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PHENOLIC COMPOUNDS OF PLANTS OF THE *Scutellaria* L. GENUS. DISTRIBUTION, STRUCTURE, AND PROPERTIES

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Information on flavones, flavanones, flavanonols, flavonols, chalcones, isoflavones, biflavonoids, lignoflavonoids, and lignane glycosides and stilbenes isolated from plants of the Scutellaria *L. genus was systematized and reviewed. A list of 208 phenolic compounds was given according to flavonoid type with an indication of the plant sources, structures, and physicochemical properties and citations of the original articles.*

Key words: *Scutellaria* (Lamiaceae), flavones, flavanones, flavanonols, flavonols, chalcones, isoflavones, biflavonoids, lignoflavonoids, lignane glycosides and stilbenes (formula, physicochemical constants, spectral data).

Plants of the *Scutellaria* L. (Lamiaceae) genus are widely distributed over the world and are represented by 360 species. The territory of the CIS contains 148 species; the flora of Uzbekistan, 32 species of skullcap [1-3]. Many *Scutellaria* species are economically significant and have been thoroughly studied. Essential oils, organic alcohols (derivatives of phenylethanol) and acids (esters and glycosides of vanillic, coumaric, syringic, and ferulic acids), iridoid sesquiterpenes, clerodane diterpenoids, steroids, cardenolides, coumarins, tanning agents, and flavonoids have been isolated from these plants [4, 5].

Flavonoids are the most widely distributed and common of the aforementioned classes of natural compounds [6, 7]. This can be seen using plants of the *Scutellaria* genus as examples. Many species of this genus and the phenolic compounds isolated from them are widely used in folk and conventional medicine. Flavonoids possessing P-vitamin, inhibitory, cytotoxic, antimetastatic, antibacterial, and other activities have been isolated from plants of this genus [5].

Tibetan medicine includes 42 known recipes that include *S. baicalensis* in addition to other plants [8]. Japanese researchers showed special interest in plants of this genus and demonstrated the relationship of many biological properties to the presence of several flavonoids in them [9]. Therefore, the high physiological activity of flavonoids indicates that they are important to the vitality of both plants and animals.

The phenolic compounds of *Scutellaria* plants include phenylpropanoid glycosides, chalcones, flavones, flavanones, isoflavones, biflavones, and lignoflavones. These compounds are known to contain reactive phenolic hydroxyls and carbonyls. These groups of compounds are certainly interrelated and undergo mutual transformations [6]. Owing to this and the ability to transform into chalcones and to form quinones, flavonoids are considered to be highly physiologically active compounds with a wide spectrum of pharmacological activity.

Therefore, phenolic compounds from *Scutellaria* plants are constantly at the center of attention of many researchers. A huge volume of literature has been accumulated worldwide on the isolation, identification, structure determination, and biological activity of flavonoids from various skullcap species. Therefore, the collection into one place of the dispersed information on phenolic compounds from *Scutellaria* plants is of definite scientific interest.

Another equally important consideration is that flavonoids are the most numerous group of natural phenolic compounds. The number of natural flavonoids of established structure that have been described in the literature is increasing at a rapid pace and at present is apparently approaching 6000 [7, 10]. Information on these compounds is scattered over many monographs and reviews [11] and is difficult to reference. The structure of a newly isolated flavonoid can be determined much quicker than it can be identified by analyzing volumes of chemical and spectral data.

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TABLE 1. Studied *Scutellaria* Species and Number of Isolated Phenolic Compounds

Plant	Number of compounds	Plant	Number of compounds
1. *S. adenostegia* Briq.	15	30. *S. orientalis* L.	6
2. *S. adsurgens* M. Pop.	14	31. *S. ovata* Hill.	7
3. *S. alpina* L.	20	32. *S. oxystegia* Juz.	3
4. *S. altaica* Fisch. ex. Sweet	1	33. *S. peregrina* Ldb.	1
5. *S. altissima* L.	11	34. *S. phyllostachya* Juz.	3
6. *S. amoena* C. H. Wright.	16	35. *S. planipes* L.	13
7. *S. araxensis* Grossh.	5	36. *S. polyodon* Juz.	13
8. *S. baicalensis* Georgi.	62	37. *S. prilipkoana* Grossh.	1
9. *S. barbata* D. Don.	1	38. *S. prostrata* Jacq. et Benth.	30
10. *S. columnae* L (All)	2	39. *S. przewalskii* Juz.	18
11. *S. comosa* Juz.	14	40. *S. pycnoclada* Juz.	16
12. *S. creticola* Juz.	14	41. *S. ramosissima* M. Pop.	11
13. *S. discolor* Colebr.	23	42. *S. rehderiana* Diels.	7
14. *S. epilobiifolia* A. Hamilt.	10	43. *S. repens* Buch-Ham, ex D. Don	14
15. *S. galericulata* I.	23	44. *S. rivularis* Wall.	28
16. *S. glabrata* Vved.	7	45. *S. scandens* Buch-Ham. ex D. Don.	16
17. *S. granulosa* Juz.	2	46. *S. scordifolia* Fisch. ex Schrank	14
18. *S. grossa* Wall.	19	47. *S. sedelmeyeria* Juz.	3
19. *S. ikonnikovii* Juz.	7	48. *S. sevanensis* Sosn.	19
20. *S. immaculata* Nevski	8	49. *S. squarrosa* Nevski	6
21. *S. incona* Spreng.	1	50. *S. strigillosa* Hemsl	15
22. *S. indica* L.	33	51. *S. supina* L.	19
23. *S. iskanderi* Juz.	10	52. *S. tenax* W. W. Smith.	5
24. *S. karjaginii* Grossh	3	53. *S. tournefortii* Benth.	4
25. *S. lateriflora* L.	1	54. *S. transiliensis* Juz.	6
26. *S. litwinowii* Bornm. Et. Sint.	10	55. *S. ussuriensis* (Regel) Kubo	2
27. *S. nepetoides* M. Pop.	4	56. *S. virularis* Wall	2
28. *S. ocellata* Juz.	7	57. *S. viscidulla* Bunge	7
29. *S. oreophila* Grossh.	5		

We have attempted to collect information about phenolic compounds from *Scutellaria* plants into a single reference. Thus, the data that we present can serve as a reference for specialists working on the chemistry of flavonoids, their distribution in natural sources, and their physicochemical properties. The composition, melting point, specific rotation, UV-, IR-, and mass-spectra, and ^{1}H and ^{13}C NMR spectra are given for every compound in several groups. The list includes information on unsubstituted flavone, 3-hydroxyflavone (flavonol), and flavanone, the cores of the corresponding groups of compounds, although they are not found in the studied samples. We feel that the data presented for these compounds can be useful for comparative studies of this type of compounds.

Phenolic compounds from 65 skullcap species have been studied (Table 1). Of these, 8 (*S. abider*, *S. karatschaica*, *S. mesostegia*, *S. grindiflora*, *S. oligodonta*, *S. platustegia*, *S. sosnowskyi*, *S. woronowii*) have been studied only preliminarily by observing flavonoids in them [12-14]. A total of 208 substances has been isolated and identified from all plant species. These include: chalcones and stilbenes, 11; flavones, 119; flavanones, 48; flavonols, 6; isoflavones, 4; biflavones, 1; lignoflavones, lignane glycosides, and stilbenes, 19.

In addition to the aforementioned compounds, certain *Scutellaria* species afforded compounds (>10) that are glycosides and esters of derivatives of phenylethanol and coumaric and ferulic acids. The last two, so-called phenylpropanoids, are biogenetic precursors of flavonoids.

The research results showed that Baikal skullcap, from which 62 compounds have been isolated, is apparently the most common and, therefore, the most thoroughly studied in all respects. After it follow *S. indica*, 33; *S. prastrata*, 30; *S. rivularis*, 28; and *S. discolor* and *S. galericulata*, from which 23 flavonoids have been isolated. Only one compound (scutellarein) was

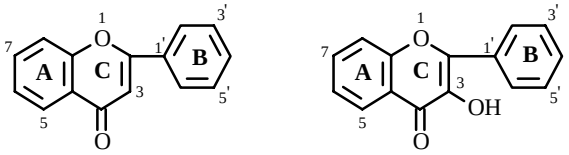
found in six species of plants from this genus.

Therefore, the flavonoid scutellarein is typical of *Scutellaria* plants although it was first isolated in 1890 from *Oroxylum indicum* [15].

METHODS FOR ESTABLISHING FLAVONOID STRUCTURES

As noted above, flavonoids are physiologically active compounds that are widely distributed in plants and possess great scientific and practical interest. The study of flavonoid structures is important for resolving issues connected with chemotaxonomy and the search for new physiologically active compounds.

The isolation, chemical transformations, synthesis, and biological conversions in addition to information about the physiological activity of natural phenolic compounds have been reviewed in monographs and articles [16-23]. Therefore, we considered it advisable to include brief data regarding the use of spectral methods to establish the structures of flavonoids using flavone (I) and flavonol (II) derivatives as examples.



I II

Significant success has been achieved in this area in the last decades owing to the appearance of new effective instrumental research methods. Important questions about the biogenesis and structure of flavonoids have been answered by the wide use of IR-, UV-, mass-, and NMR-spectroscopies.

The information value, quickness of analysis, and ability to obtain spectra practically without destroying the compound and with a minimal amount of sample favorably distinguish physical methods of research from others.

IR-spectroscopy. The carbonyl group of unsubstituted flavone absorbs in the IR spectrum at 1650 cm^{-1}. Introducing a hydroxyl group on C-3 lowers the C=O stretching vibration to 1619 cm^{-1} whereas placing it on C-5 raises the frequency to 1655 cm^{-1}. The double-bond stretching vibration appears as several strong bands at 1600-1470 cm^{-1}.

The skeletal vibrations of the benzene rings of flavonoids include two main absorption bands at 1600 and 1500 cm^{-1}. An additional one or two bands appear at 1580-1550 cm^{-1}. These bands in flavones are shifted to lower frequencies. The band at 1580 cm^{-1} almost disappears for flavones with an intramolecular H-bond between C=O and the C-5 hydroxyl [6, 20, 24].

Phenolic hydroxyls absorb at 3500-3600 cm^{-1}. Hydroxyl groups in phenolic glycosides are most commonly involved in intermolecular and intramolecular H-bonds. Therefore, they appear at lower frequencies. Several bands typical of the sugar component are found at 840-890 and 1000-1100 cm^{-1}.

UV-spectroscopy. UV spectra of many flavonoids contain two absorption maxima, one of which is located at 240-285 nm (band II), the other of which appears at 300-400 nm (band I) [6, 16-18].

The long-wavelength band in the spectra of flavones and flavonols is situated at 304-350 and 352-385 nm, respectively. Thus, the type of flavonoid can be determined from the position of this band.

Flavonoids with a higher degree of oxidation absorb at longer wavelengths compared with less oxidized flavonoids:

3,5,7-trihydroxyflavone	359 λ_{max}, nm
3,5,7,4′-tetrahydroxyflavone	367 λ_{max}, nm
3,5,7,3′,4′-pentahydroxyflavone	370 λ_{max}, nm
3,5,7,3′,4′,5′-hexahydroxyflavone	374 λ_{max}, nm

The spectra of 3′,4′-dihydroxyflavones contain in the region of band II two maxima or a main peak and a shoulder whereas those of 4′-hydroxyflavones have only one maximum.

The position of the main maximum of band II is greatly influenced by the degree of oxidation of ring A. This can be seen from the following data:

Flavone	250 λ_{max}, nm
7-hydroxyflavone	252 λ_{max}, nm
5,7-dihydroxyflavone	268 λ_{max}, nm
5,6,7-trihydroxyflavone	274 λ_{max}, nm
5,7,8-trihydroxyflavone	281 λ_{max}, nm

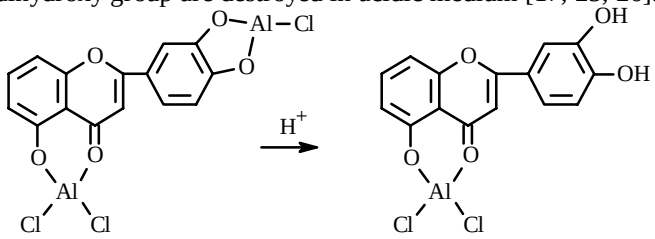
Methylation or glycosylation of hydroxyl groups at the 3-, 5-, and 4′-positions of the flavone core causes a hypsochromic shift of the bands [25]. The magnitude of this shift is 3-10 nm (band I) for substitution of the 4′-OH, 5-15 nm (bands I and II) for substitution of the 5-OH, and 12-17 nm for substitution of the 3-OH. Substitution of OH groups in other positions does not significantly affect the UV spectrum.

Various reagents that affect the chromophore system of flavonoids are commonly used to determine the position of the hydroxyl groups [25-27]. Sodium methoxide or ethoxide ionize flavonoid hydroxyl groups.

The presence of a free C-4′ hydroxyl on flavones and flavonols causes a bathochromic shift of band I by 40-65 nm without decreasing the intensity. A C-3 hydroxyl on flavonols without a C-4′ hydroxyl also causes a bathochromic shift of band I by 50-60 nm but with a decrease of intensity. Flavonols containing hydroxyls in the 3′- and 4′-positions are oxidized by sodium methoxide and give spectra in which the absorption maxima decrease in intensity with time.

Flavones and flavonols containing a C-7 hydroxyl experience a bathochromic shift of band II by 5-20 nm. The presence of groups sensitive to base (5,6,7-, 5,7,8-, and 3,3′,4′-trihydroxy groups) cause the absorption maxima to disappear over time.

A mixture of sodium acetate and boric acid enables an *ortho*-dihydroxy group to be determined in all positions of the flavone core except C-5,6. Flavones and flavonols containing this group in ring B show a bathochromic shift by 12-30 nm. Flavones and flavonols containing C-3 or C-5 hydroxyls form complexes with aluminum chloride that are stable to acid. Complexes formed by an *ortho*-dihydroxy group are destroyed in acidic medium [17, 25, 26].



The bathochromic shift of band I in 5-hydroxyflavones caused by adding $AlCl_3$+HCl is 35-55 nm. A shift of only 17-20 nm indicates the presence of hydroxyl or methoxyl on C-6 [28]. Flavonols and $AlCl_3$+HCl cause a bathochromic shift of band I by 50-60 nm. Using $ZrOCl_2$ and citric acid instead of $AlCl_3$ can determine the presence of a 3-hydroxy group in the presence of a 5-hydroxy group [27]. Reaction with $AlCl_3$ causes a bathochromic shift of 30-40 nm if the phenyl substituent contains a dihydroxy group.

A study of the spectra of several flavonoids containing a prenyl group on C-6 found that the UV spectra do not experience a bathochromic shift with $AlCl_3$ even if there is a free OH on C-5 [28]. This was explained by steric factors, i.e., hindrance to complex formation owing to the presence of a bulky substituent in the position *ortho* to the hydroxyl group [29].

^{1}H and ^{13}C NMR Spectroscopy. PMR spectroscopy (^{1}H NMR) was widely used in structural studies of several flavonoids [6, 25, 30]. Many natural flavonoids are insoluble in deuterochloroform and carbon tetrachloride. Therefore, spectra are often recorded in deuterated dimethylsulfoxide and deuteropyridine.

Flavonoids can be made much more soluble by preparing various derivatives such as trimethylsylyl esters, acetates, methyl esters, etc. The signals in PMR spectra of flavonoids are located at 0-9 ppm.

Signals of Ring A Protons. The signals of C-6 and C-8 protons in spectra of 5,7-dihydroxy flavones and flavonols appear at 5.7-6.9 ppm as doublets with a spin—spin coupling constant (SSCC) of 2.5 Hz. The H-6 signal usually resonates at stronger field than that of H-8. Glycosylation of the 7-OH shifts both signals to weak field.

Certain natural flavonoids do not contain a 5-OH. The spectra of these compounds contain at weak field (about 8 ppm) a doublet from H-5 with SSCC 8.5-9.0 Hz owing to deshielding by the C-4 carbonyl. In this instance the H-6 (quartet, J = 9 Hz, J_2 = 2.5 Hz) and H-8 (doublet, J = 2.5 Hz) signals usually appear at weaker field compared with the 5,7-dihydroxyflavonoid.

Signals of Ring B Protons. The C-2′, 3′, 5′, and 6′ protons in 4′-hydroxyflavones appear as two 2H doublets with

SSCC 8.5 Hz at 6.5-7.9 ppm. The H-3′,5′ doublet is usually located at stronger field than that of H-2′,6′. The H-2′,6′ chemical shift depends on the degree of oxidation of ring C and is δ 7.7-7.9 ppm in spectra of flavones and 7.9-8.1 ppm in spectra of flavonols.

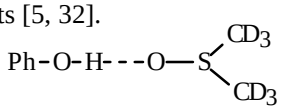
The signal for the C-5′ proton in spectra of 3′,4′-dihydroxyflavonoids resonates as a doublet at 6.7-7.1 ppm (J = 8.5 Hz). Protons on C-2′ (doublet, J = 2.5 Hz) and C-6′ (quartet, J_1 = 8.5 Hz, J_2 = 2.5 Hz) give signals at 7.2-7.9 ppm.

Methylation or glycosylation of one of these hydroxyls changes the spectrum because of redistribution of electron density on ring B.

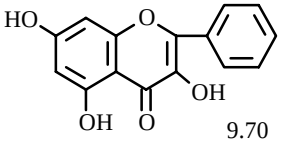
The signal of H-3 in spectra of flavones usually appears as a 1H singlet at 6.3 ppm. However, many flavonoids contain a single proton in ring A (5,6,7- or 5,7,8-trisubstituted) that resonates in the same region as H-3. In such situations it is difficult to make an unambiguous assignment of the H-3, H-6, and H-8 signals. Comparison of the spectra of fully and partially (with the C-5 hydroxyl unsubstituted) trimethylsilylated (TMS) flavonoids can distinguish these signals [31].

The H-3 signal in the spectrum of the partial TMS ester shifts to weak field by 0.15 ppm compared with the full TMS ester whereas the H-8 signal undergoes a diamagnetic shift of the same magnitude. The position of the H-6 signal is unchanged.

Deuterated DMSO is often used as the solvent to record spectra of flavonoids. Protons of hydroxyl groups in DMSO-d_6 form H-bonds to the solvent and appear as singlets [5, 32].



The chemical shifts of phenolic hydroxyls in the spectrum of 3,5,7-trihydroxyflavone recorded in DMSO-d_6 have the following values (δ, ppm):



9.70

12.40

Unfortunately, DMSO has several drawbacks as a solvent. These include its hygroscopicity, high boiling point, reaction with certain flavonoids, etc. [25].

The anomeric proton (H-1″) in PMR spectra of monoglycosides appears at weaker field than other protons of the carbohydrate moiety. The chemical shift of this proton provides some information about the site of glycosylation and the nature of the sugar. For example, the H-1″ signal in the spectra of flavonol-3-O-glucosides appears at 5.7-6.0 ppm and differs significantly from that in the corresponding 5,7- and 4′-O-glucosides of flavonoids, which usually resonates at 4.8-5.2 ppm.

Furthermore, the chemical shift of H-1″ in flavonol 3-O-glucosides differs from that in 3-O-rhamnosides, the anomeric proton of which resonates at 5.0-5.1 ppm [6, 25].

The H-1″—H-2″ SSCC in flavonoid β-glycosides is 7 Hz and is due to diaxial coupling [33]. The H-1″—H-2″ diequatorial coupling in natural α-rhamnosides is only 2-2.5 Hz [34]. The presence of rhamnose in flavonoids is easily demonstrated by the characteristic signals of the methyl group, which resonates at 0.8-1.2 ppm as a 3H doublet with SSCC 6.0-6.5 Hz or as a multiplet [25]. The anomeric proton in flavonoid biosides is observed at much stronger field. It was also found that the chemical shift of this proton depends on the site of attachment of the terminal sugar. Thus, the anomeric proton of L-rhamnose in rutinosides [-O-α-L-rhamnopyranosyl-(1→6)-O-β-D-glucopyranosides] resonates at 4.2-4.4 ppm whereas it is found at 4.9-5.0 ppm for neohesperidosides [-O-α-L-rhamnopyranosyl-(1→2)-O-β-D-glucopyranosides]. The aforementioned glycosides can also be distinguished by the chemical shifts of the protons, which are 0.7-1.0 and 1.1-1.3 ppm, respectively [35].

The sequence of binding of the sugars can in certain instances also be determined by studying the PMR spectra of the permethylates and peracetates of flavonoid biosides.

Signals of flavonoid methoxy protons appear at 3.5-4.1 ppm. The effect of solvents on the position of PMR signals of methoxyflavonoids was studied on going from chloroform to benzene [36].

It was found that the shift [$\Delta\delta = \delta(CDCl_3) - \delta(C_6H_6)$] depends on the location of the methoxy group in the flavone core. The largest shift is found for CH_3O groups occupying the C-5, C-7, and C-4′ positions. The presence of hydroxy and methoxy groups in the position *ortho* to the observed CH_3O group decreases the shift [6, 25].

A study of the ^{13}C NMR spectrum of flavone was published in 1974 [37]. The review contains spectra of several flavonoids [38]. Comparison of spectra recorded with partial and full ^{13}C—^{1}H decoupling, measurement of the SSCC, and the study of model compounds greatly facilitate the interpretation of the ^{13}C NMR spectra. The location of various substituents on

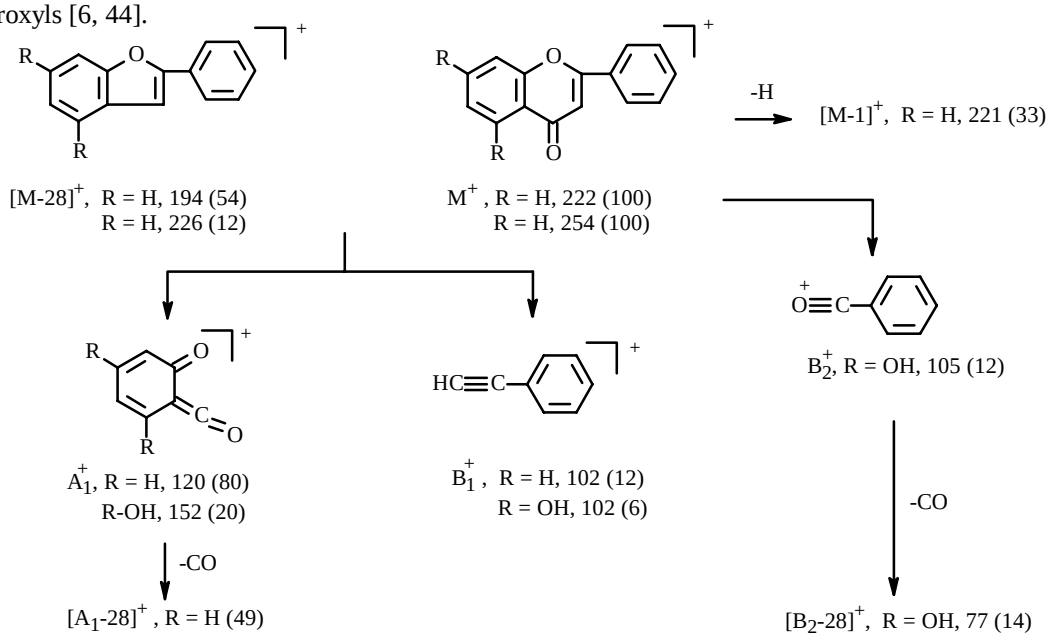
the flavonoid core [39], the location and sequence of sugar binding in glycosides, and the determination of the position of acyl groups in acylated flavonoids [38, 40] can be found using this method. The chemical shifts of C atoms in certain flavonoids are given below.

Mass Spectroscopy. Electron-impact mass spectrometry is an informative method [6, 41] for studying flavonoids and glycosides.

Mass spectrometry can produce valuble structural data and determine the molecular weight of flavonoids. Many flavonoids give a base or sufficiently strong peak for the molecular ion.

Electron impact fragments them to form $[M - H]^+$, $[M - CH_3]^+$ (for methoxyflavones), $[M - CO]^+$, and other ions. Ions formed by retrodiene decomposition of the flavone core are very interesting for structural investigations [6, 42-44].

Unsubstituted flavone gives peaks for $[M - H]^+$, $[M - CO]^+$, $[A_1]^+$, $[A_1 - CO]^+$, and $[B_1]^+$ in addition to a peak for the molecular ion (Scheme 1). Substitution in rings A and B increases correspondingly the values of $[A_1]^+$ and $[B_1]^+$. The intensity of peaks from ions formed by retrodiene decomposition is insignificant in the spectra of flavones containing four and more phenolic hydroxyls [6, 44].

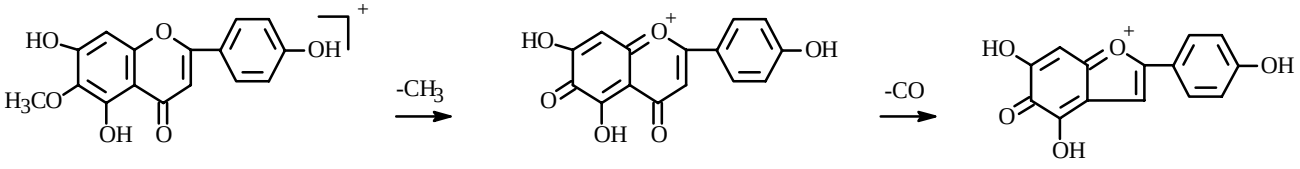


Scheme 1.

The first fragmentation of 6- or 8-methoxyflavones involves loss of $-CH_3$ radical to form a strong peak for the $[M - CH_3]^+$ ion, which in turn converts to $[M - 43]^+$ by losing CO [6, 19, 22, 41, 45].

Spectra of 2′-hydroxyflavones contain a rather strong peak for the $[M - 17]^+$ ion [22].

In exceptional instances, the peak for the molecular ion in mass spectra of flavonols is the base peak. Furthermore, peaks of the fragment ions $[M - H]^+$, $[M - CH_3]^+$, and $[M - CH_3 - CO]^+$ and very weak peaks of the corresponding fragments $[A_1]^+$, $[A_1 + H]^+$, and $[B_2]^+$ are present. The main fragmentation pattern of flavonols containing 6-OR or 8-OR groups is a process leading to the $[M - R]^+$ ion [19, 45]. In contrast with flavones, not all 6- or 8-methoxyflavonols give a peak for the $[M - 15]^+$ ion, although the spectra of these compounds contain a strong peak for the $[M - CH_3 - CO]^+$ ion, i.e., $[M - 43]^+$ (Scheme 2).

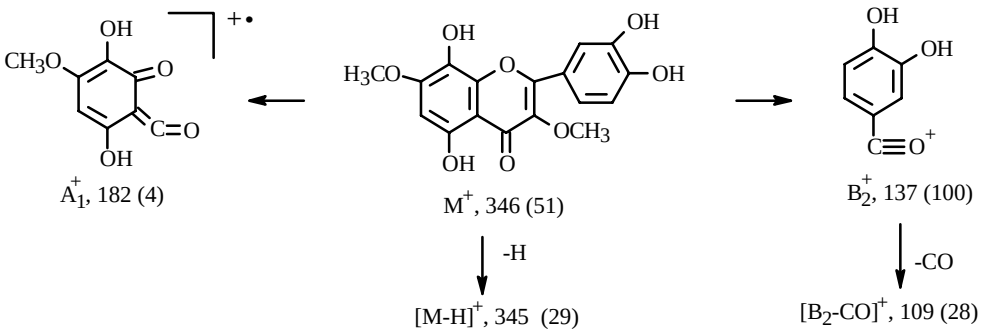


Scheme 2.

TABLE 2. Mass Spectra of Flavones

Flavones	Substituents					M		M-1		M-15		M-18	
	5	6	7	8	4′	*m/z*	%	*m/z*	%	*m/z*	%	*m/z*	%
Oroxylin A	OH	OMe	OH			284	100	283	5	269	53	266	27
Wogonin	OH		OH	OMe		284	73			269	100		
Pectolinarigenin	OH	OMe	OH		OMe	314	100	313	6	299	52	296	31
5,7-Dihydroxy-8-methoxyflavone	OH		OH	OMe		314	73			299	100		

The typical fragmentation of flavonols is shown using 3,7-dimethoxy-5,8-3′,4′-tetrahydroxyflavone as an example:



Comparison of the mass spectra of a series of 3-, 6-, and 8-methoxylated flavones and flavonols found that the relative intensities of the $[M]^+$, $[M - 1]^+$, and $[M - 15]^+$ peaks and the presence or absence of a peak for the $[M - 18]^+$ ion can differentiate 6-methoxylated from 8-methoxylated compounds (Table 2) [46].

It can be seen that the base peak in the spectra of 6-methoxyflavones is the $[M]^+$ ion. Peaks are also present for the $[M - 1]^+$ and $[M - 18]^+$ ions. The base peak for 8-methoxyflavones is the $[M - 15]^+$ ion. Peaks for the $[M - 1]^+$ and $[M - 18]^+$ ions are absent.

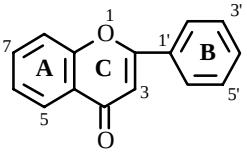
Mass spectra of TMS esters and acetates of flavonoid glycosides also provide valuable information about the structure of the sugar part [47-49].

FLAVONES

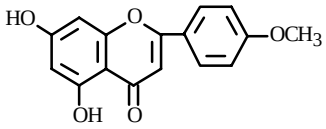
Flavones are the principal phenolic compounds in *Scutellaria* plants (119 compounds isolated) according to quantitative content and distribution in nature. Their molecules contain a conjugated chromophore and are yellow in color. Their fluorescent properties depend on the pH of the medium, the solution concentration, and the nature of the substituents [50]. They are also represented among natural food and textile dyes. Flavone itself has been found in certain *Primula* and *Dionysia* species [51]. Monosubstituted flavones (5-OH, 6-OCH_3, 7-OCH_3, 2′-OH-flavones) were isolated from plants of the *Daphnopsis*, *Primula*, *Pinus*, and *Oroxylum* genera [51, 52].

The disubstituted flavone derivatives chrysin (found in 27 species), wogonin (27), and oroxylin (19); the trisubstituted derivatives baicalin (34) and apigenin (19); and the tetrasubstituted derivatives scutellarein (26) and luteolin (16) are characteristic and most widely distributed among *Scutellaria* plants.

The variety of flavones is due to the nature, quantity, and mutual location of substituents.



It can be concluded based on the literature data that baicalin, wogonin, oroxylin, scutellarein, chrysin, and their glucuronides are compounds typical of *Scutellaria* plants. The C-methyl and C-prenyl derivatives have not yet been observed in plants of this genus.

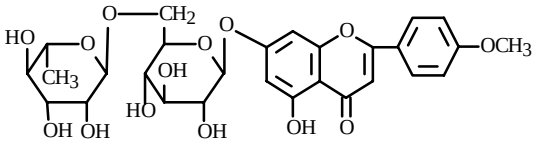


Acacetin (5,7-dihydroxy-4′-methoxyflavone)

Scutellaria polyodon [53], *S. sevanensis* [54]
$C_{16}H_{12}O_5$: 284
mp: 261-263°C

$[\alpha]_D^{20}$ -64.5°
UV: 271, 328; +NaOMe, 278, 368; +NaOAc, 280, 300, 342; +CH_3COONa/H_3BO_3, 272, 340; +$AlCl_3$, 278, 350; +$AlCl_3$/HCl, 278, 345
IR: 3170(OH), 2940 (OCH_3), 1660 (C=O γ pyrone)
PMR (Py-d_5): 3.70 (s, OCH_3), 6.64 (d, J = 2.5, H-8), 6.72 (d, J = 2.5, H-6), 6.84 (s, H-3), 7.02 (d, J = 9, H-3′,5′), 7.92 (d, J = 9, H-2′,6′)
^{13}C NMR (DMSO-d_6) [54]:

C-2	164.6	C-8	92.9	C-4′	161.8
3	103.4	9	161.8	5′	116.3
4	182.3	10	105.0	6′	128.8
5	157.7	1′	121.6	OCH_3	55.5
6	98.2	2′	128.8		
7	165.6	3′	116.3		

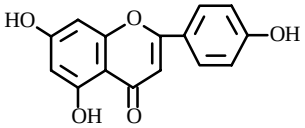


Acacetin 7-O-rutinoside (linarin)

S. polyodon [55]
$C_{28}H_{32}O_{14}$: 592
mp: 267-269°C

$[\alpha]_D^{20}$ -120° (*c* 0.65, formamide)
UV: 270, 330; +CH_3ONa, 282, 372; +CH_3COONa, 278, 342; +CH_3COONa/H_3BO_3, 270, 330; +$AlCl_3$/HCl, 315, 345
PMR (TMS ester): 3.40-3.90 (10H, glucose and rhamnose), 4.36 (s, H-1‴, rhamnose), 5.00 (d, J = 7, H-1″, glucose), 6.24 (d, J = 2.5, H-8), 6.56 (d, J = 2.5, H-6), 6.45 (s, H-3), 6.74 (d, J = 9, H-3′,5′), 7.74 (d, J = 9, H-2′,6′)
^{13}C NMR (DMSO-d_6) [38]:

C-2	163.2	C-7	164.4	C-2′	128.1
3	104.3	8	95.1	3′	113.0
4	182.4	9	161.6	4′	162.9
5	157.4	10	105.8	5′	115.0
6	100.8	1′	123.1	6′	128.8



Apigenin (5,7,4′-trihydroxyflavone)

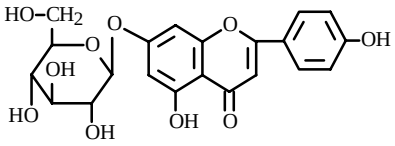
S. adenostegia [56, 57], *S. adsurgens* [58, 59], *S. alpina* [60], *S. comosa* [61], *S. creticola* [62], *S. discolor* [63], S. galericulata [64-66], *S. indica* [67], *S. iskanderi* [68], *S. karjaginii* [69], *S. ocellata* [185], *S. orietalis* [69], *S. ovata* [70], *S. polyodon* [53], *S. przewalskii* [71], *S. pycnocloda* [57], *S. rivularis* [72, 73], *S. scordiifolia* [74], *S. sevanensis* [54], *S. supina* [57]

$C_{15}H_{10}O_5$: 270
mp: 346-347°C

UV: 270, 340; +CH_3COONa, 275, 385; $ZrOCl_2$, 305, 395; +NaOH, 395
PMR (Py-d_5): 6.62 (d, J = 2.0, H-6), 6.71 (d, J = 2.0, H-8), 6.80 (s, H-3), 7.09 (d, J = 9.0, H-3′,5′), 7.84 (d, J = 9, H-2′,6′), 13.68 (br.s, 5-OH)
Mass: $[M]^+$ 270, 242, 213, 153, 152, 123, 111, 96, 89, 69

^{13}C NMR (DMSO-d_6—D_2O, 2:1) [38, 40]:

C-2	164.1	C-7	164.9	C-2′	129.8
3	104.3	8	95.6	3′	117.3
4	183.2	9	158.7	4′	161.8
5	162.0	10	105.1	5′	117.3
6	100.3	1′	122.7	6′	129.8



Apigenin 7-O-glucoside (cosmosiin)

S. adenostegia [57], *S. adsurgens* [59], *S. creticola* [62], *S. galericulata* [66], *S. immaculata* [186], *S. przewalskii* [71]

$C_{21}H_{20}O_{10}$: 432

mp: 203-205°C

$[\alpha]_D^{20}$ -52.8° (*c* 0.91, DMF)

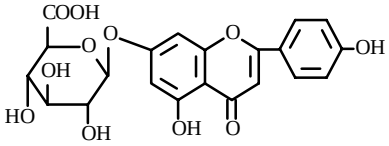
UV: 269, 338; +CH_3COONa, 268, 338, 400; +$AlCl_3$, 279, 301, 343; +CH_3ONa, 268, 398 [71]

IR: 3320 (OH), 1660 (C=O), 1595, 1500, (C_6H_5), 1460, 1420, 1078, 1058, 1035, 1000, 910, 750, 680

PMR (Py-d_5): 4.12 (6H, m, H-2″—H-6″, glucose), 5.73 (1H, d, J = 8.0, H-1″, glucose), 6.65 (1H, d, J = 2.5, H-6), 6.80 (1H, s, H-3), 6.98 (1H, d, J = 2.5, H-8), 7.13 (2H, d, J = 8.0, H-3′,5′), 7.80 (2H, d, J = 8.0, H-2′,6′)

^{13}C NMR (DMSO-d_6—D_2O, 2:1) [38, 40]:

C-2	163.3	C-7	164.6	C-2′	128.8
3	103.3	8	95.1	3′	116.3
4	182.3	9	161.9	4′	161.3
5	152.2	10	105.6	5′	116.3
6	99.7	1′	121.1	6′	128.8



Apigenin 7-O-glucuronide

S. adenostegia [57], *S. adsurgens* [59], *S. alpina* [60], *S. galericulata* [64, 65], *S. indica* [67], *S. iskanderi* [68], *S. nepetoides* [185], *S. polydon* [53], *S. przewalskii* [71], *S. pycnoclada* [57], *S. scordiifolia* [74], *S. supina* [57]

$C_{21}H_{18}O_{11}$: 446

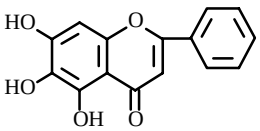
mp: 173-176°C

$[\alpha]_D$ -115.0°

UV: 270, 335; +$ZrOCl_2$, 295, 390

IR: 3400 (OH), 1730 (COOH), 1650 (C=O γ-pyrone), 1600, 1580 (C=C aromatic)

PMR (Py-d_5): 4.00-4.65 (m, H-2″,3″,4″), 4.83 (d, J = 8.5, H-5″), 5.87 (d, J = 6.5, H-1″), 6.70 (d, J = 2, H-6), 6.76 (s, H-3), 6.95 (d, J = 2, H-8), 7.15-7.32 (m, H-3′,5′), 7.50-7.72 (m, H-2′,6′) [185]

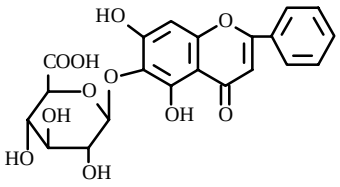


Baicalin (5,6,7-trihydroxyflavone)

S. adenostegia [56, 57], *S. adsurgens* [59], *S. alpina* [60], *S. altissima* [75, 76], *S. amoena* [77], *S. araxensis* [78], *S. baicalensis* [79-87], *S. comosa* [88], *S. creticola* [62], *S. epilobiifolia* [89], *S. galericulata* [64-66, 90], *S. grossa* [91], *S. iskanderi* [68], *S. litwinowii* [76], *S. oreophila* [92], *S. phyllostachya* [93], *S. polyodon* [53, 94], *S. prostrata* [95], *S. pycnoclada* [57], *S. rehderiana* [96], *S. rivularis* [73], *S. scandens* [97], *S. scordifolia* [74], *S. sevanensis* [54], *S. squarrosa* [98], *S. strigillosa* [188], *S. supina* [57], *S. tenax* [99], *S. viscidula* [100]

$C_{15}H_{10}O_5$: 270
mp: 260-262°C
UV: 275, 325; +CH_3COONa, 260, 375; +$ZrOCl_2$, 290, 360; +NaOH, 255, 370; +CH_3COONa/H_3BO_3, 260, 365
IR: 3540-3220 (OH), 1660 (C=O γ-pyrone)
Mass: $[M]^+$ 270, 254, 242, 225, 213, 196, 179, 168, 155, 153, 141, 129, 128, 122, 115, 111, 105, 98, 97, 95, 93, 89, 77, 75, 67, 63
PMR (Py-d_5): 6.65 (1H, s, H-3), 7.49 (1H, s, H-8), 7.55 (3H, m, H-3′,4′,5′), 7.85 (2H, m, H-2′,6′)
^{13}C NMR (DMSO-d_6): [73]

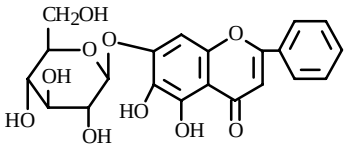
C-2	162.9	C-7	153.6	C-2′	126.2
3	104.4	8	94.1	3′	129.0
4	182.1	9	149.8	4′	131.7
5	147.0	10	104.3	5′	129.0
6	129.3	1′	130.9	6′	126.2



Baicalein 6-O-*β*-D-glucuronide

S. baicalensis [101], *S. grossa* [91]
$C_{21}H_{18}O_{11}$: 446
mp: 197°C (dec.) (CH_3OH)
$[\alpha]_D^{31}$ -55° (*c* 0.11, CH_3OH)
UV: 245 sh (4.03), 272 (4.42), 309 (4.16); +$AlCl_3$, 250 sh (4.01), 284 (4.40), 333 (4.24)
IR: 3400 (OH), 1734 (COOH), 1658 (C=O γ-pyrone), 1624, 1588 (C=C aromatic)
EI-MS *m/z* (%): 270 ($C_{15}H_{10}O_5$; 100)
FAB-MS *m/z* (%): 447 $[M + 1]^+$ (10)
PMR (DMSO-d_6): 3.26-3.64 (m, sugar protons), 4.94 (1H, d, J = 7.7, anomeric proton of glucuronic acid H-1″), 6.64 (1H, s, H-8), 6.97 (1H, s, H-3), 7.58 (3H, m, H-3′,4′,5′), 8.07 (2H, dd, J = 1.3 and 8.2, H-2′,6′), 10.62 (1H, s, 7-OH), 13.05 (1H, s, 5-OH)
^{13}C NMR (DMSO-d_6) [91]:

C-2	163.2	C-9	153.1	C-6′	126.4
3	104.7	10	104.1	1″	103.7
4	182.3	1′	130.7	2″	73.5
5	152.6	2′	126.4	3″	75.3
6	128.1	3′	129.1	4″	71.3
7	157.8	4′	132.0	5″	75.6
8	94.5	5′	129.1	6″	170.1

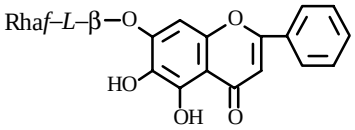


Baicalein 7-O-*β*-D-glucopyranoside

S. baicalensis [101, 102, 183], *S. glabrata* [103], *S. immaculata* [186]
$C_{21}H_{20}O_{10}$: 432
mp: 206-207°C (dec.)
UV: 279, 314; +$AlCl_3$, 290, 341
IR: 3385 (OH), 1660 (C=O γ-pyrone), 1622, 1584 (C=C aromatic)
PMR (DMSO-d_6): 5.23 (1H, d, J = 7.5, anomeric glucose proton), 6.97 (1H, s, H-3), 7.07 (1H, s, H-8), 7.58 (3H, m, H-3′,4′,5′), 8.02 (2H, m, H-2′,6′), 12.75 (1H, s, 5-OH) [101, 102]

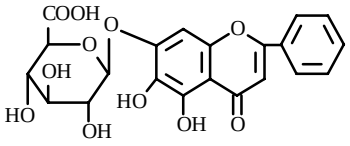
^{13}C NMR (DMSO-d_6) [183]:

C-2	163.7	C-9	149.4	C-6′	126.5
3	104.8	10	106.2	1″	101.1
4	182.8	1′	130.8	2″	73.2
5	146.7	2′	126.5	3″	75.9
6	131.0	3′	129.3	4″	69.8
7	151.8	4′	132.2	5″	77.4
8	94.3	5′	129.3	6″	60.7



Baicalein 7-O-*β*-L-rhamnofuranoside (galeroside)

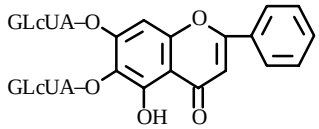
S. galericulata [64, 66, 90]
$C_{21}H_{20}O_9$: 416
mp: 189-190°C
$[\alpha]_D$ -56° (*c* 0.1, ethanol)
UV: 280, 315; +CH_3COONa, 280, 315; +CH_3COONa/H_3BO_3, 280, 315; +C_2H_5ONa, 270, 350; +$ZrOCl_2$, 295, 350
IR: 3380 (OH), 1662 (C=O γ-pyrone), 1620, 1580, 1518 (C=C aromatic)
$[M]_D^{KE}$ = -133° compared with the phenyl rhamnosides ($[M]_D$ of the phenyl-*β*-L-rhamnofuranoside, -90°) and difference spectrum (two absorption bands at 1010-1100 cm^{-1})



Baicalin (baicalein-7-O-glucuronide)

S. adenostegia [57], *S. adsurgens* [59], *S. alpina* [60], *S. altissima* [75, 104, 105], *S. amoena* [77], *S. araxensis* [78], *S. baicalensis* [79-82, 84-87, 101, 102, 106], *S. columnae* [107], *S. comosa* [88], *S. creticola* [62], *S. galericulata* [64-66, 90], *S. grossa* [91], *S. ikonnikovii* [108], *S. iskanderi* [68], *S. litwinowii* [76], *S. ocellata* [185], *S. oreophila* [92], *S. polyodon* [53, 94], *S. prostrata* [95], *S. przewalskii* [109], *S. prycnoclada* [57], *S. rivularis* [110], *S. scandens* [97], *S. scordifolia* [74], *S. squarrosa* [98], *S. strigillosa* [188], *S. supina* [57]
$C_{21}H_{18}O_{11}$: 446
mp: 220-222°C
UV: 245 (3.96), 277 (4.41), 313 (4.15); +CH_3COONa (no shifts observed); +$AlCl_3$, 289 (4.35), 340 (4.23)
IR: 3390 (OH), 1729 (COOH), 1662 (C=O γ-pyrone), 1612 (C=C aromatic)
FAB-MS: *m/z* 447 $[M + H]^+$
PMR (DMSO-d_6): 5.24 (1H, d, J = 7.1, anomeric proton of glucuronic acid H-1″), 6.98 (1H, s, H-3), 7.09 (1H, s, H-8), 7.6 (3H, m, H-3′,4′,5′), 8.0 (2H, m, H-2′,6′), 12.70 (1H, s, 5-OH)
^{13}C NMR (DMSO-d_6) [108]:

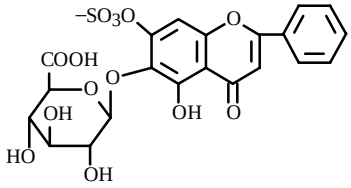
C-2	163.9	C-9	149.3	C-6′	126.1
3	104.1	10	106.0	1″	99.8
4	182.4	1′	130.3	2″	72.7
5	146.5	2′	126.1	3″	75.3
6	130.1	3′	129.1	4″	71.4
7	150.9	4′	132.1	5″	75.1
8	93.7	5′	129.1	6″	170.7



Baicalein 6,7-di-O-β-glucuranopyranoside

S. baicalensis [101]
$C_{27}H_{26}O_{17}$: 622
mp: >300°C
$[\alpha]_D^{22}$ -96.1° (*c* 0.5, H_2O)
UV: 244 sh (3.93), 273 (4.38), 306 (4.10); +CH_3COONa (no shifts observed), +$AlCl_3$, 280 (5.34), 327 (4.08)
IR: 3431 (OH), 1749 (COOH), 1658 (C=O γ-pyrone), 1625 (C=C aromatic)
FAB-MS *m/z* 623 $[M + H]^+$, 447 [MH - glucuronic acid]$^+$
PMR (DMSO-d_6): 5.00 (1H, d, J = 7.5, C6, H-1″), 5.29 (1H, d, J = 7.6, C7, H-1‴), 7.06 (1H, s, H-3), 7.12 (1H, s, H-8), 7.6 (3H, m, H-3′,4′,5′), 8.0 (2H, m, H-2′,6′), 12.89 (1H, s, 5-OH)
^{13}**C NMR** (DMSO-d_6):

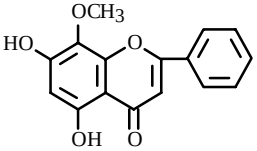
C-2	163.8	C-1′	130.5	C-4″	71.3
3	105.1	2′	126.4	5″	75.2
4	182.5	3′	129.1	6″	169.9
5	152.9	4′	132.1	(C-7)-1‴	100.5
6	129.1	5′	129.1	2‴	73.8
7	155.6	6′	126.4	3‴	75.8
8	94.8	(C-6)-1″	103.3	4‴	71.3
9	152.6	2″	72.9	5‴	75.5
10	106.3	3″	75.6	6‴	169.8



Baicalein 6-O-β-glucoronopyranosyl-7-O-sulfate

S. baicalensis [101]
$C_{21}H_{17}O_{14}S$: 525
mp: 191-193°C
UV: 275 (4.37), 3.06 sh (4.07); +CH_3COONa (no shifts observed); +$AlCl_3$, 247 sh (3.88), 287 (4.37), 329 (4.16)
IR: 3449 (OH), 1718 (COOH), 1653 (C=O γ-pyrone), 1621 (C=C aromatic)
FAB-MS *m/z*: 547 $[M + Na - H]^-$, 525 $[M - H]^-$, 445 $[M - SO_3H]^-$
PMR (DMSO-d_6): 5.08 (1H, br. s, H-1″), 7.04 (1H, s, H-3), 7.33 (1H, s, H-8), 7.60 (3H, m, H-3′,4′,5′), 8.0 (2H, m, H-2′,6′)
^{13}**C NMR** (DMSO-d_6):

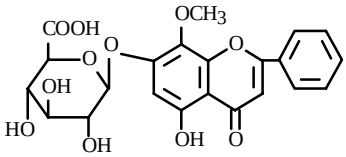
C-2	163.8	C-9	151.8	C-6′	126.5
3	104.8	10	106.4	(C-6)-1″	103.5
4	182.4	1′	130.5	2″	73.6
5	152.3	2′	126.5	3″	76.0
6	129.7	3′	129.1	4″	71.5
7	151.7	4′	132.1	5″	76.0
8	98.9	5′	129.1	6″	171.1



Wogonin (5,7-dihydroxy-8-methoxyflavone)

S. alpina [60], *S. altissima* [75, 104], *S. amoena* [77], *S. baicalensis* [79-84, 103], *S. comosa* [61], *S. discolor* [63, 111], *S. epilobiifolia* [89], *S. galericulata* [63, 65], *S. glabrata* [112], *S. grossa* [91], *S. indica* [113, 114], *S. iskanderi* [68], *S. ocellata* [185], *S. polyodon* [94], *S. prostrata* [95], *S. ramosissima* [115], *S. rehderiana* [96], *S. rivularis* [72, 116, 117], *S. scandens* [97], *S. scorifolia* [74], *S. sevanensis* [54], *S. squarrosa* [98], *S. strigillosa* [188], *S. supina* [57], *S. tenax* [99], *S. viscidula* [100]

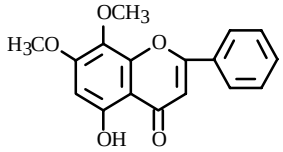
$C_{16}H_{12}O_6$: 284
mp: 202°C
UV: 245, 275, 315; +CH_3COONa, 290, 395; +NaOH, 295, 400; +CH_3COONa/H_3BO_3, 275, 315; +$ZrOCl_2$, 295, 335, 415
IR: 3450 (OH), 2930 (OCH_3), 1660 (C=O γ-pyrone), 1612, 1585 (C=C aromatic)
Mass: 284 $[M]^+$, 269 $[M - CH_3]^+$ (100), 241 $[M - CH_3 - CO]^+$, 167, 139, 105, 102
PMR (Py-d_5): 3.85 (3H, s, OCH_3), 6.70 (1H, s, H-3), 6.90 (1H, s, H-6), 7.41 (3H, m, H-3′,4′,5′), 7.98 (2H, m, H-2′,6′), 13.12 (br.s, 5-OH) [185, 188]



Wogonoside (wogonin-7-O-glucuronide)

S. alpina [60], *S. altissima* [75, 104], *S. amoena* [77], *S. baicalensis* [79, 82, 84, 106], *S. comosa* [61, 88], *S. discolor* [111], *S. galericulata* [64, 65], *S. grossa* [91], *S. immacullata* [186], *S. indica* [113], *S. iskanderi* [68], *S. ocellata* [185], *S. polyodon* [94], *S. prostrata* [95], *S. rivularis* [110], *S. scandens* [97], *S. scorifolia* [74], *S. strigillosa* [188], *S. supina* [57]

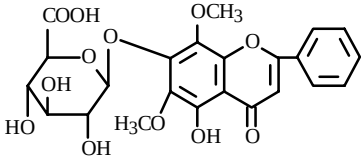
$C_{22}H_{20}O_{11}$: 460
mp: 194-196°C
$[\alpha]_D$ -15° (*c* 1, DMF)
UV: 275, 345; +$ZrOCl_2$, 415; +NaOH, 310 (dec.)
IR: 3454 (OH), 1735 (COOH), 1659 (C=O γ-pyrone), 1614 (C=C aromatic)
PMR (DMSO-d_6): 3.78 (3H, s, 8-OCH_3), 5.32 (1H, d, J = 7, H-1″), 7.06 (1H, s, H-3), 7.12 (1H, s, H-6), 7.60 (3H, m, H-3′,4′,5′), 8.00 (2H, m, H-2′,6′), 12.79 (1H, s, 5-OH)



5-Hydroxy-7,8-dimethoxyflavone (7-O-methylwogonin)

S. baicalensis [83, 84, 184], *S. rivularis* [99, 116]
$C_{17}H_{14}O_5$: 298
mp: 183-184°C (hexane)
UV: 274 (4.52), 315 (3.85), 346 (3.78)
IR: 3450 (OH), 1668 (C=O γ-pyrone), 1592, 1450, 1375, 1122
Mass: 298 $[M]^+$ ($C_{17}H_{14}O_5$)
PMR ($CDCl_3$): 3.95 (6H, s, OCH_3), 6.43 (1H, s, H-6), 6.66 (1H, s, H-3), 7.4-7.7 (3H, m, H-3′,4′,5′), 7.93 (2H, dd, J = 2.2 and 7.4, H-2′,6′), 12.55 (1H, s, 5-OH)
^{13}**C NMR** ($CDCl_3$) [83, 84]:

C-2	163.9	C-8	129.1	C-4′	131.9
3	105.4	9	157.6	5′	129.1
4	182.7	10	105.0	6′	126.4
5	158.7	1′	131.4	OCH_3	56.3
6	95.9	2′	126.4	OCH_3	61.7
7	157.6	3′	129.1		

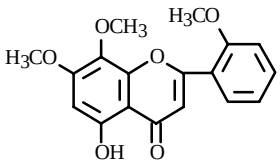


5-Hydroxy-6,8-dimethoxy-7-O-β-D-glucuronidopyranosylflavone

S. repens [187]
$C_{23}H_{22}O_{12}$: 490
mp: 149°C (dec.) (MeOH)
$[\alpha]_D^{27}$ +36.3° (*c* 0.08, MeOH)

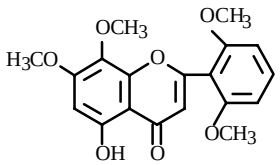
UV: 280 (4.52), 315 sh (4.01), 350 sh (3.66); +CH_3ONa, 280 (4.47), 327 sh (3.65), 395 (3.62); +$AlCl_3$, 300 (4.48), 329 sh (4.16), 416 (3.62); +$AlCl_3$/HCl, 300 (4.52), 329 sh (4.16), 416 (6.63); +CH_3COONa, 279 (4.52), 375 sh (3.50); +CH_3COONa/H_3BO_3, 278 (4.56), 315 sh (4.04), 353 sh (3.75)
IR: 3424 (OH), 1720 (COOH), 1650 (C=O γ-pyrone), 1612 (C=C aromatic)
FAB-MS *m/z* (%): 491 $[M + H]^+$ (29)
PMR (DMSO-d_6): 3.31 (1H, m, H-3″), 3.33 (1H, m, H-2″), 3.38 (1H, t, J = 9.5, H-4″), 3.57 (1H, d, J = 9.5, H-5″), 3.82 (3H, s, 6-OCH_3), 3.94 (3H, s, 8-OCH_3), 5.32 (1H, d, J = 7.3, H-1″), 7.08 (1H, s, H-3), 7.63 (3H, m, H-3′,4′,5′), 8.09 (2H, m, H-2′,6′), 12.60 (1H, s, 5-OH)
^{13}**C NMR** (DMSO-d_6):

C-2	163.7	C-9	145.4	C-6′	126.4
3	105.0	10	107.0	1″	102.6
4	182.8	1′	130.6	2″	73.7
5	148.5	2′	126.4	3″	75.8
6	136.0	3′	129.3	4″	71.5
7	149.0	4′	132.3	5″	75.5
8	132.9	5′	129.3	6″	170.1
				OCH_3	60.4
				OCH_3	61.8



5-Hydroxy-7,8,2′-trimethoxyflavone

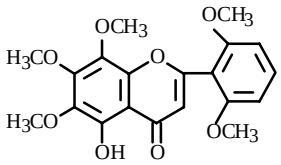
S. baicalensis [118], *S. grossa* [91]
$C_{18}H_{16}O_6$: 328
mp: 190-191°C (ethylacetate)
UV: 273, 330; +$AlCl_3$ or $AlCl_3$/HCl, 283, 296 sh, 342, 410
IR: 1660 (C=O γ-pyrone), 1615 (methoxylated aromatic ring)
Mass: 328 $[M]^+$ (67) $C_{18}H_{16}O_6$; 313 (100) $C_{17}H_{13}O_6$, 285 (10) $C_{16}H_{13}O_5$, 181 (19) $C_8H_5O_5$, 153 (23) $C_7H_5O_4$, 135 (2) $C_8H_7O_2$
PMR ($CDCl_3$): 3.92, 3.95 (3H, 6H, s, 3×OCH_3), 6.43 (1H, s, H-3), 7.05 (1H, s, H-6), and other aromatic protons H-3′, H-4′, H-5′, and H-6′



5-Hydroxy-7,8,2′,6′-tetramethoxyflavone (altisin)

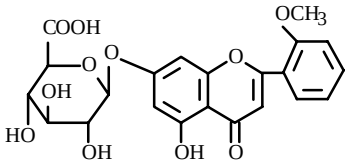
S. altissima [75, 104], *S. grossa* [91]
$C_{19}H_{18}O_7$: 358
mp: 199°C (dec.) (MeOH)
UV: 266 (4.48), 338 (3.84)
IR: 3400 (OH), 1650 (C=O γ-pyrone), 1600, 1580 (C=C aromatic)
EI-MS *m/z* (%): 358 $[M]^+$ (46), 346 $[M - CH_3]^+$ (100)
PMR (DMSO-d_6): 3.70, 3.92 (3H each, s, 2×OCH_3), 3.80 (6H, s, 2′,6′-OCH_3), 6.32 (1H, s, H-3), 6.62 (1H, s, H-6), 6.83 (2H, d, J = 8.3, H-3′,5′), 7.52 (1H, t, J = 8.3, H-4′), 12.63 (1H, s, 5-OH)
^{13}**C NMR** (DMSO-d_6) [91]:

C-2	161.7	C-9	149.9	C-6′	158.3
3	112.2	10	104.1	2′-OCH_3	56.2
4	182.2	1′	110.2	6′-OCH_3	56.2
5	157.0	2′	158.3	7-OCH_3	56.5
6	96.2	3′	104.6	8-OCH_3	61.0
7	158.7	4′	133.1		
8	128.6	5′	104.6		



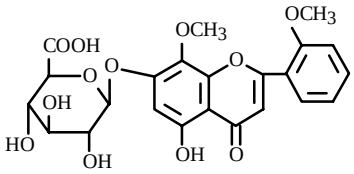
5-Hydroxy-6,7,8,2′,6′-pentamethoxyflavone

S. baicalensis [119]
$C_{20}H_{20}O_8$: 388
UV: 272, 330
IR: 3520 (OH), 2930 (OCH_3), 1660 (C=O γ-pyrone), 1615, 1575 (C=C aromatic)
Mass: 388 $[M]^+$, 373 $[M - OCH_3]^+$ (100)



5-Hydroxy-2′-methoxy-7-O-glucuronylflavone
(2′-methoxychrysin-7-O-glucuronide)

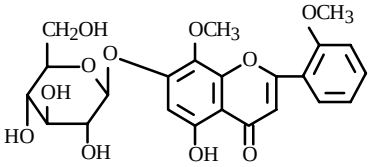
S. granulosa [120], *S. prostrata* [95]
$C_{22}H_{20}O_{11}$: 460
mp: 200-202°C
$[\alpha]_D^{20}$ -75° (ethanol)
UV: 270, 330 sh; +NaOH, 380; +$ZrOCl_2$, 290, 390
IR: 3540 (OH), 1730 (COOH), 1665 (C=O γ-pyrone), 1612, 1572 (C=C aromatic), 1093, 1080, 1018 (C–O glycosides)
PMR (TMS-ester) (CCl_4): 3.3-3.4 (4H, m, sugar protons), 5.0 (1H, d, J = 7, H-1″) [120]



5-Hydroxy-8,2′-dimethoxy-7-O-β-glucuronylflavone

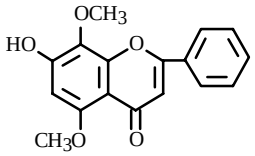
S. indica [113]
$C_{23}H_{22}O_{12}$: 490
mp: 247°C (dec.) (MeOH)
$[\alpha]_D^{14}$ -45.9° (*c* 0.04, MeOH)
UV: 275 (4.41), 333 (4.04); +CH_3ONa, 276 (4.39), 283 sh (4.37), 320 sh (4.33), 380 (3.74); +$AlCl_3$, 255 (3.94), 286 (4.37), 295 sh (4.34), 345 (4.07), 404 (3.84); +$AlCl_3$/HCl, 284 (4.36), 295 sh (4.31), 342 (4.07), 405 (3.78); +CH_3COONa, 275 (4.40), 333 (4.03); +CH_3COONa/H_3BO_3, 275 (4.40), 333 (4.03)
IR: 3500 (OH), 1714 (COOH), 1653 (C=O γ-pyrone), 1607, 1565 (C=C aromatic)
Mass: 314 (100) $C_{17}H_{14}O_6$, 299 (70) $C_{16}H_{11}O_6$
PMR (DMSO-d_6): 3.86, 3.91 (3H, s, each 2×OCH_3), 5.29 (1H, br.s, anomeric proton of glucuronic acid H-1″), 6.90 (1H, s, H-3), 6.70 (1H, s, H-6), 7.15 (1H, br.t, J = 7.6, H-5′), 7.22 (1H, br.d, J = 7.9, H-3′), 7.57 (1H, br.t, J = 7.9, H-4′), 7.86 (1H, dd, J = 7.6 and 12, H-6′), 12.54 (1H, s, 5-OH)
^{13}**C NMR** (DMSO-d_6):

C-2	161.9	C-10	105.4	C-2″	73.1
3	109.8	1′	119.5	3″	75.5
4	182.5	2′	158.1	4″	71.4
5	156.2	3′	112.8	5″	75.9
6	98.7	4′	133.5	6″	170.2
7	156.2	5′	121.1	2″-OCH_3	56.0
8	129.5	6′	129.1	8-OCH_3	61.5
9	149.5	1″	99.9		



5-Hydroxy-8,2′-dimethoxy-7-O-β-glucopyranosylflavone

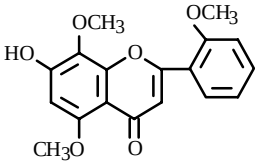
S. rivularis [110]
$C_{23}H_{24}O_{11}$: 476
UV: 275, 335; +CH_3COONa, 276, 335
IR: 3450 (OH), 2930 (OCH_3), 1650 (C=O γ-pyrone), 1610, 1570 (C=C aromatic)



7-Hydroxy-5,8-dimethoxyflavone

S. discolor [121], *S. rivularis* [73]
$C_{17}H_{14}O_5$: 298
mp: 290°C (MeOH)
UV: 244, 281, 345; +CH_3ONa, 243, 283, 370; +$AlCl_3$, 272, 332; +$AlCl_3$/HCl, 265 sh, 273, 332 sh; +CH_3COONa, 281, 360
IR: 3400 (OH), 1630 (C=O γ-pyrone), 1610, 1570 (C=C aromatic)
Mass: 298 $[M]^+$, 283 $[M - CH_3]^+$
PMR (DMSO-d_6): 3.89, 3.81 (3H, s, each 2×OCH_3), 6.52 (1H, s, H-6), 6.79 (1H, s, H-3), 7.61 (3H, m, H-3′,4′,5′), 8.06 (2H, m, H-2′,6′), 10.62 (1H, s, 7-OH)
^{13}**C NMR** (DMSO-d_6) [73]:

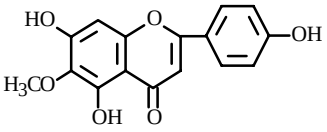
C-2	159.4	C-8	129.0	C-4′	131.5
3	108.0	9	152.0	5′	129.3
4	175.9	10	107.6	6′	125.9
5	155.2	1′	131.3	8-OCH_3	61.0
6	96.9	2′	125.9	2′-OCH_3	55.9
7	155.6	3′	129.3		



7-Hydroxy-5,8,2′-trimethoxyflavone

S. discolor [121]
$C_{18}H_{16}O_6$: 328
mp: 249°C (dec.) (MeOH)
UV: 225 sh (4.35), 270 (4.42), 331 (4.11); +CH_3ONa, 230 sh (4.37), 280 (4.50), 320 (4.02), 370 (4.02); +$AlCl_3$, 225 sh (4.41), 270 (4.47), 331 (4.19); +$AlCl_3$/HCl, 225 sh (4.40), 270 (4.45), 299 sh (4.15), 331 (4.15) (4.16); +CH_3COONa, 279 (4.47), 320 (3.99), 370 (4.00); +H_3BO_3/CH_3COONa, 273 (4.42), 327 (4.06)
IR: 3100 (OH), 1630 (C=O γ-pyrone), 1600, 1580 (C=C aromatic)
PMR (DMSO-d_6): 3.78, 3.82, 3.93 (3H, s, each 3×OCH_3), 10.55 (1H, br.s, 7-OH), 6.66 (1H, s, H-3), 6.48 (1H, s, H-6), 7.86 (1H, dd, J = 7.6 and 1.7, H-6′), 7.48-7.65 (1H, m, H-4′), 7.24 (1H, br.d, J = 7.8, H-3′), 7.08-7.24 (1H, m, H-5′)
^{13}**C NMR** (DMSO-d_6):

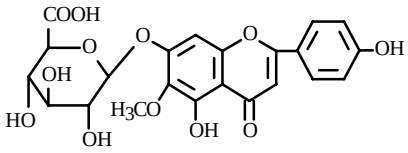
C-2	157.7	C-8	129.0	C-4′	132.6
3	112.7	9	152.1	5′	121.0
4	176.0	10	107.4	6′	128.7
5	155.1	1′	120.0	8-OCH_3	60.9
6	96.8	2′	157.5	5-OCH_3	55.9
7	155.6	3′	112.6	2′-OCH_3	55.9



Hispidulin (5,7,4′-trihydroxy-6-methoxyflavone)

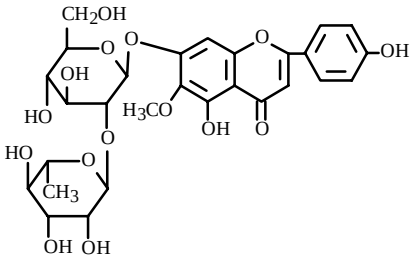
S. alpina [60], *S. amoena* [77], *S. baicalensis* [112], *S. creticola* [62], *S. litwinowii* [76], *S. orientalis* [69], *S. przewalskii* [71], *S. repens* [187], *S. rivularis* [72]
$C_{16}H_{12}O_6$: 300

mp: 288-290°C (EtOH)
UV: 335, 274; +$NaOCH_3$, 394, 326, 276; +$AlCl_3$, 363, 302, 282 sh, 264 sh; +$AlCl_3$/HCl, 356, 300, 284 sh, 262 sh; +CH_3COONa, 389, 329, 306, 274; +CH_3COONa/H_3BO_3, 340, 272 [174]
IR: 3350-3530 (OH), 2930 (OCH_3), 1665 (C=O γ-pyrone), 1614, 1573, 1517 (C=C aromatic)
Mass: 300 $[M]^+$, 282 $[M - H_2O]^+$, 271, 254, 167, 153, 139, 128, 119, 93
PMR (TMS): 6.36 (1H, s, H-3), 6.55 (1H, s, H-8), 7.73 (1H, d, J = 9.0, H-2′), 6.85 (1H, d, J = 9.0, H-3′), 6.85 (1H, d, J = 9.0, H-5′), 7.73 (1H, d, J = 9.0, H-6′) [174]



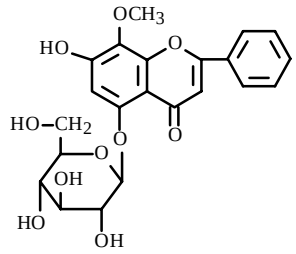
Hispidulin 7-O-glucuronide (hispiduloside)

S. creticola [62], *S. litwinowii* [76]
$C_{22}H_{20}O_{12}$: 476
UV: 275, 336; +CH_3COONa, 276, 237
IR: 3340-3550 (OH), 2930 (OCH_3), 1720 (COOH), 1660 (C=O γ-pyrone), 1612, 1570, 1515 (C=C aromatic)



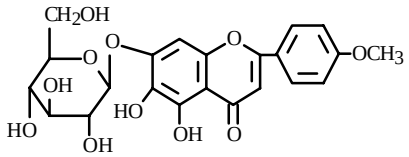
Hispidulin 7-O-glucobioside (hispidulin 7-O-neohesperidoside)

S. przewalskii [71]
$C_{26}H_{32}O_{15}$: 584
UV: 280, 335; +CH_3COONa, 275, 335; +C_2H_5ONa, 275, 370; +$Zr(NO_3)_2$, 305, 335
IR: 3340 (OH), 2930 (OCH_3), 1665 (C=O γ-pyrone), 1615, 1575, 1519 (C=C aromatic), 1092, 1065, 1020 (C–O glycosides)



Wogonin 5-O-β-D-glucoside

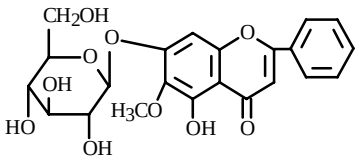
S. baicalensis [123]
$C_{22}H_{22}O_{10}$: 446
mp: 165°C (MeOH)
UV: 268 (4.42), 310 sh (4.04); +CH_3ONa, 241 (4.30), 279 (4.54), 372 (3.92); +CH_3COONa, 242 (4.24), 278 (4.47), 330 sh (3.82); +$AlCl_3$, 268 (4.38), 304 sh (4.13); +$AlCl_3$/HCl, 272 sh (4.28), 285 (4.30), 295 sh (4.29), 330 sh (3.95) [123]
IR: 1625 (C=O γ-pyrone)
PMR (DMSO-d_6): 3.40-3.83 (6H, m, sugar protons), 3.93 (3H, s, OCH_3), 4.80 (1H, d, J = 6.0, H-1″), 6.82 (1H, s, H-6), 6.95 (1H, s, H-3), 7.58-7.72 (3H, m, H-3′,4′,5′), 7.97-8.13 (2H, m, H-2′,6′)



Dinatin 7-O-glucoside

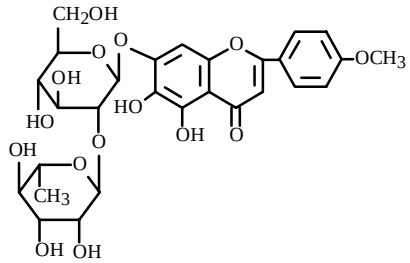
S. przewalskii [71]
$C_{22}H_{22}O_{11}$: 462

UV: 275, 325; +CH_3COONa, 270, 325; +C_2H_5ONa, 260, 365; +$Zr(NO_3)_2$, 290, 360
IR: 3350-3540 (OH), 1660 (C=O γ-pyrone), 1620, 1580, 1510 (C=C aromatic), 1089, 1060, 1015 (C–O glycosides)



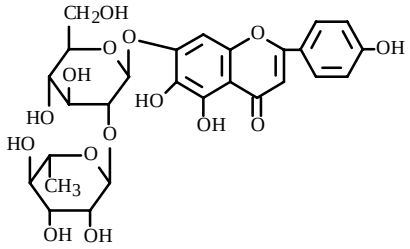
Oroxylin A 7-O-glucoside

S. creticola [62], *S. ovata* [70]
$C_{22}H_{22}O_{10}$: 446
mp: 162°C
UV: 271, 310; +CH_3COONa, 272, 311
IR: 3450 (OH), 2930 (OCH_3), 1665 (C=O γ-pyrone), 1615, 1575, 1510 (C=C aromatic)
PMR ($CDCl_3$): 7.86-7.79 (2H, H-2′,6′), 7.53-7.44 (3H, m, H-3′,4′,5′), 6.65 (1H, s, H-8), 6.57 (1H, s, H-3), 5.26 (1H, s, H-1″ glucose), 3.75 (3H, s, 6-OCH_3), 3.5-3.4 (6H, s, sugar protons)



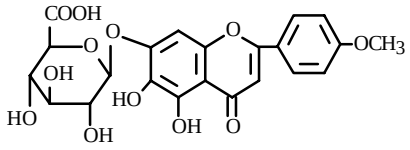
Dinatin 7-O-glucobioside (dinatin 7-O-neohesperidoside)

S. przewalskii [71]
$C_{28}H_{32}O_{15}$: 608
UV: 275, 325; +CH_3COONa, 270, 325; +C_2H_5ONa, 260, 365; +$Zr(NO_3)_2$, 290, 360
IR: 3340-3550 (OH), 2930 (OCH_3), 1665 (C=O γ-pyrone), 1618, 1578, 1512 (C=C aromatic), 1090, 1062, 1020 (C–O glycosides)



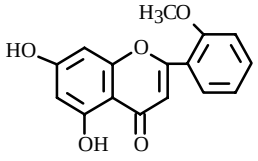
Scutellarein 7-O-glucobioside (scutellarein 7-O-neohesperidoside)

S. przewalskii [71]
$C_{27}H_{30}O_{15}$: 594
UV: 280, 335; +CH_3COONa, 285, 335; +C_2H_5ONa, 270; +$Zr(NO_3)_2$, 303, 365
IR: 3450 (OH), 1665 (C=O γ-pyrone), 1620, 1580, 1515 (C=C aromatic), 1095, 1065, 1018 (C–O glycosides)



Dinatin 7-O-glucuronide

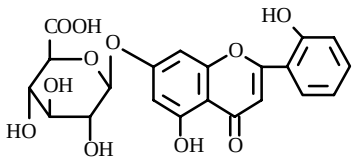
S. przewalskii [71]
$C_{22}H_{20}O_{12}$: 476
UV: 275, 325; +CH_3COONa, 270, 325; +C_2H_5ONa, 260, 365; +$Zr(NO_3)_2$, 290, 360
IR: 3450 (OH), 2930 (OCH_3), 1730 (COOH), 1660 (C=O γ-pyrone), 1620, 1575, 1515 (C=C aromatic)



5,7-Dihydroxy-2′-methoxyflavone (2′-methoxychrysin)

S. adenostegia [56], *S. epilobiifolia* [89], *S. granulose* [120], *S. phyllostachya* [93], *S. prostrata* [95], *S. sevanensis* [54], *S. strigillosa* [188]
$C_{16}H_{12}O_5$: 284
mp: 288-290°C
UV: 267, 330; +CH_3COONa, 385; +NaOH, 380; +$ZrOCl_2$, 390

PMR (DMSO-d_6): 3.94 (3H, s, OCH_3), 6.20 (1H, d, J = 2.5, H-6), 6.46 (1H, d, J = 2.5, H-8), 6.84 (1H, s, H-3), 7.14 (1H, m, $J_1 = J_2 = 8$, $J_3 = 2$, H-5′), 7.23 (1H, t, $J_1 = 8$, $J_2 = 2$, H-3′), 7.60 (1H, m, $J_1 = J_2 = 8$, $J_3 = 2$, H-4′), 7.88 (1H, q, $J_1 = 8$, $J_2 = 2$, H-6′), 10.85 (1H, s, 7-OH), 12.84 (1H, s, 5-OH) [120]

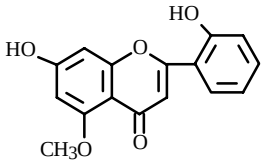


5,2′-Dihydroxy-7-O-glucuronylflavone
(7-O-glucuronyl-2′-hydroxychrysin)

S. comosa [88], *S. ikonnikovii* [108], *S. pycnoclada* [57], *S. tournefortii* [124]
$C_{21}H_{18}O_{11}$: 446
mp: 230-235°C

$[\alpha]_D$ -140.0° (EtOH)
UV: 270, 330; +$ZrOCl_2$, 290, 390; +NaOH, 405
PMR (DMSO-d_6): 5.23 (1H, d, J = 6.9, H-1″), 6.44 (1H, d, J = 2.2, H-6), 6.82 (1H, d, J = 2.2, H-8), 6.98 (1H, t, H-5′), 7.07 (1H, d, J = 8.0, H-3′), 7.13 (1H, s, H-3), 7.39 (1H, t, H-4′), 7.83 (1H, d, J = 8.0, H-6′), 12.86 (1H, s, 5-OH)
^{13}**C NMR** (DMSO-d_6) [108]:

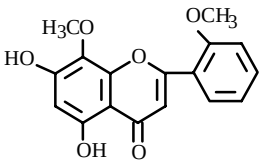
C-2	163.07	C-9	157.34	C-6′	128.25
3	105.34	10	109.12	1″	99.45
4	182.20	1′	117.35	2″	72.96
5	161.00	2′	157.08	3″	74.11
6	99.37	3′	116.82	4″	71.89
7	161.73	4′	132.84	5″	76.32
8	94.69	5′	119.13	6″	172.02



7,2′-Dihydroxy-5-methoxyflavone

S. planipes [125]
$C_{16}H_{12}O_5$: 284
mp: 282-284°C (MeOH)
UV: 261 (4.37), 276 (4.10), 333 (3.85)
IR: 3436 (OH), 1632 (C=O γ-pyrone), 1594, 1562 (C=C aromatic)
EI-MS *m/z* (%): 284 $[M]^+$ (100), 283 (47.7), 255 (30.7), 253 (3.7), 238 (43.3), 137 (29.0), 118 (11.7)
PMR (DMSO-d_6): 3.80 (s, 5-OCH_3), 6.37 (1H, d, J = 2.2, H-6), 6.50 (1H, d, J = 2.2, H-8), 6.83 (s, H-3), 6.98 (1H, dd q, J = 7.9, 7.2, and 1.2, H-5′), 7.03 (1H, dd, J = 8.2 and 1.2, H-3′), 7.35 (1H, dd q, J = 8.2, 7.2, and 1.7, H-4′), 7.82 (1H, dd, J = 7.9 and 1.7, H-6′)
^{13}**C NMR** (DMSO-d_6):

C-2	160.5	C-7	162.4	C-2′	156.2
3	112.3	8	95.1	4′	131.9
4	175.7	9	159.1	3′	116.8
5	157.3	10	107.1	5′	119.3
6	96.3	1′	117.5	6′	128.1
				5-OCH_3	55.8

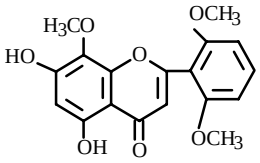


5,7-Dihydroxy-8,2′-dimethoxyflavone

S. discolor [63, 111], *S. indica* [113, 114], *S. rivularis* [72, 73], *S. strigillosa* [188], *S. virularis* [73]
$C_{17}H_{14}O_6$: 314

mp: 231°C (MeOH)
UV: 278, 328; +CH_3ONa, 264 sh, 285, 325 sh, 370; +$AlCl_3$, 255 sh, 285, 296 sh, 346; +$AlCl_3$/HCl, 255 sh, 285, 296 sh, 345; +CH_3COONa, 264 sh, 284, 323 sh, 370; +CH_3COONa/H_3BO_3, 279, 328
IR: 3450, 3000 (OH), 1640 (C=O γ-pyrone), 1610, 1570 (C=C aromatic)
Mass: 314 $[M]^+$, 299 $[M - CH_3]^+$
PMR (DMSO-d_6): 3.84, 3.95 (3H, s, each 2×OCH_3), 6.32 (1H, s, H-6), 6.86 (1H, s, H-3), 7.18 (1H, br.t, J = 7.6, H-5′), 7.26 (1H, br.d, J = 7.9, H-3′), 7.60 (1H, ddd, J = 7.9, 7.6, and 1.5, H-4′), 7.88 (1H, dd, J = 7.6 and 1.5, H-6′), 10.80 (1H, br.s, 7-OH), 12.53 (1H, s, 5-OH)
^{13}C NMR (DMSO-d_6) [73]:

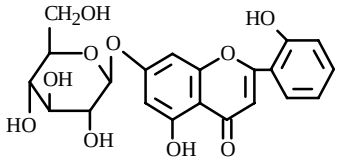
C-2	161.3	C-8	127.8	C-4′	132.2
3	109.6	9	149.9	5′	121.0
4	182.1	10	103.7	6′	129.1
5	156.4	1′	119.7	8-OCH_3	61.0
6	99.1	2′	158.0	2′-OCH_3	55.9
7	157.4	3′	112.7		



5,7-Dihydroxy-8,2′,6′-trimethoxyflavone

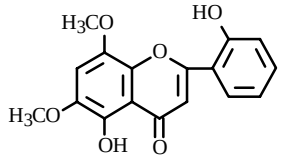
S. discolor [63, 121]
$C_{18}H_{16}O_7$: 344
mp: 206°C (dec.) (MeOH)
UV: 267 (4.42), 310 sh (3.92), 350 sh (3.72); +CH_3ONa, 277 (4.48), 335 sh (3.86), 360 (3.90); +$AlCl_3$, 277 sh (4.40), 300 sh (4.10), 326 (3.93), 395 (3.72); +$AlCl_3$/HCl, 278 sh (4.41), 300 sh (4.11), 324 (3.91), 395 (3.72); +CH_3COONa, 277 (4.45), 330 sh (3.84), 360 (3.88); +H_3BO_3/CH_3COONa, 270 (4.37), 341 (3.78)
IR: 3300, 3100 (OH), 1650 (C=O γ-pyrone), 1610, 1580 (C=C aromatic)
Mass: 344 $[M]^+$ (48), 329 $[M - CH_3]^+$ (100)
PMR (DMSO-d_6): 3.72 (3H, s, 8-OCH_3), 3.80 (6H, s, 2′,6′-$OCH_3$0, 12.51 (1H, s, 5-OH), 10.50 (1H, br.s, 7-OH), 6.28 (1H, s, H-6), 6.34 (1H, s, H-3), 7.52 (1H, t, J = 8.3, H-4′), 6.83 (2H, d, J = 8.3, H-3′,5′)
^{13}**C NMR** (DMSO-d_6):

C-2	161.2	C-8	127.8	C-4′	133.0
3	112.2	9	150.6	5′	104.5
4	182.0	10	103.8	6′	158.3
5	156.5	1′	110.3	8-OCH_3	60.9
6	99.2	2′	158.3	2′-OCH_3	56.1
7	157.4	3′	104.5	6′-OCH_3	56.1



5,2′-Dihydroxy-7-O-β-D-glucopyranosylflavone

S. ramosissima [126]
$C_{21}H_{20}O_{10}$: 432
mp: 280-281°C (MeOH)
UV: 269, 325; +CH_3COONa, 268, 327
IR: 3550-3260 (OH), 1665 (C=O γ-pyrone), 1615, 1565 (C=C aromatic), 1100-1000 (C–O glycosides)
PMR (Py-d_5): 3.88-4.43 (sugar protons), 5.63 (d, J = 6.5, H-1″), 6.59 (d, J = 2.0, H-6), 6.65 (d, J = 2.0, H-8), 6.93-7.07 (m, H-3′,5′), 7.08 (s, H-3), 7.28 (dt, J = 2.0 and 8.0, H-4′), 7.72 (dd, J = 2.0 and 8.0, H-6′), 13.48 (br.s, 5-OH)

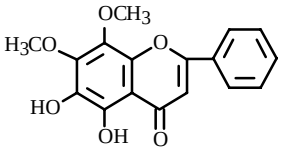


5,2′-Dihydroxy-6,8-dimethoxyflavone

S. baicalensis [127, 190]
$C_{17}H_{14}O_6$: 314
mp: 251°C (benzene)

UV: 287 (3.7), 330 (3.4); +$AlCl_3$, 292 sh, 307, 364
Mass: 314 $[M]^+$, 299 $[M - 15]^+$ (100)
PMR (DMSO-d_6): 3.91, 3.15 (3H, s, each 2×OCH_3), 6.89-7.99 (6H, m) [190]
^{13}**C NMR** (DMSO-d_6 + D_2O) [170]:

C-2	161.6	C-8	141.7	C-4′	132.4
3	108.4	9	139.2	5′	119.2
4	183.0	10	107.5	6′	128.0
5	141.1	1′	119.2	8-OCH_3	57.2
6	139.2	2′	156.4	6-OCH_3	56.8
7	116.8	3′	116.8		

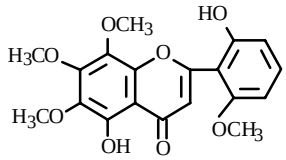


5,6-Dihydroxy-7,8-dimethoxyflavone

S. ramosissima [115]
$C_{17}H_{14}O_6$: 314
mp: 182-184°C ($CHCl_3$)
UV: 249, 272, 321

Mass: 314 $[M]^+$ (56), 299 $[M - CH_3]^+$ (100), 284 (47), 269 (78), 241 (28), 202 (25), 197 (28), 164 (44), 149 (56), 105 (56)
PMR (Py-d_5): 3.92, 4.08 (3H, s, each 2×OCH_3), 6.88 (1H, s, H-3), 7.39 (3H, m, H-3′,4′,5′), 7.91 (2H, m, H-2′,6′), 13.08 (br.s, 5-OH)
^{13}C NMR ($CDCl_3$ + CD_3OD):

C-2	164.2	C-8	133.2	C-4′	131.8
3	104.7	9	142.2	5′	129.0
4	183.0	10	106.6	6′	126.1
5	142.9	1′	131.2	OCH_3	61.2
6	133.8	2′	126.1	OCH_3	61.9
7	147.4	3′	129.0		

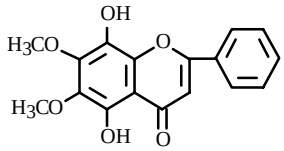


5,2′-Dihydroxy-6,7,8,6′-tetramethoxyflavone

S. baicalensis [127]
$C_{19}H_{18}O_8$: 370
mp: 180-181°C
UV: 275, 350

IR: 3380 (OH), 2930 (OCH_3), 1650 (C=O γ-pyrone), 1615, 1580 (C=C aromatic)
^{13}**C NMR** (DMSO-d_6 + D_2O) [170]:

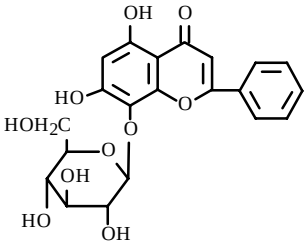
C-2	162.1	C-8	132.7	C-4′	132.2
3	111.7	9	148.2	5′	101.9
4	182.2	10	118.9	6′	158.1
5	146.0	1′	108.6	7,8-OCH_3	61.4
6	135.5	2′	156.4	6-OCH_3	60.2
7	152.7	3′	106.1	6′-OCH_3	55.8



5,8-Dihydroxy-6,7-dimethoxyflavone

S. baicalensis [128, 129]
$C_{17}H_{14}O_6$, 314
mp: 235-236°C (MeOH)
UV: 250 sh, 279, 322; +CH_3COONa, 270, 286 sh, 375; +$AlCl_3$, 255 sh, 295, 347
IR: 3420 (OH), 1650 (C=O γ-pyrone), 1615, 1600, 1580 (C=C aromatic)
Mass: 314 $[M]^+$ (84.2), 299 (100)
PMR (DMSO-d_6): 3.87 (3H, s, OCH_3), 3.77 (3H, s, OCH_3), 6.95 (1H, s, H-3), 7.95-8.10 (2H, m, H-2′,6′), 7.50-7.65 (3H, m, H-3′,4′,5′), 12.60 (1H, br.s, 5-OH)
^{13}**C NMR** (DMSO-d_6):

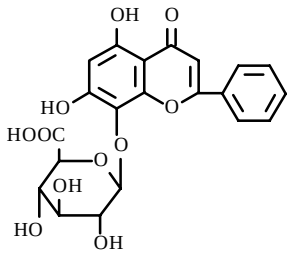
C-2	163.4	C-8	128.5	C-4′	132.1
3	104.9	9	148.5	5′	129.3
4	182.6	10	103.6	6′	126.4
5	145.8	1′	131.2	OCH_3	60.3
6	132.1	2′	126.4	OCH_3	61.3
7	151.3	3′	129.3		



5,7-Dihydroxy-8-O-β-D-glucopyranosylflavone
(norwogonin 8-O-glucoside)

S. ikonnikovii [108]
$C_{21}H_{20}O_{10}$: 434
UV: 278, 350
IR: 3540 (OH), 1665 (C=O γ-pyrone), 1620, 1580, 1520 (C=C aromatic), 1095, 1065, 1015 (C–O glycosides)
PMR (DMSO-d_6): 4.65 (1H, d, J = 7.7, anomeric proton of glucose H-1″), 6.23 (1H, s, H-6), 6.99 (1H, s, H-3), 7.08-7.59 (3H, m, H-3′,4′,5′), 8.29 (2H, d, J = 6.2, H-2′,6′), 12.66 (br.s, 5-OH)
^{13}**C NMR** (DMSO-d_6):

C-2	162.89	C-9	149.40	C-6′	126.84
3	106.66	10	102.87	1″	104.45
4	181.63	1′	130.57	2″	74.03
5	157.18	2′	126.84	3″	75.99
6	99.43	3′	128.90	4″	69.02
7	159.03	4′	131.83	5″	77.22
8	125.67	5′	128.90	6″	60.40

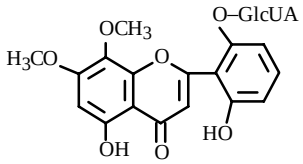


5,7-Dihydroxy-8-O-β-D-glucuronylflavone
(norwogonin 8-O-glucuronide)

S. discolor [63], *S. ikonnikovii* [108]
$C_{21}H_{18}O_{11}$: 446
mp: 212°C (dec.) (MeOH)
$[\alpha]_D^{14}$ +23.7° (*c* 0.07, MeOH)
UV: 279 (4.39), 346 (3.68); +CH_3ONa, 240 sh (4.13), 265 sh (4.31), 284 (4.42), 370 (3.78); +$AlCl_3$, 255 (3.53), 287 sh (4.32), 295 (4.34), 334 (3.90), 405 (3.64); +$AlCl_3$/HCl, 257 (4.10), 287 (4.32), 295 (4.34), 332 (3.87), 405 (3.59); +CH_3COONa, 265 sh (4.20), 284 (4.40), 370 (3.79); +CH_3COONa/H_3BO_3, 265 sh (4.21), 283 (4.39), 370 (3.73)

IR: 3400 (OH), 1730 (COOH), 1650 (C=O γ-pyrone), 1600, 1580 (C=C aromatic)
EI-MS *m/z* (%): 270 (100) $C_{15}H_{10}O_5$, 168 (95) $C_7H_4O_5$
PMR (DMSO-d_6): 3.00-4.20 (sugar protons), 4.82 (1H, d, J = 7.4, anomeric proton of glucuronic acid H-1″), 6.30 (1H, s, H-6), 7.01 (1H, s, H-3), 7.58 (3H, m, H-3′,4′,5′), 8.19 (2H, m, H-2′,6′), 12.65 (1H, s, 5-OH)
^{13}**C NMR** (DMSO-d_6):

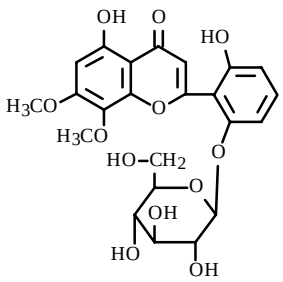
C-2	163.4	C-9	149.6	C-6′	126.8	
3	104.8	10	103.7	1″	106.4	J = 162.5
4	182.0	1′	130.6	2″	73.8	
5	157.5	2′	126.8	3″	75.3	
6	99.2	3′	129.9	4″	71.5	
7	157.6	4′	132.1	5″	76.2	
8	125.4	5′	129.2	6″	170.2	



5,6′-Dihydroxy-7,8-dimethoxy-2′-O-β-D-glucuronidopyranosylflavone

S. rivularis [110]
$C_{23}H_{22}O_{13}$: 506
mp: 276-277°C (dec.) (MeOH)
$[\alpha]_D^{25}$ +42.6° (*c* 0.5, pyridine)
UV: 266 (4.34), 310 sh (3.77), 340 (3.71); +CH_3ONa, 265 (4.35), 3.70 (3.90); +$AlCl_3$, 277 (4.34), 297 sh (4.08), 323 (3.81), 404 (3.66); +$AlCl_3$/HCl, 277 (4.33), 297 sh (4.06), 322 sh (3.80), 404 (3.66); +CH_3COONa, 266 (4.43), 310 sh (3.86), 345 (3.84); +H_3BO_3/CH_3COONa, 264 sh (4.45), 347 (3.86)
IR: 3454 (OH), 1736 (COOH), 1662 (C=O γ-pyrone), 1616, 1575 (C=C)
FAB-MS *m/z* (%): 507 $[M + 1]^+$ (3), 154 [$C_9H_8O_5$ - CO - CH_3 + 1] (100)
EI-MS *m/z* (%): 330 [$C_{17}H_{14}O_7$ (aglycone)] (57), 315 [aglycone - CH_3] (100)
PMR (DMSO-d_6): 3.73, 3.92 (3H, d, each 2×OCH_3), 6.32 (1H, s, H-6), 6.61 (1H, s, H-3), 6.68 (1H, d, J = 8.4, H-3′ or H-5′), 6.73 (1H, d, J = 8.4, H-3′ or H-5′), 7.31 (1H, t, J = 8.4, H-4′), 3.08-3.35 (3H, m, H-2″,3″,4″), 3.90 (1H, d, J = 9.5, H-5″), 5.11 (1H, d, J = 8.0, H-1″), 10.20 (1H, s, 6′-OH), 12.75 (1H, s, 5-OH)
^{13}**C NMR** (DMSO-d_6):

C-2	161.5	C-10	104.2	C-2″	72.8
3	112.1	1′	110.1	3″	75.7
4	182.1	2′	156.6	4″	71.1
5	156.6	3′	105.1	5″	75.3
6	95.7	4′	132.1	6″	169.9
7	158.1	5′	109.7	7-OCH_3	56.4
8	128.3	6′	155.6	8-OCH_3	61.0
9	149.8	1″	99.6 (d, J = 162.7)		



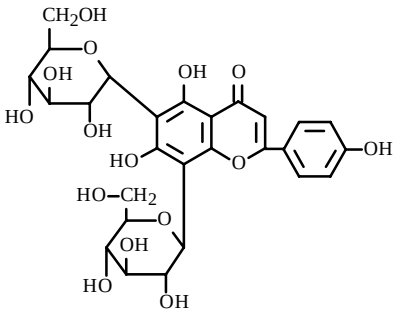
5,6′-Dihydroxy-7,8-dimethoxy-2′-O-β-D-glucopyranosylflavone

S. baicalensis [130]
$C_{23}H_{24}O_{12}$: 492
mp: 238-239°C (dec.) (MeOH) [130]
$[\alpha]_D^{25}$ -45.2° (*c* 0.02, MeOH)
UV: 263 (4.23), 305 sh (3.69), 335 (3.61); +CH_3ONa, 263 (4.20), 365 (3.67); +$AlCl_3$, 273 (4.22), 295 sh (3.93), 321 (3.74), 392 (3.58); +$AlCl_3$/HCl, 255 (4.16), 263 (4.20), 273 (4.22), 295 sh (3.93), 321 (3.73), 392 (3.55)
IR: 3424 (OH), 1658 (C=O γ-pyrone), 1614, 1578 (C=C aromatic)

PMR (DMSO-d_6): 3.71 (1H, s, 8-OCH_3), 3.91 (3H, s, 7-OCH_3), 3.06 (1H, m, H-2″), 3.08 (1H, m, H-4″), 3.19 (1H, m, H-3″), 3.23 (1H, m, H-5″), 3.48 (1H, m, H-6″), 3.68 (1H, br.dd, J = 5.8 and 12.0, H-6″), 4.54 (1H, t, J = 5.8, 6″-OH), 4.91 (1H, d, J = 7.7, H-1″), 6.31 (1H, s, H-3), 6.60 (1H, s, H-6), 6.65 (1H, d, J = 8.4, H-5′), 6.72 (1H, d, J = 8.4, H-3′), 7.29 (1H, t, J = 8.4, H-4′), 10.14 (1H, br.s, 6′-OH), 12.75 (1H, s, 5-OH)

^{13}**C NMR** (DMSO-d_6):

C-2	161.7	C-10	104.2	C-2″	73.1
3	112.2	1′	110.1	3″	76.5
4	182.2	2′	156.6	4″	69.6
5	156.7	3′	105.4	5″	77.1
6	95.8	4′	132.2	6″	60.7
7	158.2	5′	109.5	7-OCH_3	56.4
8	128.4	6′	156.2	8-OCH_3	61.1
9	149.9	1″	100.2		

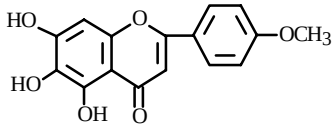


6,8-C-Diglycosideapigenin

S. supina [57]
$C_{27}H_{30}O_{15}$: 594
mp: 225-227°C
$[\alpha]_D^{20}$ +54.0° (*c* 1.0, DMF)
UV: 275, 335; +CH_3COONa, 285, 395; +$ZrOCl_2$, 290, 395; +NaOH, 285, 410
IR: 3540, 3345 (OH), 1660 (C=O γ-pyrone), 1625, 1580, 1515 (C=C aromatic), 1090, 1040, 1005 (C–O glycosides)

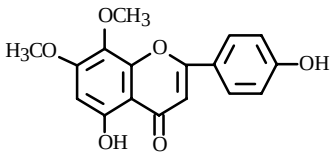
^{13}**C NMR** (DMSO-d_6—D_2O, 2:1) [38, 40]:

C-2	163.9	C-7	161.4	C-2′	129.0
3	102.6	8	103.7	3′	115.9
4	182.2	9	161.3	4′	158.7
5	155.0	10	105.3	5′	115.9
6	107.6	1′	121.5	6′	129.0



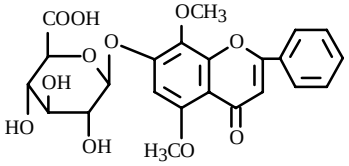
Dinatin (5,6,7-trihydroxy-4′-methoxyflavone)

S. ovata [70], *S. przewalskii* [71], *S. sevanensis* [54], *S. ussuriensis* [124]
$C_{16}H_{12}O_6$: 300
mp: 273-275°C
UV: 275, 325; +CH_3COONa, 270, 360; +C_2H_5ONa, 260, 370; +$Zr(NO_3)_2$, 290, 360
PMR (CD_3OD): 7.86-7.75 (2H, dd, J = 8, H-2′,6′), 6.96-6.85 (2H, dd, J = 8.2, H-3′,5′), 6.52 (1H, s, H-8), 6.48 (1H, s, H-3), 3.86 (3H, s, 4′-OCH_3)



7,8-Dimethoxyisoscutellarein

S. sevanensis [54]
$C_{17}H_{14}O_6$: 314
UV: 280, 335
IR: 3450 (OH), 2930 (OCH_3), 1655 (C=O γ-pyrone), 1618, 1570, 1515 (C=C aromatic)

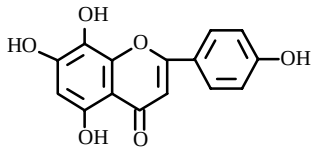


5,8-Dimethoxy-7-O-β-D-glucuronidopyranosylflavone

S. rivularis [110]
$C_{23}H_{22}O_{11}$: 474
mp: 205°C (MeOH)
$[\alpha]_D^{20}$ -77.7° (*c* 0.04, MeOH)

UV: 272 (4.37), 332 (3.79); +CH_3ONa, 272 (4.37), 332 (3.79); +$AlCl_3$, 271 (4.35), 330 (3.82); +CH_3COONa, 271 (4.43), 332 (3.88)
IR: 3424 (OH), 1720 (COOH), 1643 (C=O γ-pyrone), 1601, 1580 (C=C)
FAB-MS *m/z* (%): 475 $[M + 1]^+$ (30), 299 [$C_{17}H_{14}O_5$ (aglycone) + 1] (100)
PMR (DMSO-d_6): 3.84, 3.91 (3H, s, each 2×OCH_3), 3.40-4.00 (m, sugar protons), 5.40 (1H, d, J = 5.9, H-1″), 6.81 (1H, s, H-3,6), 7.5-7.7 (3H, m, H-3′,4′,5′), 7.9-8.1 (2H, m, H-2′,6′)
^{13}**C NMR** (DMSO-d_6):

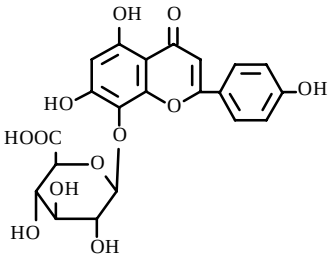
C-2	159.9	C-10	109.7	C-2″	73.1
3	108.2	1′	131.2	3″	75.5
4	176.1	2′	126.1	4″	71.3
5	155.4	3′	129.4	5″	76.2
6	96.9	4′	131.7	6″	170.2
7	154.1	5′	129.4	5-OCH_3	56.2
8	131.2	6′	126.1	8-OCH_3	61.4
9	151.6	1″	100.3 (J = 165.5)		



Isoscutellarein (5,7,8,4′-tetrahydroxyflavone)

S. baicalensis [131], *S. indica* [67], *S. pycnoclada* [57], *S. sevanensis* [54]
$C_{15}H_{10}O_6$: 286
mp: 340-342°C

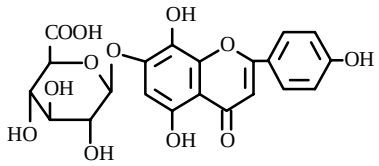
UV: 282, 308, 328 sh, 366 sh
IR: 1650 (C=O γ-pyrone), 1615, 1590, 1585, 1510 (C=C aromatic) [175]
Mass: 286 $[M]^+$ (100), 258, 257, 168 (100), 140 (25), 129 (12), 121 (8), 119 (12), 118 (8), 112 (17), 84 (8), 69 (11). Metastable peaks: 233 (186→268), 116.6 (168→140), 98.6 (286→168), 89.6 (140→112), 63 (112→84) [175]
PMR (CD_3OD): 6.19 (1H, s, H-6), 6.43 (1H, s, H-3), 6.80 (2H, dd, J = 8.5 and 2.5, H-3′,5′), 7.80 (2H, dd, J = 8.5 and 2.5, H-2′,6′) [175]



Isoscutellarein 8-O-glucuronide

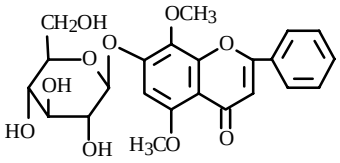
S. indica [67]
$C_{21}H_{18}O_{12}$: 462
UV: 271, 332; +CH_3ONa, 279, 329 sh, 397; +CH_3COONa, 278, 310 sh, 389; +CH_3COONa/H_3BO_3, 277, 318, 345 sh, 412 sh; +$AlCl_3$, 277, 306, 346, 386; +$AlCl_3$/HCl, 278, 305, 345, 386 [178]

IR: 3560 (OH), 1730 (COOH), 1660 (C=O γ-pyrone), 1620, 1575, 1518 (C=C aromatic), 1090, 1050, 1005 (C–O glycosides)



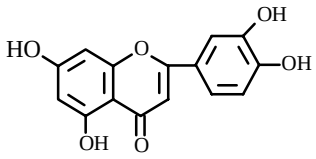
Isoscutellarin (Isoscutellarein 7-O-glucuronide)

S. pycnoclada [57]
$C_{21}H_{18}O_{12}$: 462
mp: 220°C (dec.)
$[\alpha]_D^{20}$ -152.0° (*c* 1.0, DMF)
UV: 280, 335; +$ZrOCl_2$, 365, 430; +NaOH, 400
IR: 3550 (OH), 1730 (COOH), 1665 (C=O γ-pyrone), 1618, 1578, 1515 (C=C aromatic), 1092, 1065, 1005 (C–O glycosides)



Immaculoside (5,8-dimethoxy-7-O-β-D-glucopyranosylflavone)

S. immaculata [186]
$C_{23}H_{24}O_{10}$: 460
mp: 197-199°C
UV: 270, 331; +CH_3COONa, 271, 332
IR: 3445 (OH), 2930 (OCH_3), 1664 (C=O γ-pyrone), 1619, 1578, 1516 (C=C aromatic), 1072, 1022, 1009 (C–O glycosides)
PMR (Py-d_5): 3.85, 3.92 (3H, s, each 2×OCH_3), 3.38-4.00 (sugar protons), 5.44 (1H, d, J = 6.5, H-1″), 6.72 (1H, s, H-6), 6.81 (1H, s, H-3), 7.52-7.74 (3H, m, H-3′,4′,5′), 7.92-8.15 (2H, m, H-2′,6′)

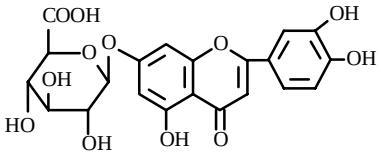


Luteolin (5,7,3′,4′-tetrahydroxyflavone)

S. adenostegia [57], *S. adsurgens* [58, 59], *S. araxensis* [78], *S. creticola* [62], *S. discolor* [63], *S. galericulata* [64, 65], *S. grossa* [91], *S. indica* [67], *S. iskanderi* [68], *S. oreophila* [92], *S. ovata* [70], *S. przewalskii* [71], *S. pycnoclada* [57], *S. rivularis* [72], *S. scordiifolia* [74], *S. sevanensis* [54], *S. supina* [57]

$C_{15}H_{10}O_6$: 286
mp: 328-331°C (dec.)
UV: 260, 274 sh, 356; +CH_3COONa, 272, 362; +CH_3COONa/H_3BO_3, 262, 373; +$AlCl_3$, 275, 406; +$AlCl_3$/HCl, 274, 388; +CH_3ONa, 271, 404
IR: 3450-3300 (OH), 1658 (C=O γ-pyrone), 1612, 1584 (C=C aromatic)
Mass: 286 $[M]^+$, 258, 229, 213, 153, 149, 137, 134, 129, 109, 107, 91, 81, 69
PMR (Py-d_5): 6.58 (1H, d, J = 2.0, H-6), 6.67 (1H, d, J = 2.0, H-8), 6.79 (1H, s, H-3), 7.08 (1H, d, J = 8.0, H-5′), 7.51 (br.s, H-2′), 7.56 (dd, J = 2.0 and 8.0, H-6′)
^{13}**C NMR** (DMSO-d_6—D_2O, 2:1) [38, 40]:

C-2	165.1	C-7	164.3	C-2′	114.4
3	103.9	8	94.9	3′	146.0
4	182.6	9	158.2	4′	149.8
5	161.6	10	104.8	5′	117.0
6	99.9	1′	123.1	6′	120.1

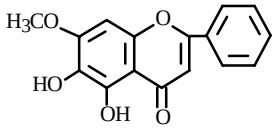


Luteolin 7-O-glucuronide

S. galericulata [64, 65], *S. iskanderi* [68], *S. przewalskii* [71], *S. pycnoclada* [57], *S. scordiifolia* [74], *S. supina* [57]
$C_{21}H_{18}O_{12}$: 462
mp: 192-195°C
$[\alpha]_D^{20}$ -98.0° (*c* 1.0, DMF)

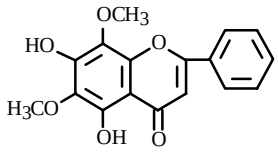
UV: 256 sh, 350; +$ZrOCl_2$, 415; +NaOH, 400; +CH_3COONa/H_3BO_3, 390
^{13}C NMR (DMSO-d_6) [176]:

C-2	165.2	C-8	98.2	C-4′	149.0
3	103.1	9	157.0	5′	116.0
4	182.0	10	105.6	6′	119.5
5	161.0	1′	123.2	COOH	172.5
6	100.2	2′	113.5		
7	163.0	3′	145.5		



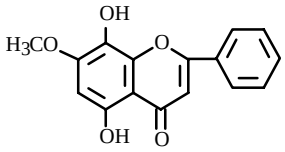
7-Methoxybaicalein (5,6-dihydroxy-7-methoxyflavone)

S. baicalensis [83]
$C_{16}H_{12}O_5$: 284
UV: 275, 340; +CH_3COONa, 275, 340; +NaOH, 410; +CH_3COONa/H_3BO_3, 275, 340; +$ZrOCl_2$, 380
IR: 3540-3250 (OH), 1660 (C=O γ-pyrone), 1630, 1580, 1515 (C=C aromatic)



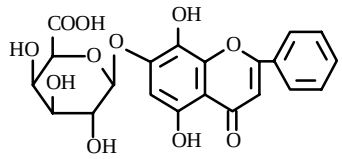
6-Methoxywogonin (5,7-dihydroxy-6,8-dimethoxyflavone)

S. repens [187], *S. sevanensis* [54]
$C_{17}H_{14}O_6$: 314
UV: 275, 318
IR: 3450 (OH), 2930 (OCH_3), 1660 (C=O γ-pyrone), 1615, 1580 (C=C aromatic)



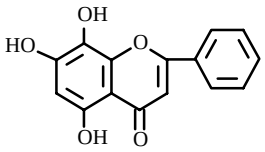
7-Methoxynorwogonin (5,8-dihydroxy-7-methoxyflavone)

S. baicalensis [83], *S. strigillosa* [188]
$C_{16}H_{12}O_5$: 284
UV: 275, 340; +CH_3COONa, 275, 340; +NaOH, 415; +CH_3COONa/H_3BO_3, 275, 340; +$ZrOCl_2$, 410
IR: 3450, 3230 (OH), 1655 (C=O γ-pyrone), 1615, 1580, 1525 (C=C aromatic)



Nepetoside A (5,8-dihydroxy-7-O-β-D-galacturonidopyranosylflavone)

S. nepetoides [185]
$C_{21}H_{18}O_{11}$: 446
mp: 204-206°C
UV: 277, 314; +CH_3COONa, 275, 315
IR: 3358 (OH), 1729 (COOH), 1664 (C=O γ-pyrone), 1612, 1575, 1492 (C=C aromatic), 1070, 1038 (C–O glycosides)
PMR (Py-d_5): 4.00-4.70 (3H, m, H-2″,3″,4″), 4.87 (1H, d, J = 8.5, H-5″), 5.95 (1H, d, J = 7.0, H-1″), 6.77 (1H, s, H-6), 6.85 (1H, s, H-3), 7.39 (3H, m, H-3′,4′,5′), 7.70 (2H, m, H-2′,6′), 12.85 (1H, br.s, 5-OH)

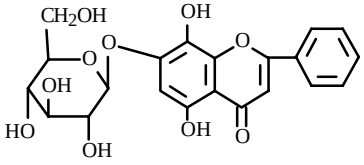


Norwogonin (5,7,8-trihydroxyflavone)

S. alpina [60], *S. baicalensis* [83, 184], *S. comosa* [88], *S. discolor* [111], *S. epilobiifolia* [89], *S. grossa* [91], *S. prostrata* [95], *S. ramosissima* [115], *S. scandens* [97], *S. strigillosa* [188], *S. supina* [57], *S. ussuriensis* [124]
$C_{15}H_{10}O_5$: 270

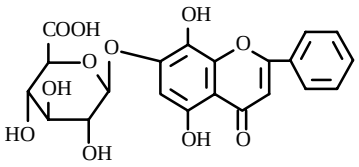
mp: 250-252°C (dec.)
UV: 246, 285, 357 sh; +$AlCl_3$, 228, 249, 290 sh, 319, 360; +CH_3COONa, 240, 287 sh, 304, 345 sh; +CH_3COONa/H_3BO_3, 292, 412 sh [184]
IR: 3250, 3000 (OH), 1640 (C=O γ-pyrone), 1600 (C=C aromatic)
PMR (DMSO-d_6): 6.95 (1H, s, H-3), 6.31 (1H, s, H-6), 8.13-8.23 (2H, m, H-2′,6′), 7.57-7.64 (3H, m, H-3′,4′,5′) [184]
^{13}**C NMR** (DMSO-d_6) [184]:

C-2	163.2	C-7	153.9	C-2′	126.7
3	104.7	8	125.2	3′	129.2
4	182.4	9	153.3	4′	132.1
5	145.8	10	103.7	5′	129.2
6	98.9	1′	131.1	6′	126.7



Norwogonin 7-O-β-D-glucopyranoside

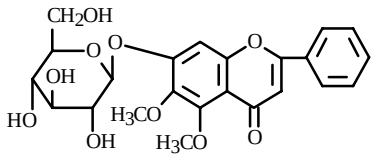
S. discolor [121], *S. baicalensis* [184], *S. immaculata* [186]
$C_{21}H_{20}O_{10}$: 432
mp: 278-280°C
UV: 279, 350; +CH_3COONa, 280, 351
IR: 3450 (OH), 1660 (C=O γ-pyrone), 1618, 1575, 1517 (C=C aromatic), 1075, 1024, 1005 (C–O glycosides)
PMR (Py-d_5): 3.98-4.74 (sugar protons), 5.62 (1H, d, J = 7.0, H-1″), 6.38 (1H, s, H-6), 6.52 (1H, s, H-3), 7.45-7.62 (3H, m, H-3′,4′,5′), 7.82-8.00 (2H, m, H-2′,6′), 12.78 (1H, br.s, 5-OH) [186]



Norwogonin 7-O-glucuronide (norwogonoside)

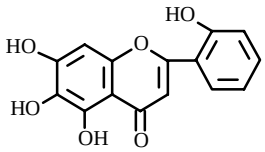
S. epilobiifolia [89], *S. grossa* [91], *S. ikonnikovii* [108], *S. nepetoides* [185]
$C_{21}H_{18}O_{11}$: 446
mp: 230-235°C
$[\alpha]_D$ -152.0°
UV: 280, 350; +$ZrOCl_2$, 310, 440; +NaOH, 315, 330
PMR (DMSO-d_6): 5.02 (1H, d, J = 7.3, H-1″), 6.65 (1H, s, H-6), 7.01 (1H, s, H-3), 7.58-7.64 (3H, m, H-3′,4′,5′), 8.10-8.15 (2H, m, H-2′,6′), 12.20 (1H, s, 5-OH)
^{13}**C NMR** (DMSO-d_6):

C-2	163.56	C-9	144.71	C-6′	126.58
3	105.03	10	105.57	1″	101.23
4	182.62	1′	130.91	2″	72.98
5	151.45	2′	126.58	3″	74.63
6	99.16	3′	129.21	4″	71.83
7	152.17	4′	132.18	5″	75.54
8	127.51	5′	129.21	6″	172.01



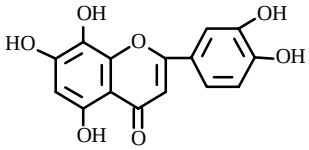
Ovatin (5,6-dimethoxy-7-O-glucopyranosylflavone)

S. ovata [70]
$C_{23}H_{24}O_{10}$: 460
mp: 149°C (dec.)
UV: 310, 265; +$AlCl_3$, 310, 290 sh, 262; +$AlCl_3$/HCl, 310, 290 sh, 263; +CH_3ONa, 360, 268, 240 sh
PMR (CD_3OD): 7.88-7.56 (2H, m, H-2′,6′), 7.53-7.48 (3H, m, H-3′,4′,5′), 6.81 (1H, s, H-3), 6.63 (1H, s, H-8), 5.24 (1H, d, J = 7.0, H-1″), 3.91 (3H, s, 5-OCH_3), 3.89 (3H, s, 6-OCH_3), 3.95-4.05 (6H, sugar protons)



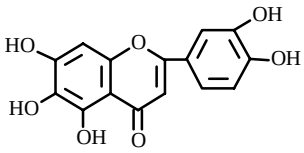
2′-Hydroxybaicalein (5,6,7,2′-tetrahydroxyflavone)

S. sevanensis [54]
$C_{15}H_{10}O_6$: 286
mp: 306°C
UV: 278, 327
IR: 3545-3235 (OH), 1660 (C=O γ-pyrone), 1618, 1578, 1519 (C=C aromatic)



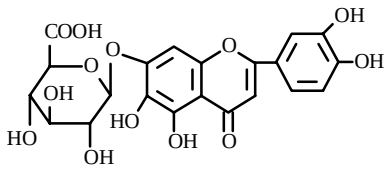
8-Hydroxyluteolin (5,7,8,3′,4′-pentahydroxyflavone)

S. sevanensis [54]
$C_{15}H_{10}O_7$: 302
mp: 198-199°C
UV: 235 sh, 248 sh, 280, 354
IR: 3450-3250 (OH), 1660 (C=O γ-pyrone), 1612, 1585, 1514 (C=C aromatic)



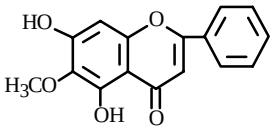
6-Hydroxyluteolin (5,6,7,3′,4′-pentahydroxyflavone)

S. galericulata [64, 65], *S. sevanensis* [54]
$C_{15}H_{10}O_7$: 302
UV: 234 sh, 245 sh, 283, 349; +CH_3COONa, 246 sh, 302 sh, 396; +CH_3COONa/H_3BO_3, 253, 289, 368; +$AlCl_3$, 250 sh, 271, 306, 416; +$AlCl_3$/HCl, 238 sh, 258, 296, 372; +CH_3ONa, 248, 306 sh, 342, 391
IR: 3440-3210 (OH), 1660 (C=O γ-pyrone), 1615, 1580, 1520 (C=C aromatic)



6-Hydroxyluteolin 7-O-glucuronide

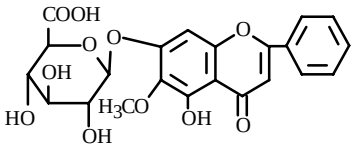
S. galericulata [64, 65]
$C_{21}H_{18}O_{13}$: 478
mp: amorph.
UV: 275, 350
IR: 3540 (OH), 1730 (COOH), 1665 (C=O γ-pyrone), 1620, 1575 (C=C aromatic), 1095, 1020 (C–O glycosides)



Oroxylin A (5,7-dihydroxy-6-methoxyflavone)

S. alpina [60], *S. altissima* [75, 104], *S. amoena* [132], *S. baicalensis* [80, 83, 84, 103], *S. creticola* [62], *S. galericulata* [64, 65], *S. grossa* [91], *S. iskanderi* [68], *S. litwinowii* [76], *S. ocellata* [185], *S. oxystegia* [4], *S. prostrata* [95], *S. ramosissima* [115], *S. rehderiana* [96], *S. scandens* [97], *S. scordifolia* [74], *S. sevanensis* [54], *S. squarossa* [98], *S. strigillosa* [188], *S. supina* [57], *S. tenax* [99], *S. viscidula* [100]

$C_{16}H_{12}O_5$: 284
mp: 218-219°C (benzene—hexane)
UV: 270, 320; +CH_3COONa, 375; +NaOH, 377; +CH_3COONa/H_3BO_3, 320; +$ZrOCl_2$, 367
IR: 3460-3350 (OH), 2930 (OCH_3), 1665 (C=O γ-pyrone), 1615, 1580 (C=C aromatic)
Mass: 284 $[M]^+$, 269, 254, 241, 226, 202, 167, 142, 124, 113, 103, 77, 69
PMR (Py-d_5): 3.85 (3H, s, OCH_3), 6.78 (1H, s, H-3), 6.85 (1H, s, H-8), 7.36 (2H, m, H-2′,6′), 13.56 (1H, br.s, 5-OH)

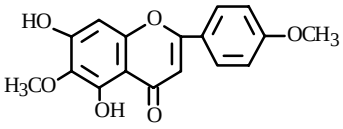


Oroxyloside (oroxylin A 7-O-glucuronide)

S. alpina [60], *S. altissima* [64, 65], *S. baicalensis* [79, 101], *S. comosa* [61], *S. creticola* [62], *S. galericulata* [64, 65], *S. grossa* [91], *S. immaculata* [186], *S. iskanderi* [68], *S. litwinowii* [76], *S. prostrata* [95], *S. scordifolia* [74], *S. squarossa* [98], *S. supina* [57]

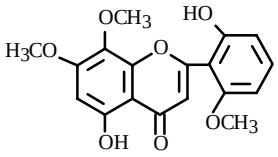
$C_{22}H_{20}O_{11}$: 460
mp: 192-194°C
UV: 245 sh (4.03), 272 (4.42), 309 (4.16); +$AlCl_3$, 250 sh (4.01), 284 (4.40), 333 (4.24); +CH_3COONa (no shifts observed)
IR: 3456 (OH), 1735 (COOH), 1658 (C=O γ-pyrone), 1612 (C=C aromatic)
FAB-MS *m/z*: 461 $[M + H]^+$, 285 $[MH - glcUA]^+$
PMR (DMSO-d_6): 3.78 (3H, s, 6-OCH_3), 5.34 (1H, d, J = 7.0, anomeric proton of glucuronic acid H-1″), 7.06 (1H, s, H-3), 7.13 (1H, s, H-8), 7.6 (3H, m, H-3′,4′,5′), 8.0 (2H, m, H-2′,6′), 12.82 (1H, s, 5-OH)
^{13}**C NMR** (DMSO-d_6):

C-2	163.7	C-10	106.1	C-2″	72.8
3	104.9	1′	130.6	3″	75.8
4	182.4	2′	126.4	4″	71.1
5	152.5	3′	129.1	5″	169.9
6	132.6	4′	132.1	6-OCH_3	60.2
7	156.2	6′	126.4		
9	152.2	1″	99.4		



Pectolinarigenin (5,7-dihydroxy-6,4′-dimethoxyflavone)

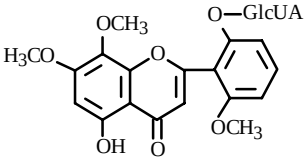
S. polyodon [53], *S. przewalskii* [71]
$C_{17}H_{14}O_6$: 314
mp: 217-219°C (EtOH)
UV: 275, 331; +CH_3COONa, 276, 295 sh, 367; +CH_3COONa/H_3BO_3, 276, 298 sh, 336; +$AlCl_3$, 262 sh, 294, 302, 356; +$AlCl_3$/HCl, 262 sh, 294, 301, 305; +CH_3ONa, 276, 296 sh, 370
IR: 3560-3350 (OH), 2932 (OCH_3), 1658 (C=O γ-pyrone), 1612, 1583 (C=C aromatic)
Mass: 314 $[M]^+$, 300, 299, 297, 296, 272, 271, 167, 157, 153, 139, 135, 133, 132 [172]
PMR (DMSO-d_6): 3.77 (3H, s, OCH_3), 3.86 (3H, s, OCH_3), 6.63 (1H, s, H-3), 6.86 (1H, s, H-8), 7.12 (2H, d, J = 9.0, H-3′,5′), 8.03 (2H, d, J = 9.0, H-2′,6′), 13.00 (1H, s, 5-OH) [172]



Rivularin (5,2′-dihydroxy-7,8,6′-trimethoxyflavone)

S. glabrata [133], *S. indica* [113], *S. ramosissima* [126], *S. rivularis* [72, 116, 117], *S. virularis* [134]
$C_{18}H_{16}O_7$: 344
mp: 259°C

UV: 270, 340
IR: 3530-3350 (OH), 2935 (OCH_3), 1664 (C=O γ-pyrone), 1617, 1583 (C=C aromatic)
Mass: 344 $[M]^+$ (73), 329 $[M - 15]^+$ (100), 221, 183, 149, 121, 111, 97, 91, 83, 69

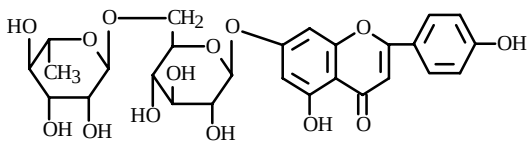


Rivularin 2′-O-glucuronide
(5-hydroxy-7,8,6′-trimethoxy-2′-O-β-D-glucuronidopyranosylflavone)

S. rivularis [110]
$C_{24}H_{24}O_{13}$
mp: 186-188°C (dec.) (MeOH)

$[\alpha]_D^{30}$ +32.7° (*c* 0.2, pyridine)
UV: 266 (4.28), 310 sh (3.69), 340 (3.61); +CH_3ONa, 270 (4.25), 376 (3.79); +$AlCl_3$, 277 (4.39), 320 sh (3.84), 400 (3.67); +$AlCl_3$/HCl, 270 (4.38), 320 sh (3.83), 400 (3.68); +CH_3COONa, 265 (4.39), 310 sh (3.83), 340 (3.71); +H_3BO_3/CH_3COONa, 265 (4.38), 310 sh (3.81), 340 (3.71)
IR: 3456 (OH), 1735 (COOH), 1660 (C=O γ-pyrone), 1618, 1588 (C=C aromatic)
FAB-MS *m/z* (%): 521 $[M + 1]^+$ (22)
EI-MS *m/z* (%): 344 [$C_{18}H_{16}O_7$ (aglycone)] (54), 329 [aglycone - CH_3] (100), 181 [$C_9H_8O_5$ - CH_3] (26), 153 [$C_9H_8O_5$ - CH_3 - CO] (31)
PMR (DMSO-d_6): 3.70, 3.78, 3.91 (3H, s, each 3×OCH_3), 6.32 (1H, s, H-6), 6.61 (1H, s, H-3), 6.88 (1H, d, J = 8.4, H-3′ or H-5′), 6.92 (1H, d, J = 8.4, H-3′ or H-5′), 7.50 (1H, d, J = 8.4, H-4′), 3.06-3.86 (3H, m, H-2″,3″,4″), 3.84 (1H, d, J = 9.1, H-5″), 5.11 (1H, d, J = 7.7, H-1″), 12.69 (1H, s, 5-OH)
^{13}**C NMR** (DMSO-d_6):

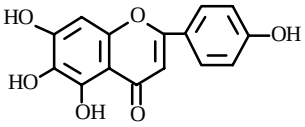
C-2	161.0	C-10	104.2	C-2″	72.8
3	112.3	1′	111.3	3″	75.8
4	182.1	2′	155.6	4″	71.3
5	156.7	3′	107.4	5″	75.2
6	95.9	4′	132.7	6″	170.1
7	158.3	5′	105.5	OCH_3	56.2
8	128.4	6′	158.1	OCH_3	56.5
9	149.8	1″	99.8	8-OCH_3	61.1



Roifolin (apigenin 7-O-rutinoside)

S. polyodon [53, 55]
$C_{27}H_{30}O_{14}$: 578
mp: 261-262°C (EtOH)

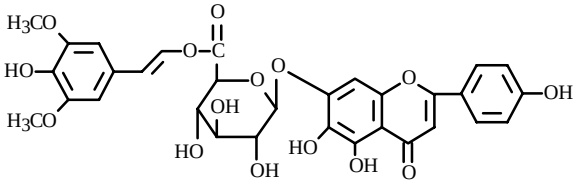
$[\alpha]_D^{20}$ -92.0° (*c* 0.1, DMF)
UV: 269, 334
IR: 3550-3340 (OH), 1665 (C=O γ-pyrone), 1615, 1578, 1510 (C=C aromatic), 1092, 1058, 1005 (C–O glycosides)



Scutellarein (5,6,7,4′-tetrahydroxyflavone)

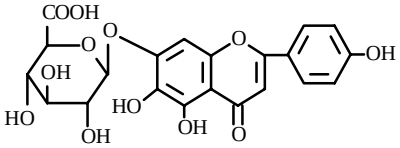
S. adenostegia [57], *S. adsurgens* [59], *S. alpina* [60], *S. altissima* [75, 104], *S. baicalensis* [81], *S. creticola* [62], *S. galericulata* [64, 65], *S. grossa* [91], *S. indica* [67], *S. litwinowii* [76], *S. polyodon* [53, 135], *S. przewalskii* [71], *S. pycnoclada* [57], *S. scordlifolia* [74], *S. sevanensis* [54], *S. supina* [57], *S. tournefortii* [136]

$C_{15}H_{10}O_6$: 286
mp: >340°C
UV: 284, 336; +CH_3COONa, 264 sh, 278, 302, 384; +CH_3COONa/H_3BO_3, 289, 344; +$AlCl_3$, 304, 375; +$AlCl_3$/HCl, 302, 361; +CH_3ONa, 279 sh, 308, 334, 384
IR: 3450 (OH), 1665 (C=O γ-pyrone), 1615, 1580, 1515 (C=C aromatic)



Scutellarein 7-O-β-D-glucuronidesinapoyl

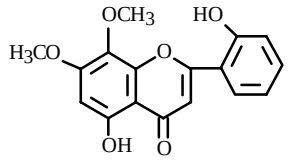
S. polyodon [135]
$C_{31}H_{28}O_{15}$: 640
UV: 285, 336; +CH_3COONa, 286, 338
IR: 3384 (OH), 1740 (C=O ester), 1665 (C=O γ-pyrone), 1615, 1584, 1510 (C=C aromatic), 834 (4′-substituent)



Scutellarin (scutellarein 7-O-glucuronide)

S. adenostegia [57], *S. adsurgens* [59], *S. alpina* [60], *S. altaica* [137], *S. altissima* [75, 104, 105], *S. baicalensis* [107], *S. barbata* [138], *S. columnae* [107], *S. creticola* [62], *S. galericulata* [64, 65], *S. grossa* [91], *S. ikonnikovii* [108], *S. ikona* [105], *S. indica* [67], *S. karjaginii* [69], *S. lateriflora* [105], *S. litwinowii* [76], *S. nepetoides* [185], *S. orientalis* [69], *S. peregrina* [105], *S. polyodon* [53, 135], *S. prilipkoana* [12], *S. przewalskii* [71], *S. pycnoclada* [57], *S. scordiifolia* [74], *S. supina* [57], *S. tournefortii* [136]
$C_{21}H_{18}O_{12}$: 462
mp: 220°C (dec.)
$[\alpha]_D$ -102.0°
UV: 285, 335; +$ZrOCl_2$, 305, 375; +NaOH, 375
PMR (DMSO-d_6): 5.17 (1H, d, J = 7.3, H-1′), 6.80 (1H, s, H-8), 6.94 (2H, d, J = 8.4, H-3′,5′), 6.99 (1H, s, H-3), 7.91 (2H, d, J = 8.4, H-2′,6′), 12.73 (1H, s, 5-OH)
^{13}**C NMR** (DMSO-d_6) [108]:

C-2	164.05	C-9	151.06	C-6′	128.29
3	102.35	10	105.80	1″	100.30
4	182.25	1′	121.09	2″	72.79
5	146.74	2′	128.29	3″	75.03
6	130.46	3′	115.92	4″	71.49
7	148.91	4′	161.24	5″	75.36
8	93.77	5′	115.92	6″	170.68

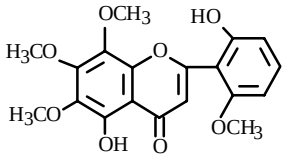


Skullcapflavone I (5,2′-dihydroxy-7,8-dimethoxyflavone)

S. alpina [60], *S. baicalensis* [84], *S. glabrata* [112], *S. prostrata* [95], *S. rivularis* [74]
$C_{17}H_{14}O_6$: 314
mp: 259-260°C

UV: 272, 343
IR: 3500-3350 (OH), 2932 (OCH_3), 1665 (C=O γ-pyrone), 1615, 1583 (C=C aromatic)
Mass: 314 $[M]^+$, 299 $[M - CH_3]^+$ (100), 271 $[M - CH_3 - CO]^+$, 181, 153, 121, 113
PMR (DMSO-d_6): 3.75, 3.84 (3H, s, each 2×OCH_3), 6.56 (1H, s, H-3), 6.97 (1H, s, H-6), 6.87-7.91 (4H, m, H-3′,4′,5′,6′), 12.91 (br.s, 5-OH)
^{13}**C NMR** (DMSO-d_6+D_2O) [170]:

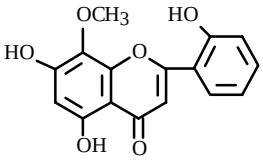
C-2	161.2	C-8	127.8	C-4′	132.3
3	108.6	9	156.1	5′	119.1
4	181.8	10	103.6	6′	128.7
5	148.6	1′	117.1	8-OCH_3	60.6
6	95.4	2′	156.4	7-OCH_3	56.1
7	157.9	3′	116.4		



Skullcapflavone II (5,2′-dihydroxy-6,7,8,6′-tetramethoxyflavone)

S. amoena [139], *S. baicalensis* [79-82, 84, 85, 140]
$C_{18}H_{16}O_7$: 344
mp: 180-181°C (ethylacetate)
UV: 270 (4.46)
IR: 3200-3100 (OH), 1650 (C=O γ-pyrone), 1600, 1560 (C=C aromatic)
PMR (DMSO-d_6): 3.76, 3.80, 3.82, 4.00 (3H, s, each 4×OCH_3), 6.22 (1H, s, H-3), 6.56 (2H, d, J = 8.0, H-3′,5′), 7.24 (1H, t, J = 8.0, H-4′), 10.0 (1H, br.s, 2′-OH), 12.67 (1H, s, 5-OH) [84]
^{13}**C NMR** (DMSO-d_6+D_2O) [170]:

C-2	162.1	C-8	132.2	C-4′	132.2
3	111.7	9	148.2	5′	101.9
4	182.2	10	118.9	6′	158.1
5	146.0	1′	108.6	7,8-OCH_3	61.4
6	135.5	2′	156.4	6-OCH_3	60.2
7	152.2	3′	106.1	6′-OCH_3	55.8



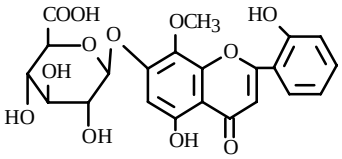
Scutevulin (5,7,2′-trihydroxy-8-methoxyflavone)

S. alpina [60], *S. baicalensis* [127, 141, 181], *S. discolor* [111], *S. indica* [113], *S. prostrata* [95], *S. rivularis* [72, 117, 181]
$C_{16}H_{12}O_6$: 300
mp: 278°C (dec.) (MeOH) [181]

UV: 234 sh, 263 sh, 281, 330, 380 sh; +CH_3ONa, 240, 282, 327 sh, 414; +$AlCl_3$, 256 sh, 284, 296 sh, 359, 400 sh; +$AlCl_3$/HCl, 255 sh, 285, 296 sh, 356, 410 sh; +CH_3COONa, 266 sh, 284, 410 sh
IR: 3350 (OH), 1650 (C=O γ-pyrone), 1600, 1570 (C=C aromatic)
Mass: 300 $[M]^+$, 285 $[M - CH_3]^+$
PMR (DMSO-d_6): 3.83 (3H, s, OCH_3), 6.30 (1H, s, H-6), 7.08 (1H, s, H-3), 7.87 (1H, dd, J = 7.9 and 1.5, H-6′), 7.43 (1H, br.t, J = 7 and 9, H-4′), 7.00-7.10 (2H, m, H-3′,5′), 12.85 (1H, s, 5-OH) [181]

^{13}**C NMR** (DMSO-d_6) [181]:

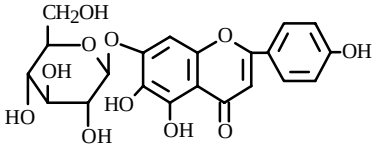
C-2	161.3	C-8	127.8	C-4′	133.0
3	109.0	9	149.8	5′	119.6
4	182.2	10	103.5	6′	128.3
5	156.3	1′	117.5	8-OCH_3	61.0
6	99.0	2′	157.1		
7	157.6	3′	117.3		



Scutevulin 7-O-glucuronide
(5,2′-dihydroxy-8-methoxy-7-O-β-D-glucopyranosylflavone)

S. prostrata [95]
$C_{22}H_{20}O_{12}$: 476
mp: 257-259°C (dec.)
$[\alpha]_D^{31}$ -101° (*c* 0.04, MeOH)
UV: 275 (4.26), 342 (3.93); +CH_3ONa, 233 sh (4.24), 261 sh (4.19), 272 (4.22), 387 (4.07); +$AlCl_3$, 284 (4.25), 297 (4.22), 353 (4.00), 382 sh (3.81); +$AlCl_3$/HCl, 284 (4.26), 298 (4.21), 350 (4.10), 383 sh (3.80); +CH_3COONa, 213 (4.62), 218 sh (4.61), 275 (4.38), 341 (4.04); +CH_3COONa/H_3BO_3, 214 (4.64), 219 sh (4.63), 275 (4.33), 345 (4.00)
IR: 3456 (OH), 1736 (COOH), 1654 (C=O γ-pyrone), 1616 (C=C aromatic)
EI-MS *m/z* (%): 300 $C_{16}H_{12}O_6$ (50), 285 $C_{15}H_9O_6$ (100)
FAB-MS *m/z* (%): 477 $[M + 1]^+$ (35), 301 $[C_{16}H_{12}O_6 + 1]$ (100)
PMR (DMSO-d_6): 3.85 (3H, s, 8-OCH_3), 3.31-3.98 (sugar protons), 5.25 (1H, d, J = 7.3, anomeric proton of glucuronic acid H-1″), 6.69 (1H, s, H-6), 7.14 (1H, s, H-3), 7.04 (1H, br.t, J = 7.4, H-5′), 7.08 (1H, dd, J = 1.5 and 8.1, H-6′), 12.61 (1H, s, 5-OH)
^{13}**C NMR** (DMSO-d_6):

C-2	161.7	C-10	105.1	C-2″	72.9
3	109.0	1′	117.2	3″	75.2
4	182.4	2′	157.1	4″	71.4
5	155.9	3′	117.1	5″	75.9
6	98.4	4′	133.1	6″	170.4
7	155.9	5′	119.6	8-OCH_3	61.4
8	129.2	6′	128.3		
9	149.2	1″	99.7		

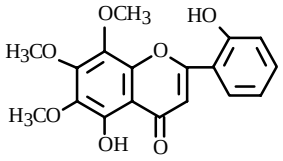


Scutellarein 7-O-β-D-glucopyranoside

S. immaculata [186], *S. indica* [67], *S. przewalskii* [71]
$C_{21}H_{20}O_{11}$: 448
mp: 194-195°C (dec.) (MeOH)
$[\alpha]_D^{18}$ -73.5° (*c* 0.07, MeOH)
UV: 287 (4.30), 337 (4.40); +CH_3ONa, 314 (4.18), 382 (4.51); +$AlCl_3$, 292 sh (4.22), 305 (4.33), 370 (4.47); +$AlCl_3$/HCl, 290 sh (4.23), 303 (4.33), 360 (4.44); +CH_3COONa, 295 (4.20), 350 (4.25), 385 (4.21); +CH_3COONa/H_3BO_3, 295 (4.39), 331 (4.35)
IR: 3350 (OH), 1660 (C=O γ-pyrone), 1605 (C=C aromatic)
Mass: 448 $[M]^+$ (tr.), 286 $[C_{15}H_{10}O_6]$ (100), 168 $[C_7H_4O_5]$ (60)
PMR (DMSO-d_6): 5.08 (1H, d, J = 5.9, anomeric proton of glucose H-1″), 6.83 (1H, s, H-3), 6.97 (2H, d, J = 8.8, H-3′,5′), 7.04 (1H, s, H-8), 7.95 (2H, d, J = 8.8, H-2′,6′), 8.56 (1H, s, 6-OH), 10.40 (1H, s, 4′-OH), 12.75 (1H, s, 5-OH)

^{13}**C NMR** (DMSO-d_6):

C-2	164.3	C-9	151.5	C-6′	128.5
3	102.6	10	106.0	1″	101.2
4	182.6	1′	121.5	2″	73.3
5	146.8	2′	128.5	3″	76.0
6	130.6	3′	116.1	4″	69.8
7	149.2	4′	161.4	5″	77.4
8	94.3	5′	116.1	6″	60.8

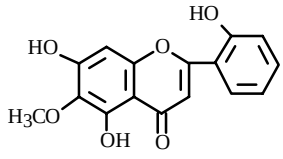


Tenaxin I (5,2′-dihydroxy-6,7,8-trimethoxyflavone)

S. baicalensis [184, 127, 142], *S. tenax* [99]
$C_{18}H_{16}O_7$: 344
mp: 234-235°C (MeO) [184]

UV: 277, 336; +$AlCl_3$, 250 sh, 285, 358; +CH_3COONa, 276, 418
IR: 3300, 3000 (OH), 1640 (C=O γ-pyrone), 1620, 1590 (C=C aromatic)
Mass: 344 $[M]^+$, 118 $[C_8H_6O]$
PMR (DMSO-d_6): 3.84, 3.91, 4.04 (3H, s, each 3×OCH_3), 7.12 (1H, s, H-3), 7.87 (1H, dd, J = 8.1 and 7.1, H-6′), 6.96-7.12 (2H, m, H-3′,5′), 7.36-7.51 (1H, m, H-4′), 12.56 (1H, s, 5-OH) [184]
^{13}**C NMR** (DMSO-d_6) [184]:

C-2	162.1	C-8	132.9	C-4′	133.3
3	108.9	9	148.6	5′	119.7
4	183.0	10	106.3	6′	128.4
5	145.6	1′	117.3	6-OCH_3	60.6
6	135.9	2′	157.3	7-OCH_3	61.5
7	152.8	3′	117.3	8-OCH_3	61.9

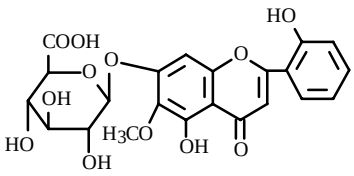


Tenaxin II (5,7,2′-trihydroxy-6-methoxyflavone)

S. amoena [139], *S. baicalensis* [127, 184], *S. viscidula* [143]
$C_{16}H_{12}O_6$: 300
mp: 270-272°C (methanol)

UV: 249, 271, 339; +$AlCl_3$, 256, 278 sh, 286, 362; +CH_3COONa, 268, 378 [184]
IR: 3500 (OH), 1650 (C=O γ-pyrone), 1610, 1570 (C=C aromatic)
Mass: 300 $[M]^+$, 285 $[M - CH_3]^+$, 118 $[C_8H_6O]$
PMR (DMSO-d_6): 3.78 (3H, s, OCH_3), 7.07 (1H, s, H-3), 6.60 (1H, s, H-8), 7.88 (1H, dd, J = 8.3 and 1.5, H-6′), 6.93-7.11 (2H, m, H-3′,5′), 7.33-7.50 (1H, m, H-4′), 13.02 (1H, s, 5-OH) [184]
^{13}**C NMR** (DMSO-d_6) [184]:

C-2	161.5	C-8	94.3	C-4′	132.5
3	108.6	9	152.8	5′	119.5
4	182.5	10	104.2	6′	128.6
5	152.8	1′	117.4	OCH_3	60.0
6	131.4	2′	156.9		
7	157.7	3′	117.2		

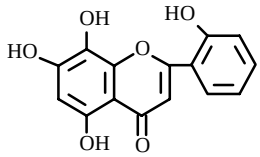


Tenaxin II 7-O-glucuronide

S. baicalensis [144]
$C_{22}H_{20}O_{12}$: 476
mp: 269°C
$[\alpha]_D^{25}$ -68.4° (*c* 0.07, MeOH)

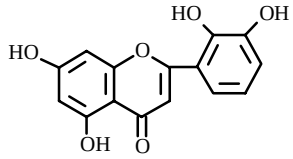
UV: 270 (4.40), 333 (4.21); +CH_3ONa, 275 (4.36), 400 (4.32); +$AlCl_3$, 275 sh (4.36), 285 (4.42), 358 (4.25); +$AlCl_3$/HCl, 275 sh (4.36), 284 (4.43), 351 (4.25); +CH_3COONa, 269 (4.34), 300 sh (4.02), 405 (3.90); +CH_3COONa/H_3BO_3, 270 (4.49), 336 (4.34)
IR: 3452 (OH), 1741 (COOH), 1645 (C=O γ-pyrone), 1608 (C=C aromatic)
PMR (DMSO-d_6): 3.77 (3H, s, 6-OCH_3), 7.07 (1H, s, H-8), 7.12 (1H, s, H-3), 7.03 (1H, br.t, J = 8.1, H-5′), 7.07 (1H, br.d, J = 7.7, H-3′), 7.23 (1H, dt, J = 1.5 and 8.1, H-4′), 7.90 (1H, dd, J = 1.5 and 8.1, H-6″), 3.35 (2H, m, H-2″,3″), 3.43 (1H, t, J = 9.5, H-4″), 4.05 (1H, d, J = 9.5, H-5″), 5.33 (1H, d, J = 7.3, H-1″), 5.29 (1H, d, J = 4.7, 3″-OH), 5.57 (1H, d, J = 5.1, 2″-OH), 10.88 (1H, s, 2′-OH), 12.88 (1H, s, 5-OH)
^{13}**C NMR** (DMSO-d_6):

C-2	161.9	C-9	152.4	C-6′	128.5
3	108.8	10	105.9	1″	99.3
4	182.5	1′	117.1	2″	72.8
5	152.5	2′	156.8	3″	75.9
6	132.4	3′	117.1	4″	71.2
7	156.2	4′	133.0	5″	75.4
8	93.9	5′	119.4	6″	170.0
				6-OCH_3	60.3



5,7,8,2′-Tetrahydroxyflavone (2′-hydroxynorwogonin)

S. creticola [62], *S. litwinowii* [76]
$C_{15}H_{10}O_6$: 286
UV: 281, 354
IR: 3540, 3250 (OH), 1655 (C=O γ-pyrone), 1610, 1580 (C=C aromatic)



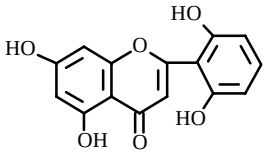
5,7,2′,3′-Tetrahydroxyflavone

S. baicalensis [127, 141, 181]
$C_{15}H_{10}O_6$: 286
mp: >360°C (MeOH) [181]

UV: 235 sh, 269, 277 sh, 295 sh, 348; +CH_3ONa, 239 sh, 274, 301 sh, 400; +$AlCl_3$, 227 sh, 252 sh, 274, 290, 300, 349, 380, 420 sh; +$AlCl_3$/HCl, 254 sh, 278, 285 sh, 295 sh, 334, 380; +CH_3COONa, 274, 303 sh, 400; +CH_3COONa/H_3BO_3, 269, 297, 378 sh
IR: 3350 (OH), 1650 (C=O γ-pyrone), 1610 (C=C aromatic)
Mass: 286 $[M]^+$, 134 $[C_8H_6O_2]$
PMR (DMSO-d_6): 7.06 (1H, s, H-3), 6.23 (1H, d, J = 1.9, H-6), 6.47 (1H, d, J = 1.9, H-8), 7.02 (1H, br.d, J = 7.4, H-4′), 6.83 (1H, br.t, J = 7.4, H-5′), 7.33 (1H, br.d, J = 7.4, H-6′), 12.95 (1H, s, 5-OH) [181]

^{13}C NMR (DMSO-d_6) [56, 170]:

C-2	161.9	C-7	164.5	C-2′	145.7
3	109.1	8	93.9	3′	146.1
4	182.1	9	157.7	4′	117.9
5	161.6	10	103.9	5′	119.3
6	98.8	1′	117.9	6′	118.6

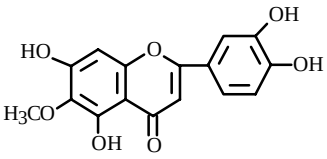


5,7,2′,6′-Tetrahydroxyflavone

S. baicalensis [103, 127, 128]
$C_{15}H_{10}O_6$: 286
mp: >360°C (MeOH) [128]

UV: 261, 310; +CH_3COONa, 268, 340; +$AlCl_3$, 269, 290 sh, 325, 370; +CH_3ONa, 269, 352; +CH_3COONa/H_3BO_3, 261, 310
IR: 3450, 3100 (OH), 1650 (C=O γ-pyrone), 1610, 1580 (C=C aromatic)
PMR (DMSO-d_6): 6.20 (1H, s, H-3), 6.23 (1H, d, J = 2.4, H-6), 6.36 (1H, d, J = 2.4, H-8), 6.43 (2H, d, J = 8.5, H-3′,5′), 7.14 (1H, t, J = 8.5, H-4′), 12.90 (1H, s, 5-OH)
^{13}C NMR (DMSO-d_6):

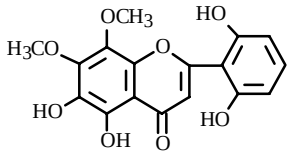
C-2	162.5	C-7	164.3	C-2′	156.8
3	108.7	8	94.0	3′	106.9
4	182.0	9	161.8	4′	131.9
5	158.4	10	104.2	5′	106.9
6	98.8	1′	112.1	6′	156.8



5,7,3′,4′-Tetrahydroxy-6-methoxyflavone (6-methoxyluteolin)

S. ovata [70]
$C_{16}H_{12}O_7$: 316
mp: 299°C

UV: 253 (4.23), 272 (4.17), 346 (4.30)
IR: 3410 (OH), 1662 (CO)
Mass: 316 $[M]^+$, 302 (8), 301 (50), 299 (4), 288 (25), 297 (2), 287 (2.5), 274 (2.5), 273 (28), 270 (4), 167 (6), 153 (2), 139 (13), 137 (3.5), 135 (10) [172]
PMR (CD_3OD): 7.37-7.32 (2H, m, H-2′,6′), 6.94-6.83 (1H, d, J = 9, H-5′), 6.51, 5.87 (1H, s, H-3), 6.43-6.41 (1H, d, J = 2, H-8), 6.21-6.18 (1H, s, J = 2, H-6), 3.88 (3H, s, 6-OCH_3) [70]



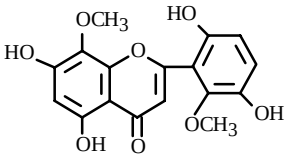
5,6,2′,6′-Tetrahydroxy-7,8-dimethoxyflavone

S. prostrata [95]
$C_{17}H_{14}O_8$: 346
mp: 274-275°C (dec.)

UV: 231 sh (4.26), 278 (4.30), 318 sh (3.93), 372 sh (3.47); +CH_3ONa, 245 sh (4.20), 288 (4.03), 349 (3.83), 380 sh (3.70); +$AlCl_3$, 232 sh (4.31), 295 (4.28), 345 (4.08), 420 (3.45); +$AlCl_3$/HCl, 292 (4.29), 335 (4.05), 420 (3.41); +CH_3COONa, 278 (4.27), 321 sh (3.89); +CH_3COONa/H_3BO_3, 279 (4.33), 326 (3.73), 387 sh (3.37)
IR: 3388 (OH), 1662 (C=O γ-pyrone), 1626 (C=C aromatic)
EI-MS *m/z* (%): 346 $[M]^+$ (80), 331 $[M - CH_3]^+$ (100), 197 $[C_8H_5O_6]$ (65)
Gives a positive qualitative reaction with $SrCl_2$
PMR (DMSO-d_6): 3.82, 3.95 (3H, s, each 2×OCH_3), 6.27 (1H, s, H-3), 6.45 (1H, d, J = 8.2, H-3′,5′), 7.14 (1H, t, J = 8.2, H-4′),

9.90 (2H, s, 2′,6′-OH), 9.05 (1H, s, 6-OH), 12.45 (1H, s, 5-OH)
^{13}**C NMR** (DMSO-d_6):

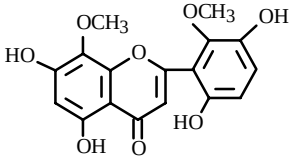
C-2	162.6	C-8	132.7	C-4″	132.7
3	111.2	9	142.8	5″	106.5
4	182.5	10	106.1	6″	156.5
5	142.9	1′	108.2	OCH_3	60.8
6	133.8	2′	156.6	OCH_3	61.6
7	147.9	3′	106.5		



5,7,2′,5′-Tetrahydroxy-8,6′-dimethoxyflavone

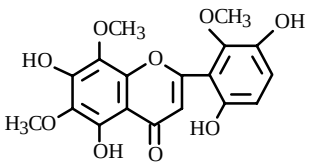
S. baicalensis [102, 183], *S. viscidula* [143]
$C_{17}H_{14}O_8$: 346
mp: 255°C (MeOH) [183]
UV: 273 (4.42), 343 (4.17); +$AlCl_3$, 278 (4.49), 326 (4.22), 378 (4.22); +$AlCl_3$/HCl, 277 (4.46), 320 (4.20), 370 (4.20); +CH_3COONa, 278 (4.44), 364 (4.19); +CH_3COONa/H_3BO_3, 268 (4.42), 347 (4.15)
IR: 3250 (OH), 1650 (C=O γ-pyrone), 1610, 1580 (C=C aromatic)
Mass: 346 $[M]^+$, 331 $[M - CH_3]^+$, 164 $[C_9H_8O_3]$
PMR (DMSO-d_6): 3.74, 3.77 (3H, s, each 2×OCH_3), 6.31 (1H, s, H-6), 6.35 (1H, s, H-3), 6.60 (1H, d, J = 8.8, H-3′), 6.93 (1H, d, J = 8.8, H-4′), 12.58 (1H, s, 5-OH) [183]
^{13}**C NMR** (DMSO-d_6) [183]:

C-2	162.0	C-7	157.5	C-3′	111.4
3	111.8	8	127.9	4′	120.1
4	182.1	9	148.5	5′	142.7
5	156.6	10	103.9	6′	146.3
6	93.3	1′	115.1	6′- OCH_3	60.6
		2′	150.7	8-OCH_3	61.0



5,7,3′,6′-Tetrahydroxy-8,2′-dimethoxyflavone (viscidulin III)

S. baicalensis [80-82, 103, 127, 142], *S. rehderiana* [145]
$C_{17}H_{14}O_8$: 346
mp: 255-256°C (MeOH)
UV: 264, 338
IR: 3500-3360 (OH), 2934 (OCH_3), 1662 (C=O γ-pyrone), 1614, 1575 (C=C aromatic)
Mass: 346 $[M]^+$ (67), 331 $[M - CH_3]^+$ (100), 316, 303, 288, 167, 139
PMR (Py-d_5): 3.75 (3H, s, OCH_3), 3.97 (3H, s, OCH_3), 6.66 (1H, s, H-3), 6.76 (1H, s, H-6), 6.84 (1H, d, J = 7.5, H-5′), 7.19 (1H, d, J = 7.5, H-4′), 13.20 (br.s, 5-OH)

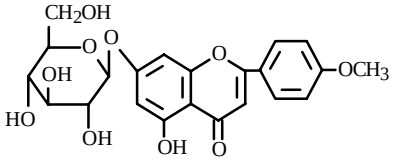


5,7,3′,6′-Tetrahydroxy-6,8,2′-trimethoxyflavone

S. planipes [125]
$C_{18}H_{16}O_9$: 376
mp: 243-245°C (dec.) (MeOH)
UV: 267, 311 (4.38, 3.98)
IR: 3360 (OH), 1664 (C=O γ-pyrone), 1626, 1594 (C=C aromatic)

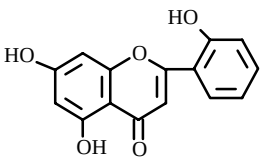
EI-MS *m/z* (%): 376 $[M]^+$ (89.1), 361 (100), 197 (3.48), 169 (22.8)
PMR (DMSO-d_6) ppm: 3.73 (3H, s, 2′-OCH_3), 3.74 (3H, s, 8-OCH_3), 3.79 (3H, s, 6-OCH_3), 6.27 (1H, s, H-3), 6.57 (1H, d, J = 8.8, H-5′), 6.88 (1H, d, J = 8.8, H-4′)
^{13}**C NMR** (DMSO-d_6):

C-2	161.7	C-8	127.8	C-4′	119.8
3	111.13	9	145.9	5′	111.06
4	182.1	10	103.0	6′	148.3
5	148.2	1′	114.8	6-OCH_3	60.1
6	131.6	2′	146.3	8-OCH_3	61.0
7	151.0	3′	142.4	2′-OCH_3	60.4



Tilianin (5-hydroxy-4′-methoxy-7-O-*β*-D-glucopyranosylflavone)

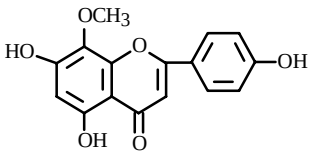
S. polyodon [53, 135]
$C_{22}H_{22}O_{10}$: 446
mp: 234-236°C
UV: 270, 325; +CH_3ONa, 290, 370; +CH_3COONa, 278, 342; +CH_3COONa/H_3BO_3, 270, 325; +$AlCl_3$ and $AlCl_3$/HCl, 278, 348, 390
PMR (Py-d_5): 7.86 (2H, d, J = 9, H-2′,6′), 7.04 (2H, d, J = 9, H-3′,5′), 7.00 (1H, d, J = 2.5, H-6), 6.85 (s, H-3), 6.76 (1H, d, J = 2.5, H-8), 5.70 (1H, d, J = 7.0, H-1″), 3.00-6.00 (6H glucose), 3.75 (s, 4-OCH_3)



5,7,2′-Trihydroxyflavone (2′-hydroxychrysin)

S. adsurgens [59], *S. alpina* [60], *S. baicalensis* [102, 127, 183], *S. prostrata* [95], *S. pycnoclada* [57], *S. sevanensis* [54], *S. tournefortii* [124]
$C_{15}H_{10}O_5$: 270
mp: 284°C (MeOH) [183]
UV: 268 (4.33), 342 (4.04); +$AlCl_3$, 254 (4.06), 277 (4.34), 287 sh (4.30), 356 (4.12), 390 sh (4.06); +CH_3COONa, 274 (4.39), 325 sh (3.77), 380 (3.95)
IR: 3350 (OH), 1650 (C=O γ-pyrone), 1610, 1580 (C=C aromatic)
Mass: 270 $[M]^+$, 118 $[C_8H_6O]$
PMR (DMSO-d_6): 6.22 (1H, d, J = 1.7, H-6), 6.49 (1H, d, J = 1.7, H-8), 6.93-7.49 (3H, m, H-3′,4′,5′), 7.06 (1H, s, H-3), 7.87 (1H, dd, J = 7.9 and 1.5, H-6′), 12.90 (1H, s, 5-OH) [183]
^{13}**C NMR** (DMSO-d_6) [183]:

C-2	161.6	C-7	164.5	C-2′	156.8
3	109.2	8	94.0	3′	117.1
4	182.1	9	157.7	4′	132.9
5	161.6	10	103.9	5′	119.6
6	98.8	1′	117.4	6′	128.7



5,7,4′-Trihydroxy-8-methoxyflavone (4′-hydroxywogonin)

S. alpina [60], *S. baicalensis* [67, 128], *S. discolor* [63, 121], *S. indica* [113], *S. prostrata* [95], *S. rivularis* [72]
$C_{16}H_{12}O_6$: 300
mp: 300-302°C (dec.) (MeOH) [128]

UV: 277, 303 sh, 328, 360 sh; +CH_3COONa, 284, 310 sh, 396; +$AlCl_3$, 264 sh, 284, 312, 353, 400; +CH_3ONa, 284, 330 sh, 400

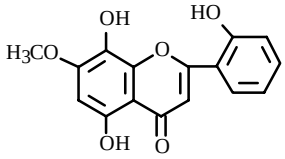
IR: 3430, 3200 (OH), 1660 (C=O γ-pyrone), 1610, 1580 (C=C aromatic)

Mass: 300 $[M]^+$ (55.6), 285 (100), 118 (19.4)

PMR (DMSO-d_6): 3.82 (3H, s, OCH_3), 6.20 (1H, s, H-6), 6.68 (1H, s, H-3), 6.87 (2H, d, J = 9, H-3′,5′), 7.81 (2H, d, J = 9, H-2′,6′), 12.35 (1H, s, 5-OH)

^{13}**C NMR** (DMSO-d_6) [128]:

C-2	163.8	C-8	127.9	C-4′	161.5
3	102.9	9	156.5	5′	116.3
4	182.1	10	103.7	6′	128.5
5	149.7	1′	121.5	OCH_3	61.1
6	99.1	2′	128.5		
7	157.2	3′	116.3		



5,8,2′-Trihydroxy-7-methoxyflavone

S. baicalensis [128, 129, 191]

$C_{16}H_{12}O_6$: 300

mp: 270-272°C

UV: 271 (4.39), 338 (4.27); +CH_3ONa, 238 sh (4.49), 272 (4.35), 290 sh (3.97), 4.64 (4.33); +CH_3COONa, 270 (4.41), 340 (4.23); +$AlCl_3$, 256 (4.14), 280 sh (4.38), 286 (4.41), 360 (4.31); +$AlCl_3$/HCl, 254 (4.11), 280 sh (4.37), 285 (4.39), 354 (4.28) [191]

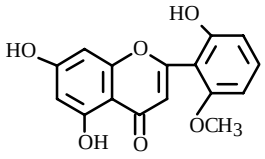
IR: 3450 (OH), 1660 (C=O γ-pyrone)

Mass: 300 $[M]^+$, 118 $[C_8H_6O]$

PMR (DMSO-d_6): 3.82 (3H, s, OCH_3), 6.62 (1H, s, H-6), 7.07 (1H, s, H-3), 7.0-7.9 (4H, m, H-3′,4′,5′,6′), 12.53 (1H, s, 5-OH)

^{13}**C NMR** (DMSO-d_6) [191]:

C-2	161.5	C-8	131.4	C-4′	132.6
3	108.6	9	152.6	5′	119.4
4	182.2	10	104.2	6′	128.5
5	152.6	1′	117.5	OCH_3	59.9
6	94.2	2′	156.5		
7	157.3	3′	117.0		



5,7,2′-Trihydroxy-6′-methoxyflavone

S. baicalensis [127, 141, 181]

$C_{16}H_{12}O_6$: 300

mp: 256-257°C (dec.) (MeOH) [181]

UV: 263, 323; +CH_3ONa, 269, 342; +$AlCl_3$, 269, 293 sh, 321, 372; +$AlCl_3$/HCl, 270, 291 sh, 318, 372; +CH_3COONa, 269, 340

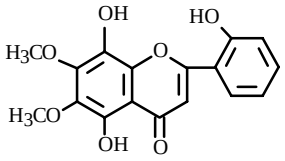
IR: 3350 (OH), 1650 (C=O γ-pyrone), 1610, 1570 (C=C aromatic)

Mass: 300 $[M]^+$, 148 $[C_9H_8O_2]$

PMR (DMSO-d_6): 3.74 (3H, s, OCH_3), 6.19 (1H, s, H-3), 6.20 (1H, d, J = 1.7, H-6), 6.32 (1H, d, J = 1.7, H-8), 6.58 (2H, br.d, J = 8.3, H-3′,5′), 7.29 (1H, br.t, J = 8.3, H-4′), 12.75 (1H, s, 5-OH) [181]

^{13}C NMR (DMSO-d_6) [181]:

C-2	161.9	C-7	164.5	C-3′	108.8
3	112.1	8	93.9	4′	132.3
4	181.9	9	158.4	5′	102.2
5	161.8	1′	104.0	6′	158.5
6	98.9	2′	156.7	6′-OCH_3	55.9

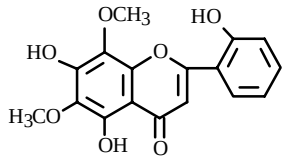


5,8,2′-Trihydroxy-6,7-dimethoxyflavone

S. baicalensis [129, 146, 191]
$C_{17}H_{14}O_7$: 330
mp: 282-283°C

UV: 277 (4.42), 338 (4.19); +CH_3ONa, 238 (4.45), 279 (4.37), 410 (4.30); +CH_3COONa, 276 (4.39), 349 (4.06); +$AlCl_3$, 257 (4.08), 290 (4.39), 360 (4.24); +$AlCl_3$/HCl, 255 (4.06), 289 (4.37), 355 (4.21) [191]
IR: 3350 (OH), 1660 (C=O γ-pyrone)
Mass: 330 $[M]^+$, 118 $[C_8H_6O]$
PMR (DMSO-d_6): 3.83 (3H, s, OCH_3), 3.90 (3H, s, OCH_3), 7.08 (1H, s, H-3), 7.17-7.90 (4H, m, H-3′,4′,5′,6′), 12.76 (1H, s, 5-OH)
^{13}C NMR (DMSO-d_6) [191]:

C-2	161.5	C-8	128.2	C-4′	132.6
3	108.7	9	148.2	5′	119.6
4	182.4	10	103.2	6′	128.3
5	145.6	1′	117.8	OCH_3	61.2
6	131.7	2′	156.7	OCH_3	60.1
7	150.8	3′	117.3		

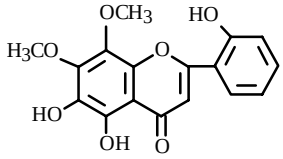


5,7,2′-Trihydroxy-6,8-dimethoxyflavone

S. repens [187]
$C_{17}H_{14}O_7$: 330
mp: 262-263°C (MeOH)

UV: 275 (4.14), 336 (4.18); +CH_3ONa, 278 (4.37), 340 sh (3.82), 409 (4.29); +$AlCl_3$, 289 (4.41), 358 (4.25), 398 sh (3.89); +$AlCl_3$/HCl, 288 (4.40), 354 (4.26), 398 sh (3.82); +CH_3COONa, 267 (4.36), 2.78 (4.36), 323 sh (3.92), 380 (4.10); +CH_3COONa/H_3BO_3, 274 (4.37), 338 (4.03)
IR: 3456 (OH), 1658 (C=O γ-pyrone), 1610, 1578 (C=C aromatic)
Mass: 330 $[M]^+$ (78), 315 $[C_{16}H_{11}O_7]$ (100)
PMR (DMSO-d_6): 3.79 (3H, s, 6-OCH_3), 3.85 (3H, s, 8-OCH_3), 7.04 (1H, br.t, J = 8.0, H-4′), 7.06 (1H, s, H-3), 7.07 (1H, br.d, J = 8.0, H-3′), 7.42 (1H, dt, J = 1.5 and 8.0, H-5′), 7.86 (1H, dd, J = 1.5 and 8.0, H-6′), 10.42, 10.85 (1H, s, each 7,2′-OH), 12.73 (1H, s, 5-OH)
^{13}C NMR (DMSO-d_6):

C-2	161.2	C-8	127.9	C-4′	132.9
3	108.6	9	145.6	5′	119.6
4	182.4	10	103.0	6′	128.2
5	148.2	1′	117.4	6-OCH_3	61.2
6	131.4	2′	156.8	8-OCH_3	60.2
7	151.0	3′	117.1		

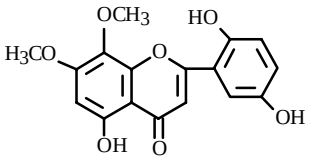


5,6,2′-Trihydroxy-7,8-dimethoxyflavone

S. glabrata [13], *S. grossa* [91], *S. rivularis* [73]
$C_{17}H_{14}O_7$: 330
mp: 249-250°C (MeOH)

UV: 247 sh (3.98), 283 (4.38), 340 (4.16); +CH_3ONa, 258 sh (4.15), 291 (4.27), 305 sh (4.18), 404 (4.17); +$AlCl_3$, 255 sh (3.99), 294 (4.38), 370 (4.28); +$AlCl_3$/HCl, 255 (4.01), 292 (4.34), 305 sh (4.23), 360 (4.24); +CH_3COONa, 285 (4.32), 320 sh (4.06), 347 sh (4.01), 410 (3.89); +CH_3COONa/H_3BO_3, 250 sh (4.02), 285 (4.39), 337 (4.14), 390 sh (3.47) [73]
IR: 3468 (OH), 1664 (C=O γ-pyrone), 1612 (C=C aromatic) [73]
EI-MS *m/z* (%): 330 $[M]^+$ (65), 315 $[M - CH_3]^+$ (100) [73]
PMR (DMSO-d_6): 3.90, 3.96 (3H each, s, each 2×OCH_3), 7.09 (1H, s, H-3), 7.04 (2H, m, H-3′,5′), 7.42 (1H, dt, J = 1.8 and 7.9, H-4′), 7.87 (1H, dd, J = 1.5 and 8.1, H-6′), 9.11 (1H, s, 6-OH), 10.84 (1H, s, 2′-OH), 12.43 (1H, s, 5-OH) [73]
^{13}**C NMR** (DMSO-d_6) [73]:

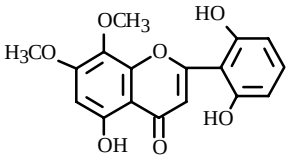
C-2	161.1	C-8	132.9	C-4′	133.0
3	108.5	9	142.1	5′	119.7
4	182.8	10	106.1	6′	128.3
5	142.4	1′	117.4	OCH_3	60.9
6	134.1	2′	156.8	OCH_3	61.8
7	148.2	3′	117.2		



5,2′,5′-Trihydroxy-7,8-dimethoxyflavone (rehderianin I)

S. rehderiana [145]
$C_{17}H_{14}O_7$: 330
mp: 265°C (ethylacetate—hexane)

UV: 277 (3.5), 374 (3.1); +CH_3ONa, 270, 350, 420; +$AlCl_3$, 280, 296 sh, 330 sh, 416; +$AlCl_3$/HCl, 280, 290 sh, 330 sh, 410; +CH_3COONa, 273, 375; +CH_3COONa/H_3BO_3, 273, 375
Mass: 330 $[M]^+$ (56), 315 (100), 287 (5), 181 (35), 165 (7), 158 (14), 153 (27), 125 (8)
PMR (DMSO-d_6): 3.83 (3H, s, OCH_3), 3.89 (3H, s, OCH_3), 6.49 (1H, s, H-6), 6.83-6.87 (2H, m, H-3′,4′), 7.11 (1H, s, H-3), 7.30 (1H, d, J = 2, H-6′), 9.09 (1H, s, OH), 12.64 (1H, s, 5-OH)



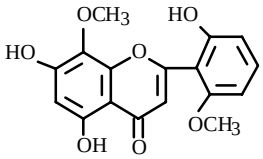
5,2′,6′-Trihydroxy-7,8-dimethoxyflavone (viscidulin II)

S. adenostegia [56], *S. adsurgens* [58, 59], *S. baicalensis* [127, 181], *S. glabrata* [112], *S. indica* [113]
$C_{17}H_{14}O_7$: 330
mp: 286°C (dec.) (MeOH)

UV: 224 sh, 267, 313 sh, 345 sh; +CH_3ONa, 266, 299 sh, 374; +$AlCl_3$, 227 sh, 275, 300 sh, 330, 375; +$AlCl_3$/HCl, 227 sh, 275, 300 sh, 330, 375; +CH_3COONa, 265, 293 sh, 345
IR: 3500-3380 (OH), 1665 (C=O γ-pyrone), 1615, 1583 (C=C aromatic)
Mass: 330 $[M]^+$, 315 $[M - CH_3]$ (100), 138, 134
PMR (DMSO-d_6): 3.73, 3.91 (3H, s, each 2×OCH_3), 6.28 (1H, s, H-3), 6.60 (1H, s, H-6), 6.44 (2H, d, J = 8.0, H-3′,5′), 7.14 (1H, t, J = 8.0, H-4′), 12.75 (1H, br.s, 5-OH) [181]

^{13}C NMR (DMSO-d_6) [56, 170]:

C-2	162.8	C-8	128.4	C-4′	132.2
3	111.8	9	149.9	5′	106.7
4	182.3	10	104.1	6′	156.9
5	146.0	1′	108.2	8-OCH_3	61.1
6	95.9	2′	156.9	7-OCH_3	56.5
7	158.3	3′	106.7		



5,7,2′-Trihydroxy-8,6′-dimethoxyflavone

S. baicalensis [66, 183, 127], *S. discolor* [121]

$C_{17}H_{14}O_7$: 330

mp: 266°C (MeOH) [183]

UV: 267 (4.69), 350 (4.39); +$AlCl_3$, 277 (4.68), 298 sh (4.51), 327 (4.42); +CH_3COONa, 276 (4.75), 362 (4.34); +CH_3COONa/H_3BO_3, 270 (4.66), 355 (4.29)

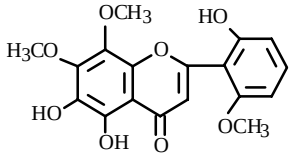
IR: 3500, 3250 (OH), 1650, 1630 (C=O γ-pyrone), 1610, 1570 (C=C aromatic)

Mass: 330 $[M]^+$, 315 $[M - CH_3]^+$, 148 $[C_9H_8O_2]$

PMR (DMSO-d_6): 3.78, 3.79 (3H, s, each 2×OCH_3), 6.32 (1H, s, H-6), 6.38 (1H, s, H-3), 6.63 (1H, d, J = 7.8, H-3′), 6.67 (1H, d, J = 8.3, H-5′), 7.34 (1H, dd, J = 7.8 and 8.3, H-4′), 12.61 (1H, s, 5-OH) [183]

^{13}C NMR (DMSO-d_6) [183]:

C-2	161.9	C-8	127.8	C-4′	132.6
3	112.2	9	150.8	5′	102.4
4	182.1	10	103.9	6′	158.6
5	156.5	1′	109.3	6′-OCH_3	56.0
6	99.2	2′	156.9	8-OCH_3	61.0
7	157.3	3′	109.0		



5,6,2′-Trihydroxy-7,8,6′-trimethoxyflavone (6-hydroxyrivularin)

S. prostrata [95]

$C_{18}H_{16}O_8$: 360

mp: 224-225°C (dec.)

UV: 277 (4.27), 317 sh (3.88), 368 sh (3.44); +$AlCl_3$, 293 (4.20), 346 (3.96), 418 sh (3.43); +$AlCl_3$/HCl, 292 (4.22), 338 (3.96), 430 (3.31); +CH_3COONa, 276 (4.21), 368 sh (3.58); +CH_3COONa/H_3BO_3, 277 (4.30), 368 sh (3.44)

IR: 3384 (OH), 1662 (C=O γ-pyrone), 1622 (C=C aromatic)

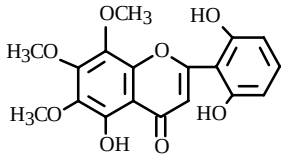
EI-MS *m/z* (%): 360 $[M]^+$ (70), 345 $[M - CH_3]^+$ (100), 197 $[C_8H_5O_6]$ (50)

Gives a positive qualitative reaction with $SrCl_2$

PMR (DMSO-d_6): 3.75, 3.80, 3.95 (3H, s, each 3×OCH_3), 6.28 (1H, s, H-3), 6.62 (2H, d, J = 8.2, H-3′,5′), 7.32 (1H, t, J = 8.2, H-4′), 9.13 (1H, br.s, 6-OH), 10.13 (1H, s, 2′-OH), 12.40 (1H, s, 5-OH)

^{13}C NMR (DMSO-d_6):

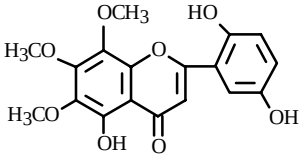
C-2	162.0	C-8	132.8	C-4′	132.3
3	111.4	9	142.8	5′	102.2
4	182.4	10	106.1	6′	158.2
5	143.0	1′	109.0	6′-OCH_3	55.8
6	134.0	2′	156.6	7-OCH_3	60.9
7	148.0	3′	108.7	8-OCH_3	61.9



5,2′,6′-Trihydroxy-6,7,8-trimethoxyflavone

S. adenostegia [56], *S. alpina* [60], *S. ramasissima* [115]
$C_{18}H_{16}O_8$: 360
mp: 246-247°C (dec.)
UV: 270 (4.34), 315 (3.95), 355 sh (3.91); +CH_3COONa, 240 sh (4.37), 265 (4.29), 360 (4.01); +CH_3ONa, 240 sh (4.37), 265 (4.29), 360 (4.01); +$AlCl_3$/HCl, 280 (4.30), 295 sh (4.23), 330 (3.97), 406 (3.65); +CH_3COONa, 269 (4.38), 315 (3.99), 355 sh (3.94)
IR: 3250, 3150 (OH), 1665 (C=O γ-pyrone), 1600 (C=C aromatic)
Mass: 360 $[M]^+$ (80), 345 $[M - CH_3]^+$ (100), 211 $[C_9H_7O_6]$ (40)
PMR (DMSO-d_6): 3.84 (6H, s, 2×OCH_3), 4.02 (3H, s, OCH_3), 6.35 (1H, s, H-3), 6.46 (2H, d, J = 8.0, H-3′,5′), 7.16 (1H, t, J = 8.0, H-4′), 9.99 (2H, s, OH-2′,6′), 12.73 (1H, s, 5-OH)
^{13}**C NMR** (DMSO-d_6) [60]:

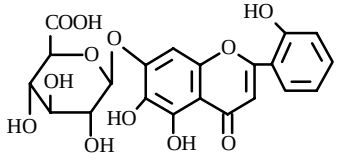
C-2	162.9	C-8	132.8	C-4′	132.3
3	119.9	9	146.5	5′	106.8
4	182.8	10	106.5	6′	157.0
5	146.7	1′	108.2	OCH_3	60.7
6	135.9	2′	157.0	OCH_3	61.5
7	152.7	3′	106.8	OCH_3	61.8



5,2′,5′-Trihydroxy-6,7,8-trimethoxyflavone

S. baicalensis [102, 183, 127]
$C_{18}H_{16}O_8$: 360
mp: 268°C (dec.) (MeOH) [183]
UV: 283 (4.39), 376 (4.08); +$AlCl_3$, 296 (4.41), 334 (4.00), 414 (4.17); +CH_3COONa, 282 (4.37), 382 (4.02); +CH_3COONa/H_3BO_3, 282 (4.39), 380 (4.10)
IR: 3400 (OH), 1650, 1635 (C=O), 1590 (C=C aromatic)
Mass: 360 $[M]^+$, 345 $[M - CH_3]^+$, 134 $[C_8H_6O_2]$
PMR (DMSO-d_6): 3.82, 3.92, 4.03 (3H, s, each 3×OCH_3), 6.90 (2H, br.s, H-3′,4′), 7.19 (1H, s, H-3), 7.33 (1H, br.s, H-6), 12.70 (1H, s, 5-OH) [183]
^{13}**C NMR** (DMSO-d_6) [183]:

C-2	162.0	C-8	132.8	C-4′	120.9
3	108.8	9	145.5	5′	150.1
4	183.0	10	106.3	6′	113.3
5	148.6	1′	118.3	6-OCH_3	60.6
6	135.9	2′	150.1	7-OCH_3	61.5
7	152.7	3′	117.0	8-OCH_3	62.0

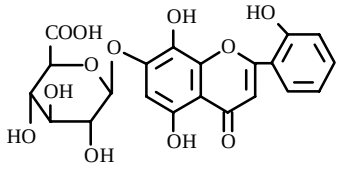


5,6,2′-Trihydroxy-7-O-glucuronylflavone (ikonnikoside I)

S. ikonnikovii [108]
$C_{21}H_{18}O_{11}$: 446
mp: 175-176°C (MeOH)
UV: 275, 330; +CH_3COONa, 275, 334
PMR (DMSO-d_6): 5.15 (1H, d, J = 7.3, anomeric proton of glucuronic acid, H-1″), 6.97, 7.01 (1H, m, H-5′), 6.98 (1H, s, H-8), 7.06 (1H, s, H-3), 7.06 (1H, d, J = 7.7, H-3′), 7.37-7.40 (1H, m, H-4′), 7.85 (1H, dd, J = 6.6 and 1.4, H-6′), 12.65 (1H, s, 5-OH)

^{13}**C NMR** (DMSO-d_6):

C-2	161.69	C-9	151.20	C-6′	128.40
3	108.54	10	105.81	1″	100.06
4	182.45	1′	117.30	2″	72.76
5	146.40	2′	156.63	3″	75.17
6	130.32	3′	117.05	4″	71.34
7	149.20	4′	132.72	5″	75.27
8	93.62	5′	119.32	6″	170.20

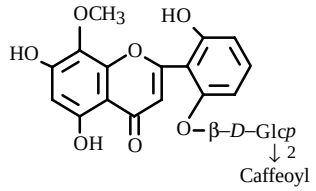


5,8,2′-Trihydroxy-7-O-glucuronidopyranosylflavone

S. rivularis [110]
$C_{21}H_{18}O_{12}$: 462
mp: 174°C (dec.) (MeOH)
$[\alpha]_D^{20}$ -75.9° (*c* 0.03, methanol)

UV: 279 (4.20), 336 (3.80); +CH_3ONa, 258 sh (3.92), 286 (4.03), 330 (3.50), 400 (3.83); +$AlCl_3$, 287 (4.19), 300 (4.18), 355 (3.95), 426 (3.54); +$AlCl_3$/HCl, 286 (4.20), 298 sh (4.18), 351 (3.94), 426 (3.54); +CH_3COONa, 281 (4.34), 330 (4.07), 400 (3.64); +H_3BO_3/CH_3COONa, 279 (4.35), 336 (3.7)
IR: 3426 (OH), 1735 (COOH), 1663 (C=O γ-pyrone), 1620, 1585 (C=C aromatic)
FAB-MS *m/z* (%): 463 $[M + 1]^+$ (33), 287 [$C_{15}H_{10}O_6$ (aglycone) + 1] (100)
PMR (DMSO-d_6): 3.4-4.0 (m, sugar protons), 5.18 (1H, d, J = 6.4, anomeric sugar proton, H-1″), 6.64 (1H, s, H-6), 7.14 (1H, s, H-3), 6.96-7.12 (2H, m, H-3′,5′), 7.30 (1H, ddd, J = 7.8, 7.6, and 1.5, H-4′), 7.99 (1H, dd, J = 7.8 and 1.5, H-6′), 8.74, 10.88 (each 1H, br.s, 2×OH), 12.31 (1H, s, 5-OH)
^{13}**C NMR** (DMSO-d_6):

C-2	161.9	C-9	145.2	C-6′	128.9	
3	109.2	10	105.5	1″	100.8	(J = 164.7)
4	183.0	1′	117.5	2″	73.1	
5	151.2	2′	157.2	3″	75.3	
6	98.4	3′	117.4	4″	71.5	
7	152.5	4′	133.2	5″	75.6	
8	127.2	5′	119.8	6″	170.3	

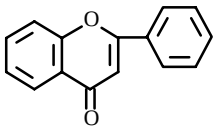


5,7,6′-Trihydroxy-8-methoxy-2′-O-β-D-(2-O-caffeoyl)-glucopyranosylflavone

S. discolor [63]
$C_{31}H_{28}O_{15}$: 640
UR: 267 (4.23), 305 sh (3.97), 332 (3.99); +CH_3ONa, 277 (4.30), 278 (4.61); +$AlCl_3$, 275 (4.24), 295 sh (3.98), 325 sh (3.85), 370 (3.99); +$AlCl_3$/HCl, 257 (4.25), 279 (4.23), 330 (4.00); +CH_3COONa, 276 (4.23), 340 (3.92), 380 sh (3.87); +CH_3COONa/H_3BO_3, 264 (4.25), 305 sh (3.86), 353 (4.00)
IR: 3400 (OH), 1700 (C=O ester), 1650 (C=O γ-pyrone), 1610 (C=C aromatic)
EI-MS *m/z* (%): 316 [$C_{16}H_{12}O_7$] (65), 301 [$C_{15}H_9O_7$] (100)
FAB-MS *m/z* (%): 641 $[M + 1]^+$ (26), 317 [$C_{16}H_{12}O_7$ + 1] (75)
PMR (DMSO-d_6); (caffeic acid, c.a.), 3.66 (3H, s, 8-OCH_3), 3.00-4.00 (m, sugar protons), 5.13 (1H, d, J = 8.3, anomeric glucose proton H-1″), 5.94 (1H, d, J = 15.6, c.a. α-H), 5.95 (1H, s, 3-H), 6.28 (1H, s, H-6), 6.65 (1H, d, J = 8.8, c.a. 5-H), 6.72 (2H, d, J = 8.3, H-3′,5′), 6.75 (1H, d, J = 8.8, c.a. 6-H), 6.92 (1H, s, c.a. 2+H), 7.10 (1H, d, J = 16.1, c.a. β-H), 7.30 (1H, t, J = 8.3, H-4′), 9.40 (2H, br.s, 2×OH), 10.10, 10.50 (1H, br.s, each 2×OH), 12.63 (1H, s, 5-OH)

^{13}**C NMR** (DMSO-d_6):

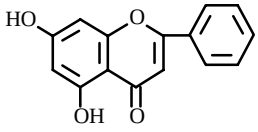
Aglycon		Caffeic acid		Glucose		
C-2	160.6	CO	165.1	C-1	98.4	J = 161.0
3	111.9	C-a	115.0	2	73.7	
4	182.0	b	145.2	3	72.9	
5	56.4	1	15.7	4	70.0	
6	98.4	2	113.4	5	77.3	
7	156.8	3	145.8	6	60.5	
8	127.5	4	148.2			
9	150.8	5	115.7			
10	104.0	6	121.2			
1′	110.2					
2′	156.2					
3′	105.4					
4′	132.2					
5′	110.0					
6′	156.0					
8-OCH_3	60.8					



Flavone

$C_{15}H_{10}O_2$: 222
mp: 95-96°C (hexane)
UV: 294, 250, 206
IR: 1644, 1567, 1370
Mass: 222 $[M]^+$, 165, 149, 120, 102, 97, 92, 64, 50 [147]
^{13}**C NMR** ($CDCl_3$) [148]:

C-2	163.0	C-7	133.5	C-2′	126.0
3	107.3	8	117.9	3′	128.8
4	178.0	9	156.0	4′	131.3
5	125.4	10	123.7	5′	128.8
6	124.9	1′	131.5	6′	126.0

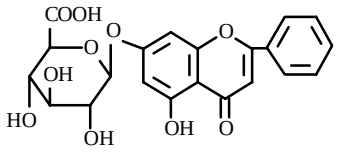


Chrysin (5,7-dihydroxyflavone)

S. adenostegia [56], *S. adsurgens* [58, 59], *S. alpina* [60], *S. amoena* [139], *S. araxensis* [78], *S. baicalensis* [79-82], *S. comosa* [61], *S. discolor* [63], *S. galericulata* [64, 65], *S. glabrata* [112], *S. grossa* [91], *S. indica* [67], *S. orientalis* [69], *S. ovata* [70], *S. oxystegia* [4], *S. phyllostachya* [93], *S. polyodon* [53], *S. prostrata* [95], *S. pycnoclada* [57], *S. scandens* [97], *S. scordiifolia* [74, 120], *S. sevanensis* [54], *S. squarrosa* [98], *S. strigillosa* [188], *S. supina* [57]
$C_{15}H_{10}O_4$: 254
mp: 290-292°C
UV: 270, 310 sh; +CH_3COONa, 375; +NaOH, 380; +$ZrOCl_2$, 290, 340, 390
Mass: 254 $[M]^+$, 152, 102
PMR (DMSO-d_6): 6.22 (1H, d, J = 2.0, H-6), 6.52 (1H, d, J = 2.5, H-8), 6.93 (1H, s, H-3), 7.58 (3H, m, H-3′,4′,5′), 8.30 (2H, m, H-2′,6′), 10.90 (1H, s, 7-OH), 12.83 (1H, s, 5-OH)

^{13}C NMR (DMSO-d_6) [38]:

C-2	163.4	C-7	164.4	C-2′	128.2
3	103.6	8	94.2	3′	114.6
4	181.1	9	157.5	4′	162.4
5	161.7	10	104.0	5′	114.6
6	99.1	1′	122.9	6′	128.2

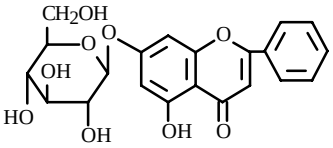


Chrysin 7-O-glucuronide

S. adsurgens [59], *S. alpina* [60], *S. comosa* [88], *S. discolor* [63], *S. galericulata* [64, 65, 136], *S. glabrata* [112], *S. grossa* [91], *S. ikonnikovii* [108], *S. immaculata* [186], *S. indica* [67], *S. orientalis* [69], *S .polyodon* [53], *S. prostrata* [95], *S. pycnoclada* [57], *S. ramosissima* [149], *S. scandens* [97], *S. scordiifolia* [74, 120], *S. supina* [57]

$C_{21}H_{18}O_{11}$: 430
mp: 219-221°C (MeOH)
UV: 270, 305; +CH_3COONa, 268, 308; +$AlCl_3$, 250, 282, 329, 378
PMR (DMSO-d_6): 5.18 (1H, br.s, H-1″), 6.48 (1H, br.s, H-6), 6.90 (1H, br.s, H-8), 7.06 (1H, s, H-3), 7.50-7.60 (3H, m, H-3′,4′,5′), 8.00-8.11 (2H, m, H-2′,6′), 12.60 (1H, s, 5-OH)
^{13}C NMR (DMSO-d_6):

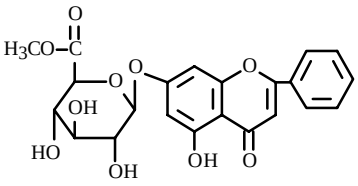
C-2	163.80	C-9	157.20	C-6′	126.58
3	105.54	10	105.71	1″	99.76
4	182.25	1′	130.67	2″	72.93
5	161.18	2′	126.58	3″	74.72
6	99.51	3′	129.25	4″	71.65
7	163.11	4′	132.27	5″	76.14
8	94.94	5′	129.25	6″	171.00



Chrysin 7-O-β-D-glucoside

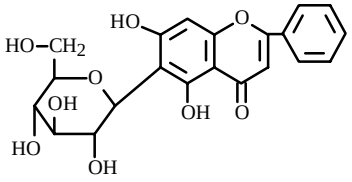
S. baicalensis [144], *S. orientalis* [69]
$C_{21}H_{20}O_9$: 416
mp: 189-192°C

$[\alpha]_D$ -65.7° (*c* 0.3, formamide)
UV: 269, 306
IR: 3540-3260 (OH), 1660 (C=O γ-pyrone), 1620, 1578, 1512 (C=C aromatic), 1090, 1065, 1005 (C–O glycosides)



Chrysin 7-O-methylglucuronide

S. comosa [61]
$C_{22}H_{20}O_{10}$: 444
mp: 184-186°C (MeOH)
UV: 270, 305
IR: 3510-3320 (OH), 1660 (C=O γ-pyrone), 1728 (C=O ester)
PMR (Py-d_5): 3.48 (3H, s, $COOCH_3$), 4.00-4.67 (3H, m, H-2″,3″,4″), 4.84 (1H, d, J = 8.5, H-5″), 5.88 (1H, d, J = 6.5, H-1″), 6.70 (1H, d, J = 2, H-6), 6.78 (1H, s, H-3), 6.97 (1H, d, J = 2, H-8), 7.15-7.33 (3H, m, H-3′,4′,5′), 7.51-7.73 (2H, m, H-2′,6′), 12.49 (1H, br.s, 5-OH)

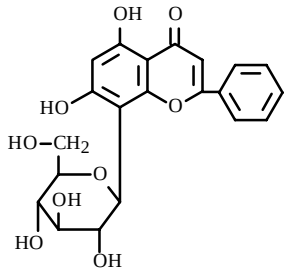


Chrysin 6-C-β-D-glucopyranoside

S. baicalensis [144]
$C_{21}H_{20}O_9$: 416
mp: 180°C
$[\alpha]_D^{25}$ +20.0° (*c* 0.04, methanol)

UV: 247 (4.13), 270 (4.40), 314 (4.00); +CH_3ONa, 262 sh (4.32), 279 (4.37), 370 (3.91); +$AlCl_3$, 253 (4.11), 283 (4.38), 331 (4.06), 382 (3.76); +$AlCl_3$/HCl, 253 (4.10), 283 (4.39), 328 (4.03), 382 (3.73); +CH_3COONa, 262 sh (4.32), 278 (4.37), 370 (3.90); +CH_3COONa/H_3BO_3, 262 sh (4.32), 271 (4.38), 328 (3.85)
IR: 3404 (OH), 1653 (C=O γ-pyrone), 1620, 1587 (C=C aromatic)
Mass: 416 $[M]^+$ (1), 268 $[M - 148]^+$ (92), 267 $[M - 149]^+$ (100)
PMR (DMSO-d_6): 6.55 (1H, s, H-8), 6.98 (1H, s, H-3), 7.60 (3H, m, H-3′,4′,5′), 8.18 (2H, br.d, J = 7.0, H-2′,6′), 3.19, 3.21, 3.41, 3.47 (1H, m, each H-5″,3″,4″,6″), 3.69 (1H, br.d, J = 11.0, H-6″), 4.05 (1H, br.t, J = 8.7, H-2″), 4.60 (1H, d, J = 9.9, H-1″), 4.62 (1H, t, J = 4.5, 6″-OH), 4.84 (3H, br.s, 2″,3″,4″-OH), 10.75 (1H, br.s, 7-OH), 13.32 (1H, s, 5-OH)
^{13}**C NMR** (DMSO-d_6):

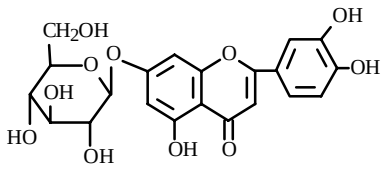
C-2	164.0	C-9	156.4	C-6′	126.4
3	105.1	10	103.5	1″	73.1
4	182.0	1′	130.7	2″	70.6
5	160.7	2′	126.4	3″	78.9
6	109.1	3′	129.2	4″	70.2
7	162.9	4′	132.0	5″	81.6
8	93.8	5′	129.2	6″	61.5



Chrysin 8-C-β-D-glucopyranoside

S. baicalensis [144]
$C_{21}H_{20}O_9$: 416
mp: 206°C
$[\alpha]_D^{25}$ -25.9° (*c* 0.07, methanol)
UV: 247 (4.10), 270 (4.44), 314 (4.01); +CH_3ONa, 261 sh (4.33), 279 (4.36), 365 (3.96); +$AlCl_3$, 253 (4.05), 281 (4.41), 330 (4.09), 385 (3.76); +$AlCl_3$/HCl, 253 (4.04), 281 (4.41), 327 (4.06), 385 (3.79); +CH_3COONa, 261 sh (4.31), 278 (4.42), 365 (3.94); +CH_3COONa/H_3BO_3, 271 (4.42), 320 (3.91)
IR: 3468 (OH), 1652 (C=O γ-pyrone), 1616, 1582 (C=C aromatic)
Mass: 416 $[M]^+$ (2), 268 $[M - 148]^+$ (20), 267 $[M - 149]^+$ (100)
PMR (DMSO-d_6): 6.32 (1H, s, H-6), 6.99 (1H, s, H-3), 7.55 (3H, br.t, J = 7.3, H-3′,5′), 7.63 (1H, br.t, J = 7.3, H-4′), 8.19 (2H, br.d, J = 7.3, H-2′,6′), 3.26, 3.28, 3.41, 3.57 (1H, m, each, H-5″,3″,4″,6″), 3.79 (1H, br.dd, J = 4.5 and 11.2, H-6″), 3.86 (1H, br.t, J = 8.6, H-2″), 4.72 (1H, d, J = 9.9, H-1″), 4.64 (1H, t, J = 4.5, 6″-OH), 4.92 (1H, br.s, 2″-OH), 4.99 (1H, d, J = 3.7, 3″-OH), 5.00 (1H, d, J = 5.1, 4″-OH), 10.95 (1H, br.s, 7-OH), 13.04 (1H, s, 5-OH)
^{13}**C NMR** (DMSO-d_6):

C-2	163.4	C-9	156.2	C-6′	126.9
3	104.7	10	104.3	1″	73.4
4	182.2	1′	131.1	2″	70.8
5	160.4	2′	126.9	3″	78.6
6	98.4	3′	129.0	4″	70.5
7	162.9	4′	132.0	5″	81.9
8	104.8	5′	129.0	6″	61.3



Cinaroside (luteolin-7-O-glucoside)

S. araxensis [78], *S. creticola* [62], *S. ocellata* [185], *S. oreophila* [92], *S. przewalskii* [71]

$C_{21}H_{20}O_{11}$: 448

mp: 240-242°C

$[\alpha]_D$ -27.6° (pyridine)

UV: 255, 267 sh, 348; +CH_3COONa, 259, 266 sh, 365 sh, 405; +CH_3COONa/H_3BO_3, 259, 372; +$AlCl_3$, 274, 298 sh, 329, 432; +$AlCl_3$/HCl, 273, 294 sh, 358, 387; +CH_3ONa, 263, 300 sh, 394

IR: 3480-3300 (OH), 1665 (C=O γ-pyrone), 1560, 1510 (C=C aromatic), 1095, 1030, 900 (C–O glycosides)

PMR (Py-d_5): 3.90-4.05 (6H, sugar protons), 5.66 (1H, d, J = 7.0, H-1″), 6.67 (1H, d, J = 2.5, H-6), 6.77 (1H, s, H-3), 6.84 (1H, d, J = 2.5, H-8), 7.13 (1H, d, J = 8.0, H-5′), 7.38 (1H, dd, J = 8.0 and 2.5, H-6′), 7.74 (1H, d, J = 2.5, H-2′)

^{13}**C NMR** (DMSO-d_6+D_2O, 2:1) [38, 40]:

C-2	164.5	C-7	162.9	C-2′	113.7
3	103.2	8	94.9	3′	145.7
4	181.6	9	156.9	4′	149.7
5	161.1	10	105.5	5′	116.0
6	99.7	1′	121.6	6′	119.0