Review Article

Systematic Review on Xanthones and Others Isolates From Genus *Swertia*

Anupam Jamwal*

Department of Pharmaceutical Sciences and Drug Research, Punjabi University, Patiala, Punjab, India.

ABSTRACT

The genus *Swertia* belongs to family Gentianaceae and having xanthones as major class of natural compounds presents along with others such as triterpenoids, bitters, flavonoids, steroids etc. This review has been compiled using references using databases *viz.* Chemical abstracts, Medicinal and Aromatic Plant Abstracts, Pub Med, Scirus, Science Direct, Sci-finder and online journal. The data has been compiled from 2001 onwards and contain approximately 150 compounds of the genus *Swertia* with varying structural patterns till date.

Keywords: *Swertia*, xanthone, iridoids/secoiridoids, triterpenoids.

INTRODUCTION

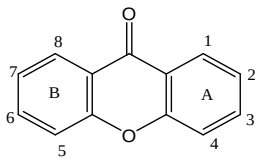
The genus *Swertia* belongs to family Gentianaceae which is known to have about 700 species and 80 genera. *Swertia chirata* commonly known as 'chirayata' is considered the most important for its medicinal properties. The plant is a native of temperate Himalayas, found at an altitude of 1200-3000 m (4000-10,000 ft) from Kashmir to Bhutan and in the Khasia hills at 1200-1500 m (4000-5000 ft). It is an official drug of the Indian Pharmacopoeial list 1946.[9] The bitterness, anthelmintic, hypoglycemic and antipyretic properties are attributed to amarogentin, swerchirin, swertiamarin and other active principles of the herb.[4] *Swertia* are reported in India viz *S. chirata, S. purpurascens, S. paniculata, S. tetragona, S. cordata, S. petiolata, S. lurida, S. alata, S. nervosa, S. angustifolia, S. alternifolia* and *S. cuneata.*[3] Many species of genus *Swertia* are found globally, like *S. davidi, S. mussotti, S. calycina, S. tetraptera, S. kouitchinensis, S. thomsonii, S. verticillifolia, S. macrosperma, S. perzewalskii, S. decussata, S. japonica, S. mileensis, S. punicea, S. corymbosa, S. franchetiana, S. pseudochinensis, S. longifolia* and *S. hookeri.*

The phytochemical investigations of the genus *Swertia* have yield approximately 200 compounds with varying structural patterns till date. Xanthones, iridoids/secoiridoids and triterpenoids constitute the major classes of compounds reported from genus *Swertia*.[25]

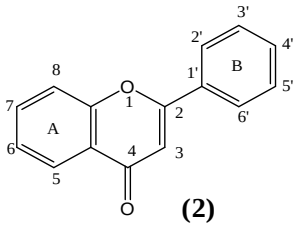
1. Xanthones
2. Iridoids and secoiridoids
3. Triterpenoids
4. Flavonoids
5. Lignans, alkaloids and volatile constituents
6. Miscellaneous

1. Xanthones

Xanthones are class of tricyclic compounds characterized by a dibenzo-γ-pyrone nucleus (**1**). The prefix 'xanth' means 'yellow' color of these compounds and '-one' is from their 'keto' nature. The xanthones bear a close structural relationship to the other naturally occurring γ-pyrone derivatives like flavonoids (**2**) and chromones.[26]



(1)



(2)

The symmetrical nature of the xanthone nucleus coupled with its mixed biogenetic origin in the higher plants necessitates that the carbons be numbered according to a biosynthetic convention. Carbons 1-4 are assigned to the acetate-derived ring **A,** and carbons 5-8 to the shikimate-derived ring **B**. The numbering system is based on xanthen-9-one as the basic skeleton structure.[27] The standard oxidation pattern of 1,3,5 and 1,3,7 is quite evident although only a small number of xanthones with trioxygenated pattern have been isolated. Most abundant xanthones are tetraoxygented and pentaoxygented with additional oxygenation occurring at C-8, C-6, C-4 and C-2 of dibenzo-γ-pyrone nucleus. The different xanthones isolated since 2000 are listed in table 1 and are classified:

Xanthones can be classified into six major groups depending upon oxygenation pattern.

1. Simple oxygenated xanthones
   a. Monooxygenated
   b. Dioxygenated
   c. Trioxygenated
   d. Tetraoxygenated
   e. Pentaoxygenated
   f. Hexaoxygenated
2. Dimeric xanthones
   a. Homoxanthones (identical halves)
   b. Heteroxanthones (different halves)
3. Xanthone glycosides
   a. *O*-Glycosides
   b. *C*-Glycosides
4. Prenylated xanthones
5. Xanthonolignoids
6. Miscellaneous

Table 1: Xanthone isolated since 2000

S. No.	Name	Oxidation pattern	Source	Reference
		1 3 8		
1	1,8-dihydroxy-3-(3-hydroxybutoxy)xanthone (daviditin B)	OH *O*-butoxy OH	*S. davidi*	29
		1 3 5		
2	1-hydroxy-3,5-dimethoxyxanthone	OH OMe OMe	*S. bifolia* *S. chirata*	30 31
3	1-*O*-[*β*-D-xylopyranosyl(1 → 6)-*β*-D-glucopyranosyl]-3,5-dimethoxyxanthone	*O*-xyl-glu OMe OMe	*S. franchetiana*	62
		1 3 7		
4	1-hydroxy-3,7-dimethoxyxanthone	OH OMe OMe	*S. pseudochinensis*	22
TETRAOXYGENATED XANTHONES				
		1 2 6 8		
5	1,2,6,8-tetrahydroxyxanthone (norswertianin)	OH OH OH OH	*S. ciliate*	37
6	1,2,8-trihydroxy-6-methoxyxanthone (gentiakochianin or swertianin)	OH OH OMe OH	*S. punicea* *S. decora* *S. yunnanensis* *S. delavayi*	38 34 39 36
7	1,6,8-trihydroxy-2-methoxyxanthone (isobellidifolin or swertianol)	OH OMe OH OH	*S. punctata* *S. longifolia*	23 41
8	2,8-dihydroxy-1,6-dimethoxyxanthone (gentiacauleine)	OMe OH OMe OH	*S. speciosa* *S. longifolia* *S. franchetiana*	18 35 40

9	1,8-dihydroxy-2,6-dimethoxyxanthone (swertiaperennine)	OH OMe OMe OH	*S. longifolia*	35
10	2,6,8-trihydroxy-1-*O*-*β*-D-glucopyranosylxanthone	*O*-glu OH OH OH	*S. punctata*	23
		1 3 5 8		
11	1,3,5,8-tetrahydroxy xanthones (desmethyl bellidifolin)	OH OH OH OH	*S. pubescens* *S. davidi* *S. pseudochinensis*	45 44,51 22
12	1,3,5-trihydroxy-8-*O*-*β*-glucopyranosylxanthone (norswertianolin)	OH OH OH *O*-glu	*S. chirata* *S. davidi* *S. erythrosticta* *S. pubescens*	43 66 67 45
13	1,3,8-trihydroxy-5-methoxyxanthone	OH OH OMe OH	*S. davidi*	49
14	1,5,8-trihydroxy-3-methoxyxanthone (bellidifolin)	OH OMe OH OH	*S. pseudochinensis* *S. chirata* *S. davidi* *S. speciosa* *S. ciliata* *S. franchetiana* *S. punctata* *S. pubescens* *S. mussotii* *S. punicea* *S. macrosperma* *S. japonica* *S. binchuangensis*	22,42 31,43 44 18 37 40,47 23 45 46 42,38 32,33 42 42
15	1,8-dihydroxy-3,5-dimethoxyxanthone (methylbellifolin or swerchirin)	OH OMe OMe OH	*S. pseudochinensis* *S. speciosa* *S. yunnanensis* *S. punctata* *S. chirata* *S. bifolia* *S. mussotii* *S. longifolia* *S. macrosperma*	22 18 39 23 31 30 46 35,48 32
16	1,3,8-trihydroxy-5-*O*-*β*-D-glucopyranosyl xanthones	OH OH *O*-glu OH	*S. davidi*	66
17	1,5-dihydroxy-8-*O*-*β*-D-glucopyranosyl-3-methoxyxanthone (swertianolin)	OH OMe OH *O*-glu	*S. japonica* *S. pseudochinensis* *S. binchuangensis* *S. punicea* *S. punctata* *S. franchetiana* *S. chirata* *S. davidi* *S. ciliata* *S. erythrosticta* *S. pubescens*	42 42,22 42 42,38,64,65 42,23 62,47,21,78 43, 60 44 37 67 45
18	1,4,5,8-tetrahydro-1,5-dihydroxy-8-*O*-*β*-D-glucopranosyl-3-methoxyxanthone (tetrahydroswertianolin)	OH OMe OH *O*-glu	*S. pseudochinensis*	22
19	1,8-dihydroxy-5-*O*-*β*-D-glucopyranosyl-3-methoxyxanthone (isoswertianolin)	OH OMe *O*-glu OH	*S. pubescens* *S. davidi*	45 66
20	1,5-dihydroxy-3,8-dimethoxyxanthone	OH OMe OH OMe	*S. cuneata*	50
21	8-hydroxy-1-*O*-primeverosyl-3,5-dimethoxyxanthone	*O*-prim OMe OMe OH	*S. longifolia*	41
22	3,8-dihydroxy-1-*O*-primeverosyl-5-methoxyxanthone	*O*-prim OH OMe OH	*S. punctata*	23
		1 3 5 6		
23	1,5-dihydroxy-6-*O*-primeverosyl-3-methoxyxanthone	OH OMe OH *O*-prim	*S. longifolia*	41
		1 4 5 7		

24	1,5-dihydroxy-4-*O*-[β-xylose(2 1)rhamnose]-7-methoxyxanthone (pseudonolin)	OH *O*-xyl-rha OH OMe	*S. pseudochinensis* *S. punicea* *S. binchuangensis* *S. japonica*	22 42 42 42
		1 3 7 8		
25	1,3,7,8-tetrahydroxyxanthone	OH OH OH OH	*S. przewalskii*	54
26	1,3,8-trihydroxy-7-methoxyxanthone (isoswertianin)	OH OH OMe OH	*S. punctata*	23
27	1,7,8-trihydroxy-3-methoxyxanthone (swertianine)	OH OMe OH OH	*S. przewalskii* *S. thomsonii* *S. alata* *S. decussate*	54 56 52 57
28	1,7-dihydroxy-3,8-dimethoxyxanthone (gentiacaulien)	OH OMe OH OMe	*S. przewalskii* *S. punicea* *S. bifolia* *S. thomsonii* *S. davidi* *S. nervosa*	54,55 38 30 56 53 28
29	1,8-dihydroxy-3,7-dimethoxyxanthone (methlyswertianin or swertiaperennin)	OH OMe OMe OH	*S. bifolia* *S. punicea* *S. mussotii* *S. alata* *S. nervosa* *S. macrosperma* *S. decora* *S. delavayi* *S. punctata* *S. franchetiana* *S. davidi*	30 19 46 52 28 32,33 34 36 23 40 53
30	1-hydroxy-3,7,8-trimethoxyxanthone (decussatin)	OH OMe OMe OMe	*S. alata* *S. decora* *S. franchetiana* *S. nervosa* *S. macrosperma* *S. punicea* *S. bifolia*	52 34 40 28 32,33 19 30
31	1,8-dihydroxy-7-*O*-*β*-D-glucopyranosyl-3-methoxyxanthone	OH OMe *O*-glu OH	*S. ciliata* *S. przewalskii* *S. mussotii*	37 54 61
32	8-hydroxy-1-*O*-primeverosyl-3,7-dimethoxyxanthone	*O*-prim OMe OMe OH	*S. punicea*	19
33	7-hydroxy-1-*O*-*β*-D-glucopyranosyl-3,8-dimethoxyxanthone	*O*-glu OMe OH OMe	*S. przewalskii*	54
34	8-hydroxy-1-*O*-*β*-D-glucopyranosyl-3,7-dimethoxyxanthone	*O*-glu OMe OMe OH	*S. przewalskii*	54,55
35	7-hydroxy-1-*O*-[*β*-D-xylopyranosyl-(1→6)-*β*-D-glucopyranosyl]-3,8-dimethoxyxanthone	*O*-xyl-glu OMe OH OMe	*S. przewalskii*	54
36	8-hydroxy-1-*O*-[*β*-D-xylopyranosyl-(1→6)-*β*-D-glucopyranosyl]-3,7-dimethoxyxanthone	*O*-xyl-glu OMe OMe OH	*S. przewalskii*	54
37	1,7-dihydroxy-8-*O*-[*β*-D-xylopyranosyl-(1→ 6)-*β*-D-glucopyranosyl]-3-methoxyxanthone	OH OMe OH *O*-xyl-glu	*S. przewalskii*	54
38	8-hydroxy-1-*O*-gentiobiosyl-3,7-dimethoxyxanthone	*O*-genti OMe OMe OH	*S. punctata*	23
39	1-*O*-primeverosyl-3,7,8-trimethoxyxanthone	*O*-prim OMe OMe OMe	*S. punicea*	19
40	1,8-dihydroxy-7-*O*-[α-L-rhamnopyranosyl-(1 2)-*β*-D-xylopyranosyl]-3-methoxyxanthone	OH OMe *O*-rham-xyl OH	*S. franchetiana*	47,28
41	7-hydroxy-1-*O*-[*β*-D-xylopyranosyl-(1 →4)-*β*-D-xylopyranosyl]-3,8-dimethoxyxanthone	*O*-xyl-xyl OMe OH OMe	*S. thomsonii*	56
42	1-*O*-*β*-D-glucopyranosyl-3,7,8-trimethoxyxanthone	*O*-glu OMe OMe OMe	*S. franchetiana*	62
		1 2 3 5		
43	1,5-dihydroxy-2,3-dimethoxyxanthone	OH OMe OMe OH	*S. mileensis*	58
45	1,2,3,5-tetramethoxyxanthone	OMe OMe OMe OMe	*S. mileensis*	58
46	1-*O*-[*β*-D-xylopyranosyl-(1 → 6)-*β*-D-glucopyranosyl]-2,3,5-trimethoxyxanthone	*O*-xly-glu OMe OMe OMe	*S. franchetiana*	62

		1 2 3 7		
47	1-hydroxy-2,3,7-trimethoxyxanthone	OH OMe OMe OMe	*S. mileensis*	58
		1 3 4 7		
48	1-hydroxy-3-*O*-*β*-D-glucopyranosyl-4,7-dimethoxyxanthone	OH *O*-glu OMe OMe	*S. tetraptera*	68
49	1-hydroxy-3-*O*-[*β*-D-xylopyranosyl-(1 ⟶6)-β-D-glucopyranosyl]-4,7-dimethoxyxanthone (tetraswerosideB)	OH *O*-xyl-glu OMe OMe	*S. tetraptera*	68
PENTAOXYGENATED XANTHONES				
		1 2 3 6 8		
50	1,8-dihydroxy-2,3,6-trimethoxyxanthone	OH OMe OMe OMe OH	*S. mileensis*	58
51	1-hydroxy-2,3,6,8-tetramethoxyxanthone	OH OMe OMe OMe OMe	*S. mileensis*	58
		1 2 3 6 7		
52	2-*C*-*β*-D-glucopyranosyl-1,3,6,7-tetrahydroxyxanthone (mangiferin)	OH *C*-glu OH OH OH	*S. chirata* *S. punicea* *S. punctata* *S. franchetiana* *S. mussotii* *S. davidi* *S. delavayi* *S. corymbosa* *S. pubescens*	69,70 38,64,65 23 62,21,47 61,72,46,21 73 74 75 45
		2 3 4 5 8		
53	2,4,5-trihydroxy-3,8-dimethoxyxanthone (swertiadecoraxanthone-II)	OH OMe OH OH OMe	*S. decora*	34,59
		1 3 4 5 8		
54	1,5,8-trihydroxy-3,4-dimethoxyxanthone	OH OMe OMe OH OH	*S. davidi*	29
		1 2 3 5 7		
55	1,5-dihydroxy-2,3,7-trimethoxyxanthone	OH OMe OMe OH OMe	*S. mileensis*	58
56	1-hydroxy-2,3,5,7-tetramethoxyxanthone	OH OMe OMe OMe OMe	*S. franchetiana* *S. mileensis*	40 58
		1 2 3 4 5		
57	1-hydroxy-2,3,4,5-tetramethoxyxanthone	OH OMe OMe OMe OMe	*S. franchetiana* *S. mileensis* *S. chirata*	40 58 31
		1 2 3 4 7		
58	1-hydroxy-2,3,4,7-tetramethoxyxanthone	OH OMe OMe OMe OMe	*S. mileensis* *S. chirata*	58 31
		1 2 3 4 6		
59	1-hydroxy-2,3,4,6-tetramethoxyxanthone	OH OMe OMe OMe OMe	*S. mileensis*	58
		1 3 4 7 8		
60	1,8-dihydroxy-3,4,7-trimethoxyxanthone (davaditin A)	OH OMe OMe OMe OH	*S. davidi*	53
		1 4 5 6 7		
61	1-hydroxy-4,5,6,7-tetramethoxyxanthone (swertiadecoraxanthone I)	OH OMe OMe OMe OMe	*S. decoras*	34,59,76
HEXAOXYGENATED XANTHONES				
		1 2 3 4 5 7		
62	1,5-dihydroxy-2,3,4,7-tretramethoxyxanthone	OH OMe OMe OMe OH OMe	*S. mileensis*	59

1. Iridoid and secoirridoid glycosides

The bitter principles of the genus *Swertia* can be classified into three groups:

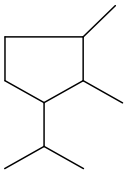
(a) Iridoid glycosides

(b) Secoiridoid glycosides

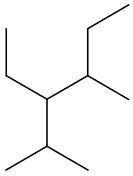
(c) Biphenyl glycosides

Irridoid and secoiridoids are a class of compounds having iridane **(3)** and secoiridane **(4)** nucleus

.



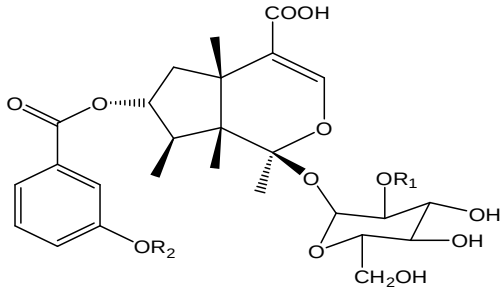
(3)

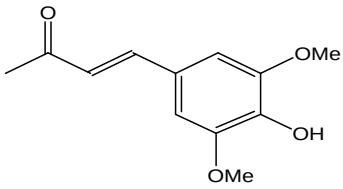
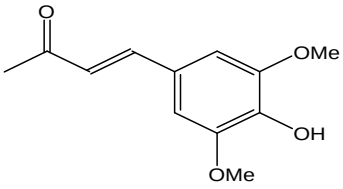
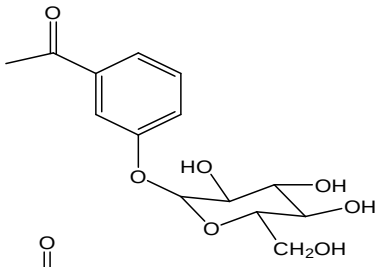
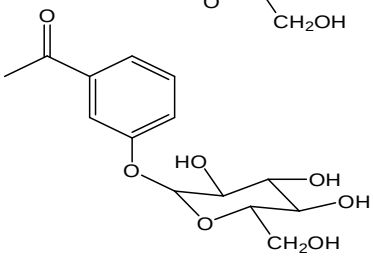


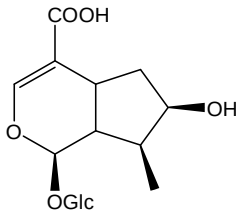
(4)

Irridoid glycosides

The present literature survey of the genus *Swertia* had revealed isolation of four iridoid glucosides, senburiside-I **(5)**,[80] senburiside-III **(6),**[80] senburiside-IV **(7)**[80,81] and loganic acid **(8).**[67] Two new iridoid diglycosides 6'-*O*-α-D-mannopyranoslyswertiamarin **(9)** and 6'-*O*-β-D-fructofuranosylswertiamarin **(10)** have been reported from *S. japonica*.[17]



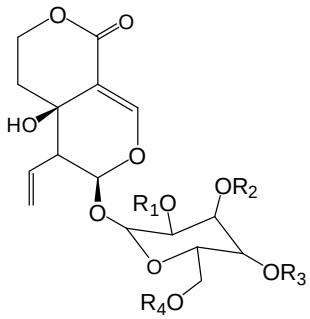
	R_1	R_2
(5)		H
(6)		
(7)	H	

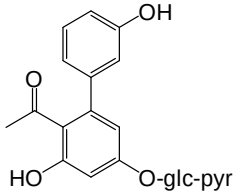


(8)

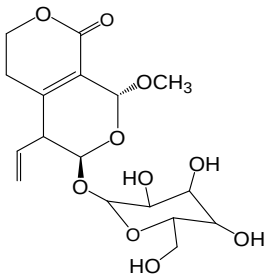
Secoiriodoid glycosides

Six new secoiridoid diglycosides have been reported from *S. japonica*.[17] These are 6'-*O*-α-L-arabinopyranosylswertiamarin **(11),** 3'-*O*-*β*-D-glucopyranosylswertiamarin **(12)** ,4'-*O*-*β*-D glucopyranosylswertiamarin **(13)**, 3'-*O*-*β*-D-galactopyranosylswertiamarin (**14)**, 6'-*O*-*α*-D-galactopyranosylswertiamarin **(15)**, 5''-*O*-*β*-glucopyranosylamaroswerin **(16)**.

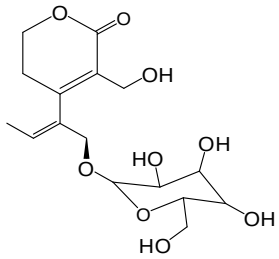


	R_1	R_2	R_3	R_4
(9)	H	H	H	*α*-D-mann-pyr
(10)	H	H	H	*α*-D-fru-fur
(11)	H	H	H	*α*-L-ara-pyr
(12)	H	*β*-D-glc-pyr	H	H
(13)	H	H	*β*-D-glc-pyr	H
(14)	H	*β*-D-gal-pyr	H	H
(15)	H	H	H	*α*-D-gal-pyr
(16)		H	H	H

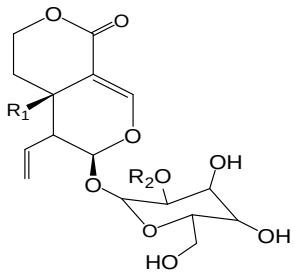
Two more new secoiridoid glycosides, swertiajaposide A **(17)** and swertiajaposide B **(18)** have also been reported from *S. japonica*.[16] Five of the earlier isolated secoiridoid glycosides swertiamarin **(19),** amarogentin **(20),** amaroswerin **(21),** sweroside **(22)** and gentiopicroside **(23)** have been re-reported from different species of *Swertia* and are detailed in a tabulated form below.

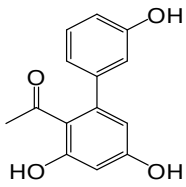


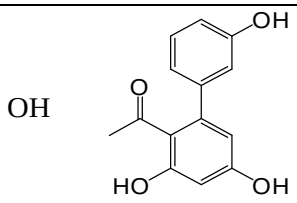
(17)



(18)

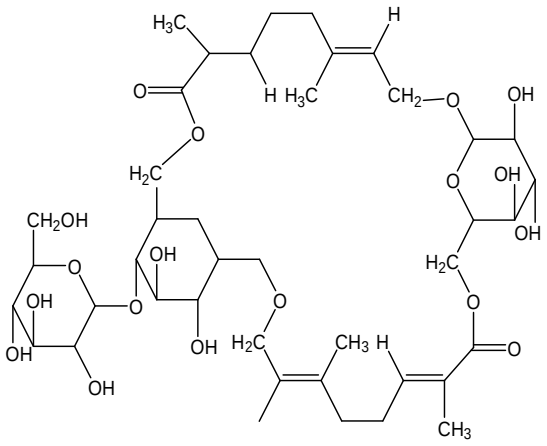


	Name	Substituent		Source	Reference
		R_1	R_2		
(19)	Swertiamarin	OH	OH	*S. franchetiana* *S. pseudochinensis* *S. punicea* *S. davidi* *S. mussotii* *S. nervosa* *S. chirata* *S. binchuanensis* *S. delavayi* *S. cordata*	78,79,62,80,47 22,82 38,65 83,84,66 72,46,86 85 86,12,69 71 74 12
(20)	Amarogentin	H		*S. punicea* *S. pseudochinensis* *S. chirata* *S. binchuanensis* *S. japonica*	42 22 43,69 42 42

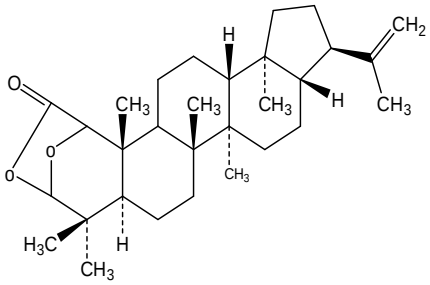
(21)	Amaroswerin		*S. pseudochinensis* *S. chirata* *S. binchuanensis* *S. japonica* *S. punicea*	22 69 42 42 42
(22)	Sweroside	H OH	*S. pseudochinensis* *S. chirata* *S. franchetiana*	22,82 69 47,80,62,79,78
(23	Gentiopicroside		*S. pseudochinensis* *S. punicea* *S. mussotii* *S. chirata* *S. binchuanensis* *S. franchetiana*	64,65 86,61,88 86,43 71 74 79,78,62,80,47 22,82

2. Terpenoids

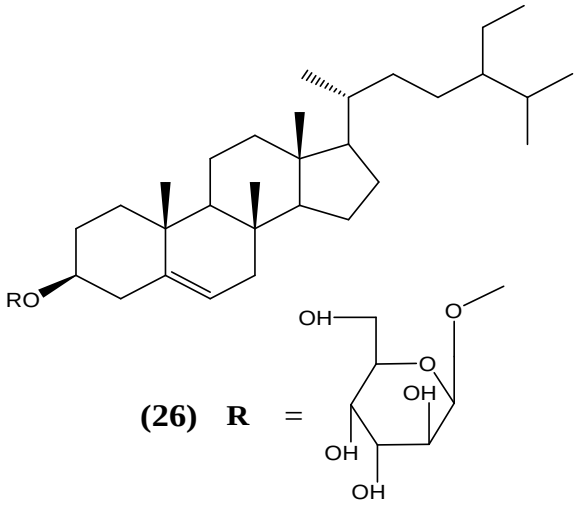
A new monoterpenoid glycoside mileenside **(24)** has been isolated from *S. mileensis.*[89] A triterpenoid thysanolactone **(25)** has been reported from *S. yunnanensis*[39] and *S. japonica.*[90] *β*-Daucosterol **(26)** from *S. bifolia*[30] and three terpenoids hederagenin **(27)**, erythrodiol-3-*O*-palmitate **(28)** and maslinic acid **(29)** have been isolated from *S. japonica*.[90] A new triterpenoid chiratane **(30)** has been isolated from *S. chirata.*[30]



(24)

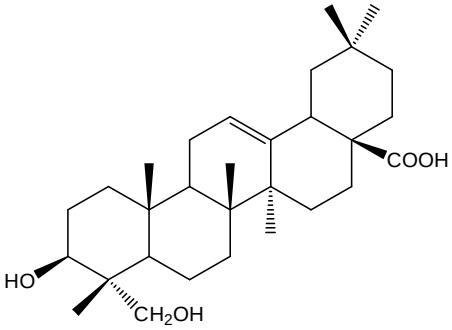


(25)

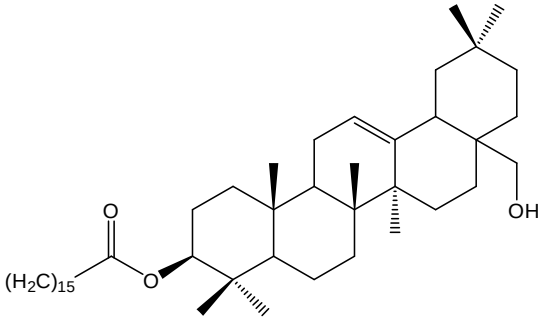


**(26) R = **

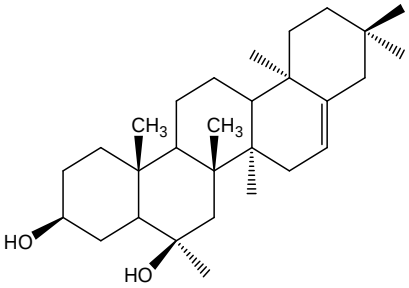
(33) R = H



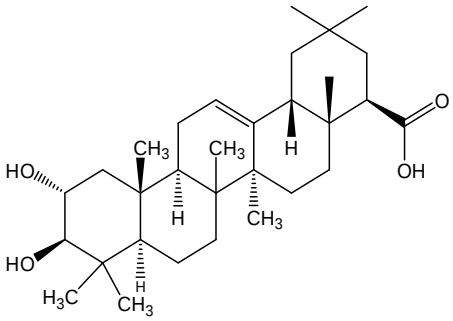
(27)



(28)

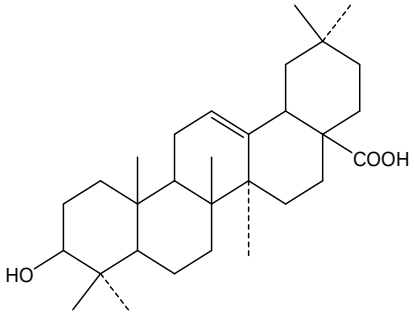


(29)

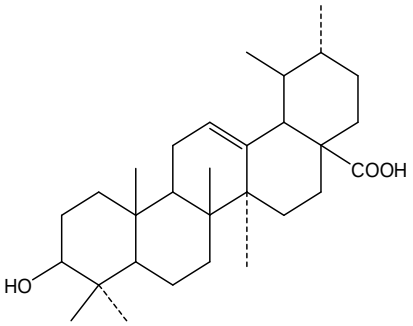


(30)

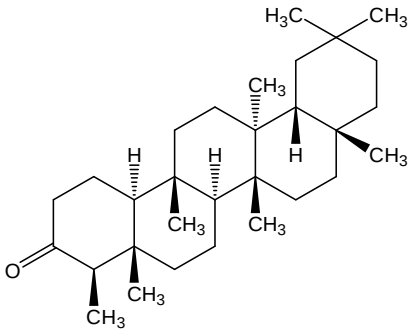
Oleanolic acid **(31)** has been isolated from a large number of *Swertia* species viz. *S. mussotii*,[46] *S. japonica,*[90] *S. davidi,*[84] *S. ciliata*,[37] *S. przewalskii,*[45] *S. pseudochinensis,*[82] *S. franchetiana,*[91] *S. corymbosa,*[75] *S. binchuanensis,*[71] *S. delavayi,*[74,36] *S. punicea,*[38] and *S. chirata.*[43] Ursolic acid **(32)** has been reported from *S. davidi,*[84,49] *S. przewalskii,*[54] *S. corymbosa,*[75] *S. speciosa*[18] and *S. thomsonii.*[56]



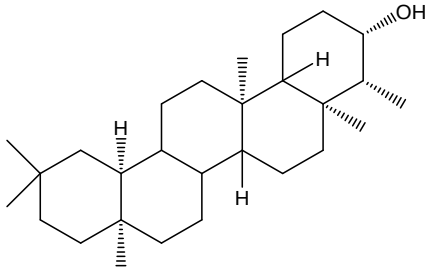
(31)



(32)

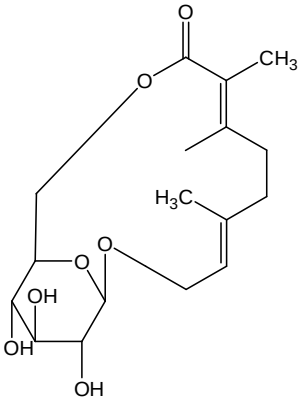


(34)

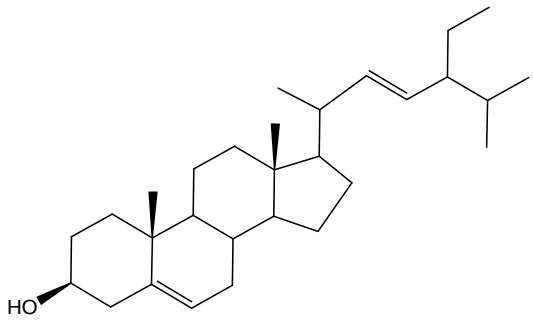


(35)

β-Sitosterol **(33)** has been isolated from *S. ciliata*,[37] *S. przewalskii,*[54] *S. speciosa,*[18] *S. franchetiana,*[40] *S. chirata*[43] and *S. bifolia.*[30] Friedelin **(34)** and epi-friedelinol **(35)** have been reported from *S. corymbosa.*[75] A new monoterpene glycoside 2,6-dimethyl-2E,6E-octadienoic acid-1,6'-lactone-8-*β*-D-glucopyranoside **(36)** has been isolated from *S. punicea*.[19]



(36)

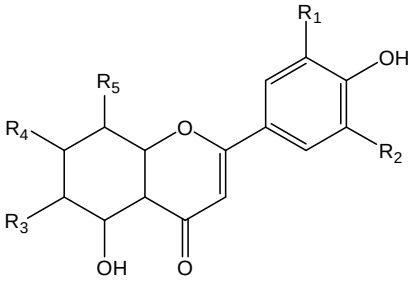


(37)

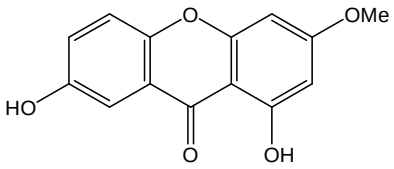
Stigmasterol **(37)** has been re-reported from *S. chirata* during the period of present review.[63] Some of the terpenoids which are commonly occurring in plant kingdom and also reported in genus *Swertia* are 24-ethylcholest-4-en-3-one from *S. chirata,*[60] 3*β*,28-dihydroxyoleanane-3-palmitate from *S. ciliata,*[37] lupeol from *S. corymbosa,*[75] taraxer-14-en-3-one from *S. speciosa*,[18] 3*β*-hydroxy-11-oxoolean-12-ene-28-oic acid from *S. japonica*.[90]

3. Flavonoids and flavonoid glycosides

No new addition has been made to this class of phytoconstituent and seven of the already reported flavonoids were reported again during the period of present review. Isovitexin **(38)** from *S. punicea,*[19] isoorientin **(39)** from *S. mussotii*,[21] *S. punctata,*[23] *S. erythrosticta*[67] and *S. franchetiana,*[78,79,62,47,21] luteloin **(40)** from *S. przewalskii*[54] and *S. decora,*[76] swertisin **(41)** from *S. franchetiana*[78,62,47,21] and *S. mussotii*,[46] isoswertisin **(42)** from *S. franchetiana,*[78] quercetin **(43)** from *S. decora*[76] and gentisein **(44)** from *S. longifolia.*[4]



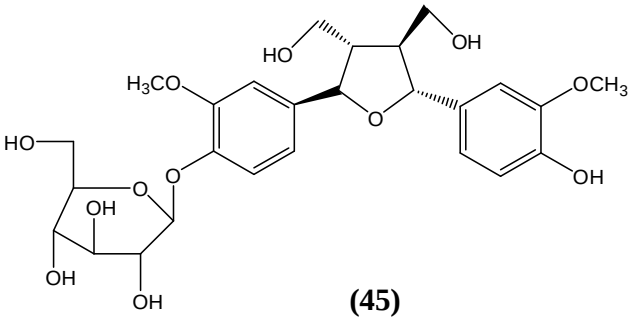
		R_1	R_2	R_3	R_4	R_5
(38)	Isovitexin	H	H	glu	OH	H
(39)	Isoorientin	OH	H	glu	OH	H
(40)	Luteolin	OH	H	H	OH	H
(41)	Swertisin	H	H	glu	OMe	H
(42)	isoswertisin	H	H	glu	OH	glu
(43)	Quercetin	H	OH	H	OH	H



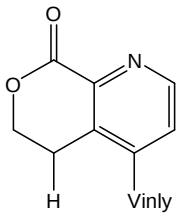
(44)

4. Lignans, alkaloids and volatile constituents

A new lignan glycoside 7R,7'R,8S,8'S-(+)-neo-olivil-4-*O*-*β*-D-glucopyranoside **(45)** has been isolated from *S. japonica.*[16] Only one already reported alkaloid gentianine **(46)** has been isolated during present period of review from *S. yunnanensis*.[92]



(45)

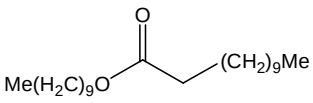


(46)

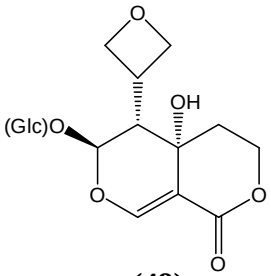
Essential oil of genus *Swertia* is known since long. Many volatile components have been isolated during the period of present review. *S. chirata* yielded hexadecanoic acid, ethyloleate, 4-(phenylmethyl)-pyridine, butanedioic acid, butylated hydroxytoluene, 3a,6a-dihydro-2(3H,4H)-cyclopenta[b]furanone, linoleic acid[93] and *S. chirata* also yielded camphor, 2-heptadecanone, cedrol, 3-buten-2-one and undecanoic acid.[94] In addition to above, *S. densifolia* yielded linalool, stearic acid, hydroquinone, α-terpineol and octadecanal.[95]

5. Miscellaneous constituents

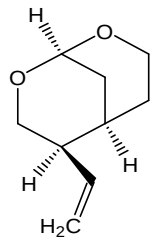
A nonacosanyl-hentriacontanoate **(47)** has been isolated from *S. chirata,* [63] epi-eustomoside **(48)** from *S. punicea* [19] and (-)-semburin **(49)** and (-)-isosemburin **(50)** from *S. japonica.*[96]



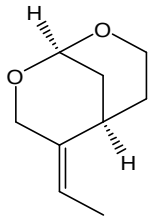
(47)



(48)



(49)



(50)

Other compounds which have been isolated are *m*-hydroxybenzoic acid, deacetylcentapicrin and vanillic acid from *S. chirata*,[43] 1-oxoisochroman-5-carboxaldehyde from *S. franchetiana,*[62] 3-butenyl 6'-*O*-α-L-arabinopyranosyl-*β*-D-glucopyranoside from *S. japonica*[16] and polysaccharides from *S. mussotii*.[97]

CONCLUSION

This systematic review contains specific time bound data completion of isolated xanthones and other class of natural compounds form genus *Swertia* and quite useful for research aspirates working on afore-mentioned genus.

REFERENCES

1. Flora of China, Published by Science Press, Beijing 1995; 16:101-124.
2. Chopra RN, Nayar SL and Chopra IC. Glossary of Indian Medicinal Plants, Council of Scientific and Industrial Research, New Delhi; 1956.
3. Hooker JD. The Flora of British India, *Reeve & Co, London*., 1883; 4: 121.
4. Karan M, Vasisht K and Handa SS. Supplement to Cultivation and Utilization of Medicinal Plants. Regional Research Laboratory, Council of Scientific and Industrial Research Jammu-Tawi. 1996; 1: 349- 354.
5. Joshi K. *Swertia*. Gentianaceae in Nepal: ethnobotany and agenda for sustainable management. Ethanobotanical Leaflets. 2008; 12: 1-6.
6. Ghosal S, Sharma P and Jaiswal DK. Chemical constituents of Gentianaceae XXIII: tetraoxygenated and pentaoxygenated xanthones of *Swertia angustifolia* Buch.-Ham. Journal of Pharmaceutical Sciences. 1978; 67: 55-60.
7. Ghosal S, Sharma PV, Chaudhuri RK and Bhattacharya SK., Chemical constituents of Gentianaceae XIV: tetraoxygenated and pentaoxygenated xanthones of *Swertia purpurascens* Wall. Journal of Pharmaceutical Sciences. 1975; 64: 80-83.
8. Khetwal S, Pande S and Tiwari U. Xanthones from *Swertia alata*. Indian Journal of Pharmaceutical Sciences. 1997; 7: 190-191.
9. Handa KL. A modified method for the assay of *Swertia chirata*. Indian Journal of Pharmaceutical Sciences. 1952; 14: 87-88.
10. Khan MI, Ahmad N, and Haqqani MH. Xanthones and ursolic acid from *Swertia* species. Planta Medica. 1977; 32: 280-281.
11. Prakash A, Basumatary PC, Ghosal S and Handa SS. Chemical constituents of *Swertia paniculata.* Planta Medica. 1982; 45: 61-62.
12. Bhandari P, Kumar N, Gupta AP, *et. al.,* Micro-LC determination in *Swertia* species and bacoside- A in *Bacopa monnieri*. Chromatographia. 2000; 64: 599-602.

13. Rahman AU, Pervin A, Feroz M, *et. al.,* Phytochemical studies on *Swertia cordata*. Journal of Natural Products. 1994; 57: 134-137.
14. Khan MI and Haqqani MI. Chemical investigation of *Swertia cordata.* Fitoterapia. 52; 1981:165-166.
15. Kulanthaivel P, Pelletier SW, Khetwal KS and Verma DL. Isolation of new xanthones and 2-hydrodimethyterephthalate from *Swertia petiolata.* Journal of Natural Products. 1988; 57: 397-381.
16. Kikuchi M and Kikuchi M. Studies on the constituents of *Swertia japonica* Makino II: On the structure of new glycosides. Chemical & Pharmaceutical Bulletin. 2005; 53: 48-51.
17. Kikuchi M and Kikuchi M. Studies on the constituents of *Swertia japonica* Makino I. On the structure of new glycosides. Chemical & Pharmaceutical Bulletin. 2004; 52: 1210-1214.
18. Rana VS and Rawat MSM. A new xanthone glycoside and antioxidant constituents from the rhizomes of *Swertia speciosa*. Chemistry & Biodiversity. 2005; 2: 1310-1315.
19. Ming X, Qiu MH, Nie RL and Zhang GL. A new monoterepene glycoside from *Swertia punicea*. Chinese Chemical Letters. 2000; 11: 709-710.
20. Kikuzaki H, Kawasaki Y, Kitamura S and Nakatani N. Secoiridoid glucosides from *Swertia mileensis*. Planta Medica. 1996; 62: 35- 38.
21. Li YL, Ding CX, Wang HL, *et. al.,* Separation and determination of flavones and xanthone glycosides in Tibetan folk medicinal species *Swertia mussotii* and *Swertia franchetiana* by capillary electrophoresis. Journal of Analytical Chemistry. 2008; 63: 574-576.
22. Li JC, Feng L, Sun BH, Ikeda T and Nohara T, Hepatoprotective activity of the constitutents in *Swertia pseudochinensis*. Biological & Pharmaceutical Bulletin. 2005; 23: 534-537.
23. Menkovic N, Fodulovic SK, Bulatovic V, *et. al.,* Xanthones from *Swertia punctata*. Phytochemistry. 2002; 61: 415-420.
24. Wang JN, Hou CY, Liu YL, *et. al.,* Swertifrancheside, an HIV-reverse transcriptase inhibitor and the first flavone xanthone dimer from *Swertia franchetiana.* Journal of Natural Products. 1994; 57: 211-217.
25. Brahmachari G, Mondal S, Gangopadhyay A, *et. al*., *Swertia* (Gentianaceae): chemical and pharmacological aspects. Chemistry & Biodiversity., 2004; 1:1627-1651.
26. Roberts JC. Naturally occurring xanthones. Chemical Reviews. 1961; 61: 591- 605.
27. Peres V, Nagem TJ and Oliveira FF. Tetraoxygenated naturally occurring xanthones. Phytochemistry. 2000; 55: 683-710.
28. Bhatia A, Karan M and Vasisht K., Xanthones from *Swertia nervosa* Wall. Indian Journal of Pharmaceutical Sciences. 2004; 66:708-709.
29. Tan G, Xu K, Li F, *et. al.,* Daviditin B from *Swertia davidi* Franch. Yaoxue Xuebao. 2003; 38: 931-933.
30. Ji L. Study on chemical constituents of *Swertia bifolia*. Xibei Zhiwu Xuebao. 2005; 25: 161-163.
31. Shi G, Lu R, Yang Y, *et. al.,* Crystal structure of 1,5,8-trihydroxy-3-methoxy xanthone from *Swertia chirayita.* Journal of Chemical Crystallography. 2005; 35: 135-139.
32. Guan D, Zhang Y and Xie O. Determination of the contents of effective constituents in *Swertia macrosperma*. Zhongguo Yaofang. 2007; 18: 680-681.
33. Zhang YY, Guan D, Xie OL and Yu DH. Antioxidant effect of xanthones *in vitro*. Zhong Chengyao. 2007; 29:342-345.
34. Xiao H, Lu Y, Chen Z, *et. al*., Chemical studies on new xanthones

from *Swertia decora*. Zhongguo Yaoxue Zazhi. 2001; 36: 302-304.
35. Hajimehdipour H, Amanzadeh Y, Ebrahimi SE and Mozaffarian V. Three tetraoxygenated xanthones from *Swertia longifolia*. Pharmaceutical Biology. 2003; 41: 497-499.
36. Xiao H, Liu GM, Wang Z and Rao SZ. Chemical constituents of *Swertia devlavayi*. Zhongguo Xiandai Yingyong Yaoxue. 2007; 24:120-121.
37. Rahman IU, Mohammad A, Reinecke MG and Ahmad V. A new xanthone glucopyranoside from *Swertia ciliata*. Journal of Chemical Society of Pakistan. 2000; 22: 142-151.
38. Zhang X, Tian L, Chen J and Liu Y. Chemical components of *Swertia punicea* Hemsl. Zhongcaoyao. 2007; 38: 1153-1154.
39. Zi M, Fang X, Xiao Y and Zhang HP. Study on the bioactive chemical constituents in *Swertia yunnanensis*. Linchan Huaxue Yu Gongye. 2000; 20: 85-87.
40. Wang S, Xiao H, Liu X, *et. al.,* Study on xanthone components of *Swertia franchetiana*. Zhongcaoyao. 2003; 34: 878-879.
41. Hajimehdipour H, Amanzadeh Y, Ebrahimi SE, *et. al.,* Two new xanthone diglycosides from *Swertia longifolia* Boiss. Natural Product Research. 2006; 20: 1251-1257.
42. Wang Z, Ma C, Tang S, *et. al.,* Qualitative and quantitative analysis of *Swertia* herbs by high performance liquid chromatography-diode array detection-mass spectrometry (HPLC-DAD-MS). Chemical & Pharmaceutical Bulletin. 2008; 56: 485-490.
43. Cai L, Wang S, Li T, and Xia Y. The research on chemical constituents from *Swertia chirayita.* Huaxi Yaoxue Zazhi. 2006; 21:111-113.
44. Xu K, Li F, Tan J, *et. al.,* HPLC determination of main constituents in *Swertia davidi* Franch. Yaowu Fenxi Zazhi. 2005; 25: 14-16.
45. Xu X and Yang J, Chemical constituents of *Swertia pubescens.* Zhongguo Yaoxue Zazhi. 2005; 40: 657-659.
46. Yang H, Ding C, Duan D and Liu J. Variation of active constituents of an important Tibet folk medicine *Swertia mussotii* Franch (Gentianaceae) between artificially cultivated and naturally distributed. Journal of Ethnopharmacology. 2005; 98: 31-35.
47. Li Y, Wang L, Wang X, *et. al.,* Separation and determination of the major active components in Tibetan folk medicinal species *Swertia franchetiana* by HPLC with DAD. Journal of Liquid Chromatography and Related Technologies. 2007; 30: 1687-1696.
48. Hajimehdipour H, Amanzadeh Y, Ebrahimi SE, *et. al.,* Protective effect of *Swertia longifolia* Boiss and its active compound swerchirin on paracetamol-induced hepatotoxicity in mice. Journal of Pharmacy and Pharmacology. 2006; 58: 277-280.
49. Xu K, Xu P, Liu W, *et. al.,* Chemical constituents from *Swertia davidi* Franch. Tianran Chanwu Yaanjiu Yu Kaifa. 2002; 14: 18-19.
50. Khetwal, KS, Rajput PS, Sajwan K, *et. al.,* 1,5-dihydroxy-3,8-dimethoxy xanthone from *Swertia cuneata*. Indian Journal of Chemistry Section B: Organic Chemistry Including Medicinal Chemistry. 2003; 42B: 935-955.
51. Zhang Y, Zheng Y, Xu X and Fu S. Determination of demethylbellidifolin in different parts of *Swertia davidi* Franch by HPLC. Zhongguo Yaofang. 2007; 18: 1163-1164.
52. Karan M, Bhatnagar S, Wangtak P and Vasisht K. Phytochemical and antimalarial studies on *Swertia alata* Royle. Acta Horticulturae. 2005; 42: 139-145.

53. Tan G, Xu K, Xu P, *et. al.,* Studies on the chemical constituents of *Swertia davidi* Franch. Yaoxue Xuebao. 2002; 37: 630-632.
54. Tan L, Zhang X, Wang M, *et. al.,* Studies on chemical constituents of *Swertia przewalskii.* Zhongcaoyao. 2002; 33: 583-586.
55. Yang Y, Liao Z, Guo L and Chen Y. Capillary electrophoretic analysis of pharmacologically active xanthone compounds from *Swertia przewalskii* pissjauk extract. Journal of Liquid Chromatography and Related Technologies. 2003; 26:1219-1229.
56. Ahmad VU, Rahman IU, Khan MA, *et. al.,* A xanthone dixylopyranoside from *Swertia thomsonii*. Chemical Sciences. 2002; 57: 122-126.
57. Patro BS, Chintalwar GJ, and Chattopadhyay S. Antioxidant activities of *Swertia decussata* xanthones. Natural Product Research. 2005; 19: 347-354.
58. Guo, A., Li, J., Fu, H., Lin, W., Xanthone derivatives from medicinal plant *Swertia mileensis.* Zhongcaoyao. 2003; 34: 107-109.
59. Xiao H, Yang L, Chen Z, *et. al.,* New xanthones from *Swertia decora*. Journal of Chinese Pharmaceutical Sciences. 2001;10: 172-174.
60. Chakravarty AK, Sarkar T, Das B and Masuda, K. A new chiratane triterpenoid from *Swertia chirata.* Indian Journal of Chemistry Section B: Organic Chemistry Including Medicinal Chemistry. 2001; 40B: 228-231.
61. Ma Y, Chen G, Ji W, *et. al.,* Determination of three medicinal bioactive components in different parts of *Swertia mussotii* Franch by RP-HPLC. Yaowu Fenxi Zazhi. 2005; 25: 1078-1081.
62. Wang S, Xu Q, Xian H, *et. al.,* Glycoside constituents from *Swertia franchetiana.* Zhongcaoyao. 2004; 35: 847-849.
63. Pant N, Jain DC and Bhakuni RS. Some chemical constituents of *Swertia chirata*. Indian Journal of Chemistry Section B: Organic Chemistry including Medicinal Chemistry. 2002; 41B: 1980-1986.
64. Zhang X, Huang F, Chen J and Liu Y. Determination of three glycosides of *Swertia punicea* by RP-HPLC. Zhongguo Zhongyao Zazhi. 2007; 32: 1184-1186.
65. Zhang X, Tian L, Hou J, *et. al.,* Study on HPLC fingerprint of *Swertia punicea*. Zhongguo Yiyuan Yaoxue Zazhi. 2006; 26: 922-924.
66. Zeng G, Tan G, Xu K, *et. al.,* Water soluble chemical constituents of *Swertia davidi* Franch. Yaoxue Xuebao. 2004; 39: 351-353.
67. Li Y, Ding C, Liu J, *et. al.,* Glycosides from *Swertia erythrosticta*. Zhongcaoyao Zazhi Bianjibu. 2002, 33, 104-106.
68. Liao ZX, Li YL, Wang M.K., *et. al.,* Two new xanthone glycosides from *Swertia tetraptera.* Chinese Chemical Letters. 2001; 12: 433-435.
69. Suryawanshi S, Mehrotra N, Asthana RK, *et. al.,* Liquid chromatography/tandem mass spectrometric study and analysis of xanthone and secoiridoid glycoside composition of *Swertia chirata*, a potent antidiabetic. Rapid Communication in Mass Spectrometry. 2006; 20: 3761-3768.
70. Huang Y, Bi L, Chen C, *et. al.,* Extraction of *Swertia chirayita* (Roxb.ex Fleming) karsren. Zhongchengyao. 2008; 30:190-192.
71. Xia C, Liu G and Zhang H. Determination of four effective consitutents in *Swertia binchuanensis* by HPLC. Zhongguo Yaoke Daxue Xuebao. 2007; 38: 43-46.
72. Cao Y, Wang Y and Ye J. Differentiation of *Swertia mussotii* Franch from artemisiae capillaris herba by capillary electrophoresis with electrochemical detection. Journal of Pharmaceutical and

Biomedical Analysis. 2005; 39: 60-65.
73. Zhang Y, Zheng Y, Xu X and Fu S. Quantitative determination of mangiferin in different parts of *Swertia davidi* Franch by HPLC. Shizhen Guoxi Guoyao. 2007; 18: 789-790.
74. Xia C, Liu G and Wang Y. Quantitative determination of four effective components in *Swertia delavayi* by HPLC. Zhongguo Yiyuan Yaoxue Zazhi. 2007; 27: 598-601.
75. Ramesh N, Viswanathan WB, Saraswathy A, *et. al.,* Antimicrobial and phytochemical studies of *Swertia corymbosa*. Fitoterapia. 2002; 73:160-164.
76. Xiao H, Lu Y, Chen Z, *et. al.,* Xanthone constituents in *Swertia decora.* Zhongcaoyao. 2005; 36: 166-169.
77. Jia Z, Chen Z and XM. Detection of mangiferin in *Swertia mussotii* injection by HPLC. Zhongchengyao. 2006; 28: 1703-1704.
78. Tian W, Chen Z, Zhai J, *et. al.,* HPLC fingerprinting of total glycosides of *Swertia franchetiana*. Yaoxue Xuebao. 2005; 40: 447-452.
79. Tian W, Zhang D, Cheng X, *et. al.,* Analysis of five glycosides in *Swertia franchetiana* H-smith extracts by high performance liquid chromatography and atmospheric pressure chemical ionization- mass spectrometry. Fenxi Huaxue. 2005; 33: 1265-1268.
80. Wang, S. S., Zhao, W. J., Han, X. W., Liang, X. M., Two new iridoid glycosides from the Tibetan folk medicine *Swertia franchetiana*. Chemical & Pharmaceutical Bulletin. 2005; 53: 674-676.
81. Kikuchi M, Kakuda R, Yaoita Y and Kikuchi M. New secoiridoid glycosides from *Swertia japonica*. Helvetica Chimica Acta. 2008; 91: 1236-1243.
82. Huang W, Xu C, Zhou D, *et. al.,* Determination of iridoids and triterpenes in herb of *Swertia pseudochinesis* by RP-HPLC. Zhongguo Zhongyao Zazhi. 2007; 32: 2494-2496.
83. Li F, Zhou Y and Zhou MH. Quantitative determination of the high purity swertiamarin by HPLC. Guangpu Shiyanshi. 2007;24: 944-948.
84. Peng X, Wang H, Chen S and Zhou S. Studies on the efficacious chemical constituents of medicinal of *Swertia davidi*. Ziran Kexueban. 2001; 22; 59-60.
85. Guo Z, Xu K, Li F, *et. al.,* Determination of swertiamarin in *Swertia nervosa* (G.Don) wall by HPLC. Zhongnan Yaoxue. 2006; 5: 242-244.
86. Tian CW, and Zhang T HPLC determination of swertiamarin and gentiopicroside contents in *Swertia* herb. Zhongcayao. 2006; 37: 442-443.
87. Baelmans R, Deharo E, Bourdy G, *et. al.,* A search for natural bioactive compounds in *Bolivia* through a multidisciplinary approach Part IV. Is a new heme polymerization inhibition test pertinent for the detection of antimalarial natural products. Journal of Ethnopharmacology. 2002; 73: 271-275.
88. Song P, Kang ZQ, and Yu J, Determination of gentiopicroside in Tibetan drug *Swertia mussotii* Franch by RP-HPLC. Huaxi Yaoxue. 2007; 22: 564-565.
89. Di YT, Liao X, Peng S. *et. al.,* A novel monoterpene glycoside from *Swertia mileensis*. Chinese Chemical Letters. 2003; 14:1154-1155.
90. Kikuchi M and Kikuchi M. Studies on the constituents of *Swertia japonica* Makino III. On the triterpenoids and phenol glycosides. Journal of Tohoku Pharmaceutical. 2004; 51: 49-53.

91. Cheng H, Feng W, Meng X. *et. al.,* Comparisons of oleanolic acid contents in *Swertia franchetiana* from different areas of Qinghai province. Zhongyaocai. 2007; 30: 521-52.
92. Zi M, Yuan LM, Liu P. *et. al.,* Separation of alkaloids from *Swertia yunnanensis* by high speed countercurrent chromatography. Linchan Huaxue Xu Gongye. 2002; 22: 74-76.
93. Shi G, Lu R, Xang Y, *et. al.,* Studies on chemical constituents of essential oil from *Swertia chirayita*. Xibei Zhiwu Xuebao. 2004; 24: 296-300.
94. Gyawali R, Ryu KY, Shim SL, *et. al.,* Essential oil constituents of *Swertia chirata* Buch-Ham. Journal of Food Science and Nutrition. 2006:11: 232-236.
95. Naik DG, Dandge C, Puntambekar H and Deshpande, P. Chemical examination of *Swertia densifolia* leaf essential oil and its repellent activity towards *Apis cerana indica* F. Journal of Apicultural Research. 2008; 47: 63-67.
96. Kadota K, Taniguchi T and Ogasawara K. Enantio and diastereoselective synthesis of (-)-semburin and (-)-isosemburin, monoterpenes isolated from *Swertia japonica*. Synlett. 2002; 2: 334-336.
97. Li L. Extraction and determination of polysaccharides from *Swertia mussotii.* Ziran Kexueban. 2007; 33: 52-55.