scutellaria barbata* with cytotoxic activities. Chemical & Pharmaceutical Bulletin 55, 1218–1221.

Dong, J.P., Chen, J.P., 1992. Study on the flavonoids of *S. hypericifolia* Levl. Chinese Traditional and Herbal Drugs 23, 619 (in Chinese).

Duke, J.A., 1986. Handbook of Medicinal Herbs. CRC Press, Boca Raton, FL, p. 440.

Esquivel, B., Calderón, J.S., Flores, E., 1998. A neo-clerodane diterpenoid from *Scutellaria seleriana*. Phytochemistry 47, 135–137.

Esquivel, B., Flores, E., Hernández-Ortega, S., Toscano, R.A., 1995. Neo-clerodane diterpenoids from *Scutellaria drummondii*. Phytochemistry 38, 175.

Ezer, N., Akcos, Y., RodrÍguez, B., 1998. Neo-clerodane diterpenoids from *Scutellaria orientalis* subsp. *sintenisii*. Phytochemistry 49, 1825–1827.

Federation of Asian Pharmaceutical Associations, 1978. Asian Pharmacopoeia, Asian Crude Drugs, their Preparations and Specifications, Manila.

Franzyk, H., Rasmussen, J.H., Jensen, S., 1998. Ozonolysis of Protected Iridoid Glucosides. European Journal of Organic Chemistry, 365–370.

Gao, Z.H., Huang, K.X., Yang, X.L., Xu, H.B., 1999. Free radical scavenging and antioxidant activities of favonoids extracted from the radix of *Scutellaria baicalensis* Georgi. Biochimica et Biophysica Acta 1472, 643–650.

Gousiadou, C., Karioti, A., Heilmann, J., Skaltsa, H., 2007. Iridoids from *Scutellaria albida* ssp. *albida*. Phytochemistry 68, 1799–1804.

Guo, Q.L., Zhao, L., You, Q.D., Yang, Y., Gu, H.Y., Song, G.L., Lu, N., Xin, J., 2007. Anti-hepatitis B virus activity of wogonin *in vitro* and *in vivo*. Antiviral Research 74, 16–24.

Ha, K.T., Kim, J.K., Kang, S.K., Kim, D.W., Lee, Y.C., Kim, H.M., Kim, C.H., 2004. Inhibitory effect of Sihoga-Yonggol-Moryo-Tang on matrix metalloproteinase-2 and -9 activities and invasiveness potential of hepatocellular carcinoma. Pharmacological Research 50, 279–285.

He, X.G., 2000. On-line identification of phytochemical constituents in botanical extracts by combined high-performance liquid chromatographic–diode array detection–mass spectrometric techniques. Journal of Chromatography A 880, 203.

Heo, H., Shin, Y.S., Cho, W.H., Choi, Y.S., Kim, H., Kwon, Y.K., 2009. Memory improvement in ibotenic acid induced model rats by extracts of *Scutellaria baicalensis*. Journal of Ethnopharmacology 122, 20–27.

Himeji, M., Ohtsuki, T., Fukazawa, H., Tanaka, M., Yazaki, S., Ui, S., Nishio, K., Yamamoto, H., Tasaka, K., Mimura, A., 2007. Difference of growth-inhibitory effect of *Scutellaria baicalensis*-producing flavonoid wogonin among human cancer cells and normal diploid cell. Cancer Letters 245, 269–274.

Hu, B.H., Liu, Y.L., Zhang, T., 1990. Study on the structure of sculeamoenin from *Scutellaria amoena* C. H. Wright. Acta Pharmaceutica Sinica 25, 302–306.

Hu, B.H., Liu, Y.L., 1989. Study on the structure of the new flavonoids from *Scutellaria amoena* C.H. Wright. Acta Pharmaceutica Sinica 24, 200–206.

Huen, M.S.Y., Justin, Leung, J.W.C., et al., 2003. 5,7-Dihydroxy-6-methoxyflavone, a benzodiazepine site ligand isolated from *Scutellaria baicalensis* Georgi, with selective antagonistic properties. Biochemical Pharmacology 66, 125–132.

Hui, K.M., Huen, M.S.Y., Wang, H.Y., Zheng, H., Sigel, E., Baur, R., Ren, H., Li, Z.W., Wong, J.T.F., Xue, H., 2002. Anxiolytic effect of wogonin, a benzodiazepine receptor ligand isolated from *Scutellaria baicalensis* Georgi. Biochemical Pharmacology 64, 1415–1424.

Hussain, H., Ahmad, V.U., Anwar, S., Miana, G.A., Krohn, K., 2008. Chemical constituents of *Scutellaria linearis*. Biochemical Systematics and Ecology 36, 490–492.

Ishimaru, K., Nishikawa, K., Omoto, T., Asai, I., Yoshihira, K., Shimomura, K., 1995. Two flavone 2′-glucosides from *Scutellaria baicalensis*. Phytochemistry 40, 279–281.

Jiangsu New Medical College, 1977. Dictionary of Chinese Materia Medical. Science and Technology Press of Shanghai, ShangHai (in Chinese).

Johan, G., de Boer, Quiney, B., Walter, P.B., Thomas, C., et al., 2005. Protection against aflatoxin-B_1-induced liver mutagenesis by *Scutellaria baicalensis*. Mutation Research 578, 15–22.

Katsuya, F., Takane, F., Hitoshi, S., Akio, O., 1987. Essential Oil of *Scutellaria baicalensis* G. Agricultural Biology and Chemistry 51, 1449.

Kikuchi, Y., Miyaichi, Y., Yamagnchi, Y., Kizu, H., Tomimori, T., 1991a. Studies on the nepalese crude druges XIV. On the phenolic compounds from the root of scutellaria prostrata JACQ. ex BENTH. Chemical & Pharmaceutical Bulletin 39, 1047–1050.

Kikuchi, Y., Miyaichi, Y., Tomimori, T., 1991b. Studies on the nepalese crude druges. XIII On the flavonoid and iridoid constituents of the root of *Scutellaria grossa* WALL. Chemical & Pharmaceutical Bulletin 39, 1051–1054.

Kikuchi, Y., Miyaichi, Y., Yamagnchi, Y., Kizu, H., Tomimori, T., Vetschera, K., 1991c. Studies on the constituents of scutellaria speciesXIV On the constituents of the roots and the leaves of *Scutellaria alpina* L. Chemical & Pharmaceutical Bulletin 39, 199–201.

Kikuchi, Y., Miyaichi, Y., Tomimori, T., 1991d. Studies on the nepalese crude drugs. XIV new flavonoids from the root of *Scutellaria prostrata* JACQ. ex BENTH. Chemical & Pharmaceutical Bulletin 39, 1466–1472.

Kim, D.H., Jeon, S.J., Son, K.H., Jung, J.W., Lee, S., Yoon, B.H., Lee, J.J., Cho, Y.W., Cheong, J.H., Ko, K.H., Ryu, J.H., 2007. The ameliorating effect of oroxylin A on scopolamine-induced memory impairment in mice. Neurobiology of Learning and Memory 87, 536–546.

Kim, Y.O., Leem, K., Park, J., Lee, P., Ahn, D.K., Lee, B.C., Park, H.K., Suk, K., Kim, S.Y., Kim, H., 2001. Cytoprotective effect of *Scutellaria baicalensis* in CA1 hippocampal neurons of rats after global cerebral ischemia. Journal of Ethnopharmacology 77, 183–188.

Kim, D.H., Kim, H.K., Park, S., Kim, J.Y., Zou, Y., Cho, K.H., Kim, Y.S., Kim, D.H., Yu, B.P., Choi, J.S., Chung, H.Y., 2006. Short-term feeding of baicalin inhibits age-associated NF-κB activation. Mechanisms of Ageing and Development 127, 719–725.

Kizu, H., Imonto, Y., Tomimori, T., et al., 1987. Structure of Scuterivulactone D determined by two dimensional NMR spectroscopy A new diterpenoid from a Chinese crude drug “Ban Zhi Lian”. Chemical & Pharmaceutical Bulletin 35, 1656–1659.

Krakauer, T., Li, B.Q., Yong, H.A., et al., 2001. The flavonoid baicalin in inhibits suerantigen induced inflammatory cytokines and chemokines. FEBS Letters 500, 52–55.

Kumagai, T., M¨uller, C.I., Desmond, J.C., Imai, Y., Heber, D., Koeffler, H.P., 2007. *Scutellaria baicalensis*, a herbal medicine: anti-proliferative and apoptotic activity against acute lymphocytic leukemia, lymphoma and myeloma cell lines. Leukemia Research 31, 523–530.

Lam, T.L., Lam, M.L., Au, T.K., Ip, D.T.M., Ng, T.B., Fon, W.P., Wan, D.C.C., 2000. A comparison of human immunodeficiency virus type-1protease inhibition activities by the aqueous and methanol extracts of Chinese medicinal herbs. Life Sciences 67, 2889–2896.

Lawrence, B.M., Hogg, J.W., Terhune, S.J., Morton, J.K., Gill, L.S., 1972. Terpenoid composition of some Canadian Labiatae. Phytochemistry 11, 2636–2638.

Lee, H.H., Yang, L.L., Wang, C.C., Hu, S.Y., Chang, S.F., Lee, Y.H., 2003. Differential effects of natural polyphenols on neuronal survival in primary cultured central neurons against glutamate-and glucose deprivation-induced neuronal death. Brain Research 986, 103–113.

Lee, T.K., Lee, Y.J., Kim, D.I., Kim, H.M., Chang, Y.C., Kim, C.H., 2006. Pharmacological activity in growth inhibition and apoptosis of cultured human leiomyomal cells of tropical plant *Scutellaria barbata* D Don (Lamiaceae). Environmental Toxicology and Pharmacology 21, 70–79.

Lee, S.W., Song, G.S., Kwon, C.H., Kim, Y.K., 2005. Beneficial effect of flavonoid baicalein in cisplatin-induced cell death of human glioma cells. Neuroscience Letters 382, 71–75.

Li, B.Q., Fu, T., Gong, W.H., Dunlop, N., Kung, H.F., Yan, Y.D., Kang, J., Wang, J.M., 2000a. The flavonoid baicalin exhibits anti-inflammatory activity by binding to chemokines. Immunopharmacology 49, 295–306.

Li, B.Q., Fu, T., Yao, D.Y., Mikovits, J.A., Ruscetti, F.W., Wang, J.M., 2000b. Flavonoid baicalin inhibits HIV-1 infection at the level of viral entry. Biochemical and Biophysical Research Communications 276, 534–538.

Li, Y.L., Ooi, L.S.M., Wang, H., But, P.P.H., Ooi, V.E.C., 2004. Antiviral activities of medicinal herbs traditionally used in southern mainland China. Phytotherapy Research 18, 718–722.

Li, Z.P., Wei, H.Q., 1994. Chemical compounds of the genus *Scutellaria* World. Phytomedicines 9, 47.

Liang, Y.Z., Xie, P.S., Chan, K., 2004. Quality control of herbal medicines. Journal of Chromatography B 812, 53–70.

Lim, B.O., Yu, B.P., Kim, S.C., Park, D.K., 1999. The antioxidative effect of Ganhuangenin against lipid peroxidation. Phytotherapy Research 13, 479–483.

Lim, B.O., 2003. Effects of wogonin, wogonoside, and 3,5,7,2′,6′-pentahydroxyflavone on chemical mediator production in peritoneal exduate cells and immunoglobulin E of rat mesenteric lymph node lymphocytes. Journal of Ethnopharmacology 84, 23–29.

Lin, C.C., Shieh, D.E., 1996. In Vivo Hepatoprotective effect of baicalein, baicalin and wogonin from *Scutellaria rivularis*. Phytotherapy Research 10, 651–654.

Lin, C.C., Shieh, D.E., Yen, M.H., 1997. Hepatoprotective effect of the fraction of Ban-zhi-lian on experimental liver injuries in rats. Journal of Ethnopharmacology 56, 193–200.

Lin, Y.L., 1987a. Scutellones A, A new diterpene from *S.rivularis*. Journal of Chemical Research 10, 320–321.

Lin, Y.L., 1987b. Aurantiamide from aerial parts of *Scutellaria rivularis*. Planta Medica 53, 507.

Lin, Y.L., 1988a. Structures of scutellones D and F determined from X-ray diffraction, spectral and chemical evidence Neoclerodane-type diterpenoids from *S. rivularis* Wall. Chemical & Pharmaceutical Bulletin 36, 2642–2646.

Lin, Y.L., 1988b. Scutellones C and F, two new neoclerodane-type diterpenoids from *S. rivularis* Wall. Chemical & Pharmaceutical Bulletin 27, 779–783.

Lin, Y.L., 1989. Four new neoclerodane-type diterpenoids, scutellones B, G, H, I, from aerial parts of *S. rivularis* Wall. Chemical & Pharmaceutical Bulletin 37, 582–585.

Liu, I.X., Durhan, D.G., Richards, R.M., 2000. Baicalin synergy with beta-lactam antibiotics against methicillin-resistant staphylococcus aureus and other beta-lactam resistant strains of *S. aureus*. Journal of Pharmacy and Pharmacology 52, 361–366.

Liu, Y.B., 2005. Study on the extraction technology and chemical compounds of *Scutellaria barbata*, Master thesis. Capital Normal University (in Chinese).

Liu, Y.L., Li, N.W., Song, W.Z., 1980. Study on the flavonoids of *Scutellaria amoena* C.H. Wright. Chinese Traditional and Herbal Drugs 11, 337–340 (in Chinese).

Liu, M.L., Li, M.L., Wang, F.H., 1984. Study on the flavonoids of *Scutellaria tenax* W.W. Smith. Acta Pharmaceutica Sinica 19, 545.

Liu, M.L., Li, M.L., Liang, X.T., 1986. Study on the flavonoids of *Scutellaria viscidula* Bunge. Chinese Traditional and Herbal Drugs 17, 438 (in Chinese).

Ma, S.C., Du, J., But, P.P.H., Deng, X.L., Zhang, Y.W., Ooi, V.E.C., Xu, H.X., Lee, S.H.S., Lee, S.F., 2002. Antiviral Chinese medicinal herbs against respiratory syncytial virus. Journal of Ethnopharmacology 79, 205–211.

Makino, T., Hishida, A., Goda, Y., Mizukami, H., 2008. Comparison of the major flavonoid content of *S. baicalensis*, *S. lateriflora* and their commercial products. Journal of Nature Medicine 62, 294–299.

Malakov, P.Y., Papanov, G.Y., 1996. A Clerodane diterpenoids from *Scutellaria altissim*. Phytochemistry 41, 855.

Malakov, P.Y., Papanov, G.Y., 1997a. 11-Episcutecyprin. A neo-clerodane diterpenoid from *Scutellaria columna*. Phytochemistry 46, 955–958.

Malakov, P.Y., Papanov, G.Y., 1997b. A Neo-Clerodane diterpenoids from *Scutellaria orientalis* subsp. *Pinnatifid*. Phytochemistry 46, 587–589.

Malakov, P.Y., Papanov, G.Y., 1997c. Scutorientalin D A neo-clerodane diterpenoids from *Scutellaria orientalis* subsp. *Pinnatifida*. Phytochemistry 44, 121–124.

Malakov, P.Y., Papanov, G.Y., 1998a. 11-Episcutecolumnin C A neo-Clerodane diterpenoids from *Scutellaria columnae*. Phytochemistry 49, 811–815.

Malakov, P.Y., Papanov, G.Y., 1998b. Neo-Clerodane diterpenoids from *Scutellaria alpin*. Phytochemistry 49, 2449–2452.

MarÍa, C., De La Torre, RodrÍguez, B., Bruno, M., Piozzi, F., Savona, G., Vassallo, N., Servettaz, O., 1995. *Neo*-Clerodane diterpenoids from *Scutellaria alpina*. Phytochemistry 38, 185–187.

Min, L.W., 2009. New therapeutic aspects of flavones: the anticancer properties of Scutellaria and its main active constituents Wogonin Baicalein and Baicalin. Cancer Treatment Reviews 35, 57–68.

Ministry of Health and Welfare of Japan, 1996. The Japanese Pharmacopoeia, 13th ed. (English Version), Tokyo.

Ministry of Health and Welfare of Korea, 1998. Pharmacopoeia of the Republic of Korea, 7th ed. Seoul, Taechan yakjon.

Miyaichi, Y., Imoto, Y., Tomimori, T., et al., 1987. Studies on the constituents of *Scutellaria* species (IX). Chemical & Pharmaceutical Bulletin 35, 3720.

Miyaichi, Y., Imoto, Y., Tomimori, T., Namba, T., 1988. Studies on the Nepalese crude druges. IX On the flavonoid constituents of the root of *Scutellaria scandens*. Buch. HAM. ex. D. Don. Chemical & Pharmaceutical Bulletin 36, 2371–2376.

Miyaichi, Y., Kizu, H., Tomimori, T., Lin, C.C., 1989. Studies on the constituents of Scutellaria species on the flavonoid constituents of the aerial parts of *Scutellaria indica* L. Chemical & Pharmaceutical Bulletin 39, 794–797.

Miyaichi, Y., Tomimori, T., 1994. Studies on the constituents of scutellaria species XVI Phenol glycosides of the root of *scutellaria baicaleinsis* Georgi. Journal of Nature Medicine 48, 215.

Miyaichi, Y., Tomimori, T., 1995. Studies on the constituents of scutellaria species XVII Phenol glycosides of the root of *Scutellaria baicaleinsis* Georgi. Journal of Nature Medicine 49, 350.

Miyaichi, Y., Morimoto, T., Yaguchi, K., Kizu, H., 2006. Studies on the constituents of *Scutellaria* species (XXI): constituents of the leaves of *Scutellaria strigillosa* Hemsley. Journal of Nature Medicine 60, 157–158.

MuÑoz, D.M., Torre, M.C.D., RodrÍeuez, B., Simmonds, M.S.J., Blaney, W.M., 1997. Neo-Clerodane insect antifeedants from *Scutellaria alpina* subsp. *javalambrensis*. Phytochemistry 44, 593–597.

Nagai, T., Moriguchi, R., Suzuki, Y., Tomimori, T., Yamada, H., 1995. Mode of action of the anti-influenza virus activity of plant flavonoid, 5,7,4′-trihydroxy-8-methoxyflavone, from the roots of *Scutellaria baicalensis*. Antiviral Research 26, 11–25.

Park, B.K., Heo, M.Y., Park, H., Kim, H.P., 2001. Inhibition of TPA-induced cyclooxygenase-2 expression and skin inflammation in mice by wogonin, a plant flavone from *Scutellaria radix*. European Journal of Pharmacology 425, 153–157.

Park, H.G., Yoon, S.Y., Choi, J.Y., Lee, G.S., Choi, J.H., Shin, C.Y., Son, K.H., Lee, Y.S., Kim, W.K., Ryu, J.H., Ko, K.H., Cheong, J.H., 2007. Anticonvulsant effect of wogonin isolated from *Scutellaria baicalensis*. European Journal of Pharmacology 574, 112–119.

Pharmacopoeia Commission, Ministry of Pubic Health, 2000. Pharmacopoeia of the People's Republic of China. Part 1, Beijing (in Chinese).

Qian, B., 1987. Clinical-Effects of Anticanter Chinese Medicine. Shanghai Translation Publishing House.

RodrÍguez, B., Maria, C., De La Torre, Gomez-Serranillos, P., 1996. Neo-Clerodane diterpenoids from *Scutellaria galericulat*. Phytochemistry 41, 247.

Rosselli, S., Bruno, M., Simmonds, M.S.J., Senatore, F., Rigano, D., Formisano, C., 2007. Volatile constituents of *Scutellaria rubicunda Hornem* subsp. *linnaeana* (Caruel) Rech (Lamiaceae) endemic in Sicily. Biochemical Systematics and Ecology 35, 797–800.

Schinella, G.R., Tournier, H.A., Prieto, J.M., Mordujovich de Buschiazzo, P., Ríos, J.L., 2002. Antioxidant activity of anti-inflammatory plant extracts. Life Sciences 70, 1023–1033.

Shang, Y.Z., Cheng, J.J., Qi, J.M., Miao, H., 2005. Scutellaria flavonoid reduced memory dysfunction and neuronal injury caused by permanent global ischemia in rats. Pharmacology, Biochemistry and Behavior 82, 67–73.

Shao, Z.H., Li, C.Q., Hoek, T.L.V., Becker, L.B., Schumacker, P.T., Wu, J.A., Attele, A.S., Yuan, C.S., 1999. Extract from *Scutellaria baicalensis* Georgi attenuates oxidant stress in cardiomyocytes. Journal of Molecular and Cellular Cardiology 31, 1885–1895.

Shoemaker, M., Hamilton, B., Dairkee, S.H., Cohen, I., Campbell, M.J., 2005. *In vitro* anticancer activity of twelve Chinese medicinal herbs. Phytotherapy Research 19, 649–651.

Skaltsa, H.D., Lazari, D.M., Mavromati, A.S., Tiligada, E.A., Constantinidis, T.A., 2000. Composition and antimicrobial activity of the essential oil of *Scutellaria albida* L. ssp. albida from Greece. Planta Medica 66, 672–674.

Skaltsa, H.H., Lazari, D.M., Kyriazopoulos, P., Golegou, S., Triantaphyllidis, S., Sokovic, M., Kypriotakis, Z., 2005. Journal of Essential Oil Research 17, 232.

Son, D., Lee, P., Lee, J., Kim, H., Kim, S.Y., 2004. Neuroprotective effect of wogonin in hippocampal slice culture exposed to oxygen and glucose deprivation. European Journal of Pharmacology 493, 99–102.

Song, S.H., Wang, Z.Z., Zhang, Y., Hu, X.G., 2006. Study on HPLC Fingerprint of *Scutellaria baicalensis*. Zhongguo Yaoxue Zazhi 41, 413–417 (in Chinese).

Sonoda, M., Nishiyama, T., Matsukawa, Y., Moriyasu, M., 2004. Cytotoxic activities of flavonoids from two *Scutellaria* plants in Chinese medicine. Journal of Ethnopharmacology 91, 65–68.

State Food Drug Administration of China, 2000. Technical Requirements for the Development of Fingerprints of TCM Injections, SFDA, Beijing (in Chinese).

Su, Y.L., Huang, L., Chen, Z.Y., 2004. Isolation and elucidation of antioxidant constituents from acetone extract in root of *Scutellaria rehderiana*. China Joutnal of Chinese Material Medicine 29, 863 (in Chinese).

Suh, S.J., Yoon, J.W., Lee, T.K., Jin, U.H., Kim, S.L., Kim, M.S., Kwon, D.Y., Lee, Y., Kim, C.H., 2007. Chemoprevention of *Scutellaria bardata* on human cancer cells and tumorigenesis in skin cancer. Phytotherapy Research 21, 135.

Takagi, S., Yamuki, M., Inoue, K., 1980. Studies on the water-soluble constituents of the roots of *Scutellaria baicalensis* Georgi (wogon). Yakugaku Zasshi 100, 1220.

Takagi, S., Yamaki, M., Inoue, K., 1981. Flavone Di-C-glycosides from *Scutellaria baicalensis*. Phytochemistry 20, 2443.

Tan, Y., Lv, Z.P., Bai, X.C., Liu, X.Y., Zhang, X.F., 2006. Traditional Chinese medicine Bao Gan Ning increase phosphorylationnof CREB in liver fibrosis in vivo and in vitro. Journal of Ethnopharmacology 105, 69–75.

Tomimori, T., Miyaichi, Y., Kizu, H., 1981. One the flavonoid constituents from the roots of *Scutellaria baicalensis* Georgi. Yakugaku Zasshi 101, 899.

Tomimori, T., Miyaichi, Y., Kizu, H., 1982. On the flavonoid constituents from the roots of *Scutellaria baicalensis* Georgi. Yakugaku Zasshi 102, 388–391.

Tomimori, T., Miyaichi, Y., Imoto, Y., et al., 1983. Studies on the constituents of *Scutellaria* species II. On the flavonoid constituents of the roots of *Scutellaria baicalensis* Georgi (2). Yakugaku Zasshi 103, 607–611.

Tomimori, T., Miyaichi, Y., Imoto, Y., et al., 1984a. Studies on the constituents of Scutellaria species IV on the flavonoid constituents of the root of *Scutellaria baicalensis* Georgi. Yakugaku Zasshi 104, 529.

Tomimori, T., Imoto, Y., 1984b. Studies on the constituents of *S. species* V. on the flavonoid constituents of "Ban Zhi Lian", the whole herb of *Scutellaria rivularis* Wall. Yakugaku Zasshi 38, 252–254.

Tomimori, T., Miyaichi, Y., Imoto, Y., Kizu, H., Namba, T., 1985. Studies on the Nepalese crude drugs. V. On the flavonoid constituents of the root of *Scutellaria discolor* Colebr (1). Chemical & Pharmaceutical Bulletin 33, 4457–4463.

Tomimori, T., Miyaichi, Y., Imoto, Y., Kizu, H., Namba, T., 1986. Studies on the Nepalese crude drugs. VI. On the flavonoid constituents of the root of *Scutellaria discolor* Colebr (2). Chemical & Pharmaceutical Bulletin 34, 406.

Tomimori, T., Imoto, Y., Ishida, M., Kizu, H., Namba, T., 1988. Studies on Nepalese crude drugs (VIII). On the flavonoid constituents of the seed of *Oroxylum indicum* Vent. Shoyakugaku Zasshi 42, 98–101.

Wang, H.H., Liao, J.F., Chen, C.F., 2000. Anticonvulsant effect of water extract of *Scutellariae radix* in mice. Journal of Ethnopharmacology 73, 185–190.

Wang, H.W., Lin, C.P., Chiu, J.H., Chow, K.C., Kuo, K.T., Lin, C.S., Wang, L.S., 2007. Reversal of inflammation-associated dihydrodiol dehydrogenases (AKR1C1 and AKR1C2) overexpression and drug resistance in nonsmall cell lung cancer cells by wogonin and chrysin. Internation Journal of Cancer 120, 2019–2027.

Wang, H.Y., Xiao, L.H., Liu, L., 2003. Study on the chemical constitutes of the roots of *Scutellaria viscidula* Bunge. Journal of Shenyang Pharmaceutical University 20, 399 (in Chinese).

Wang, S.S., Zheng, Z.G., Weng, Y.Q., Yu, Y.J., Zhang, D.F., Fan, W.H., Dai, R.H., Hu, Z.B., 2004. Angiogenesis and anti-angiogenesis activity of Chinese medicinal herbal extracts. Life Sciences 74, 2467–2478.

Wang, Y.Q., Keiichi, M., Kunio, T., Toru, O., Shoji, S., 1988. Studies of the constitutents of Scutellaria I: the flavonoid glucuronides of "BO YE HUANG CHIN". Chemical & Pharmaceutical Bulletin 36, 3206.

Wang, Z.Q., 1981. Studies on the chemical compounds of *Scutellaria Bartata* D.Don. Chinese Traditional and Herbal Drugs 12, 19 (in Chinese).

Wang, Z.Q., Li, Y.W., 1996. Scutebarbatine A, a new neoclerodane-type diterpenoid alkaloid from *S.barbata*. Chinese Chemical Letters 7, 333–334 (in Chinese).

Willis, J.C., 1966. A Dictionary of the Flowering Plants and Ferns, 7th ed. Cambridge University Press, UK.

Woo, K.J., Lim, J.H., Suh, S.I., Kwon, Y.K., Shin, S.W., Kim, S.C., Choi, Y.H., Park, J.W., Kwon, T.K., 2006. Differential inhibitory effects of baicalein and baicalin on LPS-induced cyclooxygenase-2 expression through inhibition of C/EBP β DNA-binding activity. Immunobiology 211, 359–368.

World Health Organization, 1991. Guidelines for the Assessment of HerbalMedicines, WHO, Munich, Geneva.

Woz′niak, D., Lamer-Zarawska, E., Matkowski, A., 2004. Antimutagenic and anti-radical properties of flavones from the roots of *Scutellaria baicalensis* Georgi. Nahrung/Food 48, 9–12.

Wu, J.A., Attele, A.S., Zhang, L., et al., 2001. Anti-HIV activity of medicinal herbs: Usage and potential development. American Journal of Chinese Medicine 29, 69–81.

Xiang, R.D., Zheng, J.F., Yao, Z.C., 1982. Study on the chemical consituents of *Scutellaria Bartata* D.Don. Chinese Traditional and Herbal Drugs 13, 345 (in Chinese).

Xiao, L.H., Wang, H.Y., Song, S.J., Zhang, G.P., Song, H.X., Xu, S.X., 2003. Isolation and identification of the chemical constituents of roots of *Scutellaria amoena* C. H.Wrigh. Journal of Shenyang Pharmaceutical University 20, 181–183 (in Chinese).

Xu, Y.M., Guo, L.W., Chen, J.W., 1992. Seperation and purification polysaccharides from *Scutellaria Bartata* D.Don. Nature Product Research and Development 4, 1–5 (in Chinese).

Yaghmai, M.S., 1988. Volatile constituents of *Scutellaria lateriflora* L. Flavour and Fragrance Journal 3, 27.

Yang, L.X., Liu, D., Feng, X.F., Cui, S.L., Yang, J.Y., Tang, X.J., He, X.R., Liu, J.F., 2002. Detrmination of flavone for *Scutellaria baicalensis* from different areas by HPLC. China Journal of Chinese Materia Medica 27, 166–170 (in Chinese).

Yang, Z.C., Wang, B.C., Yang, X.S., Wang, Q., Ran, L., 2005. The synergistic activity of antibiotics combined with eight traditional Chinese medicines against two different strains of *Staphylococcus aureus*. Colloids and Surfaces B: Biointerfaces 41, 79–81.

Yin, X.L., Zhou, J.B., Jie, C.F., Xing, D.M., Zhang, Y., 2004. Anticancer activity and mechanism of *Scutellaria barbata* extract on human lung cancer cell line A549. Life Sciences 75, 2233.

Yu, L.R., Liu, M.L., Wang, X.T., 1984. Study the flavoniods of *Scutellaria viscidula* Bunge 19, 397–398.

Yu, J., Lei, J., Yu, H., Cai, X., Zou, G., 2004. Chemical composition and antimicrobial activity of the essential oil of *Scutellaria barbata*. Phytochemistry 65, 881.

Yu, J.Q., Liu, H.B., Lei, J.C., Tan, W.J., Hu, X.M., Zou, G.L., 2007. Antitumor activity of chloroform fraction of *Scutellaria barbata* and its active constituents. Phytotherapy Research 21, 817–822.

Zeng, G.F., Chen, Z.L., 1957. Studies on the flavonoids of the Chinese traditional medicine V: the chemical compounds of the genus *Scutellaria*. Yao Xue Xue Bao 1, 47 (in Chinese).

Zhang, C.Z., Zhang, Y.F., Chen, J.P., Liang, X.M., 2005. Purification and characterization of baicalin-β-D-glucuronidase hydrolyzing baicalin to baicalein from fresh roots of *Scutellaria viscidula* Bge. Process Biochemistry 40, 1911–1915.

Zhang, Y.Y., Don, H.Y., Guo, Y.Z., Ageta, H., Harigaya, Y., Onda, M., Hashimoto, K., Ikeya, Y., Okada, M., Maruno, M., 1998. Comparative study of *Scutellaria Planipes* and *Scutellaria Baicalensis*. Biomedical Chromatography 12, 31–33.

Zhang, Y.Y., Wang, X.Y., Wang, X.R., Xu, Z.H., Liu, Z., Ni, Q., Chu, X.P., Qiu, M.F., Zhao, A.H., Jia, W., 2006. Protective effect of flavonoids from *Scutellaria baicalensis* Georgi on cerebral ischemia injury. Journal of Ethnopharmacology 108, 355–360.

Zhang, Z.Z., Lian, X.Y., Li, S.Y., Stringer, J.L., 2009. Characterization of chemical ingredients and anticonvulsant activity of American skullcap (*Scutellaria lateriflora*). Phytomedicine 16, 485–493.

Zhou, Z.H., 1997. New flavonoids glycosides from *Scutellaria amoena*. In: Yang, C.R. (Ed.), Advances in Plant Glycosides Chemistry, Biology. Elsevier, Netherlands, pp. 305–310.

Zhou, Y., Hirotani, M., Yoshikawa, T., Furuya, T., 1997. Flavonoids and phenylethanoids from hairy root cultures of *Scutellaria baicalensi*. Phytochemistry 44, 83–87.

Zhou, Z.H., Yang, C.R., 2000. Five new flavonoid glycosides from *Scutellaria amoena*. Acta Botanica Yunnanica 22, 475–481 (in Chinese).

Zhu, P.Y., Liu, G.Q., 1993. Isolation and identification of the diterpenoid and flavone in *Scutellaria barbata* D.Don. Journal of Plant Resources and Environment 2, 63–64.