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Review Article

Phytochemical and Ethnomedicinal Uses of Family Gentianaceae

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Abstract

Cognitive capacity of human beings has placed natural products in the core of our lives. It has redefined role of science in establishment of its values for society. Evolution of sciences along with various inductivist views and epistemological evidences has changed shape and state of affairs in the world of natural products. As a matter of fact importance of these constituents growing rapidly in our lives. Volatile constituents of *Swertia* hold many idiosyncratic qualifications, enough to consider them as a promising candidate for their medicinal exploitation. Claim of this genus for a reliable alternative in the present remedial system seems to be acceptable. Many other therapeutic activities have been reported which endorse belief that this genus is going to revolutionize state of affairs in the world of essential oil. This study is devoted to the comprehensive review of recent research work on the genus and is bolstered by epistemic achievements and evidences collected by research community in recent times. The discussion in this study has been devoted to captivating and bewitching role of essential oil of the genus *Swertia* for various therapeutic purposes. This study gives a core idea of contemporary state of affairs and recent scientific developments.

Key words: *Swertia*, therapeutic, natural products, scientific, volatile constituents

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INTRODUCTION

Gentianaceae is a family of flowering plants comprising approximately 70-80 genera and 900-1200 species. The plants of the family are annual and perennial herbs or shrubs. They are native to Northern temperate areas of the world¹. Plants belonging to genus *Gentiana* are very well-known for their pharmacological properties. They are intensely bitter and once upon a time were valuable remedy for digestive system ailments. The medicinal value is due to presence of bitter glycosides².

The family Gentianaceae is characterized by the presence of a group of rare yellow pigments (xanthenes) in most of its members³. The plants species of genus *Swertia* are diverse and large genus populated with 170 species. The plants species of genus *Swertia* are diverse and large genus populated with 170 species^{4,5} distributed at the mountainous region of tropical Asia, Europe, America and Africa. Himalayan regions houses most of the *Swertia* species^{6,7}. *Swertia chirayita* is known to contain various active principles including xanthenes, secoiridoid glycosides, flavonoids, alkaloids, phenolics^{4,6}.

Among the plants often used in traditional medicine, *Swertia* species, which belong to the Gentianaceae family play a vital role. A variety of *Swertia* plants are used as crude drugs in the Indian pharmacopoeia. *Swertia chirata*, commonly known as chirayata, demands special attention in this regard because of its multidirectional use as a bitter stomachic, febrifuge, anthelmintic, antimalarial and antidiarrheal⁸. In Chinese traditional medicine, 20 species of this genus are being used for the treatment of hepatic, choleric and inflammatory diseases⁹. Other traditionally important *Swertia* species substitute for the traditional healing. The *S. davidi* is used as remedy for acute bacillary dysentery, *S. alata* as an appetite tonic and febrifuge, *S. minor* in the treatment of malarial and fever, *S. petvolata* and *S. thomsonii* finds its applications in the amchies system of medicine⁴. Other important plants species includes *S. angustifolia*, *S. corymbosa*, *S. decussta*, *S. hookeri*, *S. macrosperma*, *S. petiolata*, *S. lawii*, *S. paniculata*, *S. punctata*, *S. calycina*, *S. purpurascens*, *S. bimaculata*, *S. ciliata*, *S. densifolia*, *S. japonica* and *S. frachetiana* that are used in folklore medicine and as substitutes for *S. chirayita* in various countries for treatment of liver disorders, fever, dysentery, diarrhea, stomach problems and other ailments^{4,6,10}.

The main aim of this study is to collect all the possible information regarding the chemical constituents and

ethnomedicinal uses of the family Gentianaceae, thus will help to the researchers and scientists to take action for future study in this discipline.

CHEMICAL CONSTITUENTS

The phytochemical investigation of the genus *Swertia* as carried out so far, has afforded some 200 compounds with varying structural patterns. Among these constituents, xanthenoids, terpenoids, flavonoids and alkaloids were presented from the major classes, together with other compounds, according to the following classification⁴.

Xanthenoids: Xanthenes are secondary metabolites commonly occurring in higher plant families, fungi and lichen¹¹. Their pharmacological properties have raised great interest. Structures of xanthenes are related to that of flavonoids and their chromatographic behaviors are also similar. Flavonoids are frequently encountered in nature, whereas xanthenes are found in limited number of families. Xanthenes always occur in the family Gentianaceae, Guttiferae, Moraceae, Clusiaceae and Polygalaceae. Xanthenes are sometimes found as the parent polyhydroxylated compounds but most are mono or polymethyl ethers or are found as glycoside¹². Xanthenes are class of tricyclic compounds characterized by a dibenzo- γ -pyrone nucleus. The prefix 'Xanth' means 'Yellow' color of these compounds and '-one' is from their 'Keto' nature. The xanthenes bear a close structural relationship to the other naturally occurring γ -pyrone derivatives like flavonoids and chromones. Xanthenes can be classified into six major groups depending upon oxygenation pattern^{13,14} (Fig. 1-3).

Xanthenes and their glycosides have been isolated from *Swertia* species. Mangiferin is the most common C-glycosides

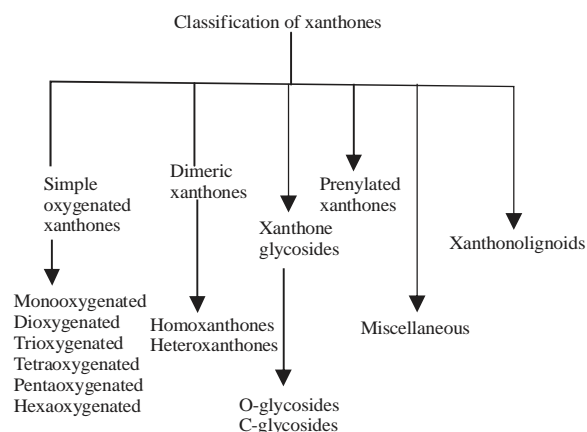


Fig. 1: Pictorial representation of the classification of xanthenes

in *S. chirayita*, *S. mussotii*, *S. cordata*, *S. macrosperma* and *S. connata*. Xanthone O-glycosides (swertianolin) from

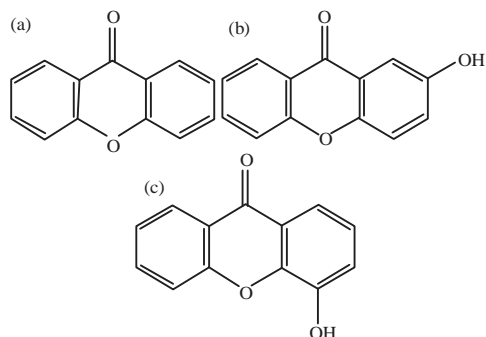


Fig. 2(a-c): Structure of mono oxygenated (a) Xanthone, (b) 2-hydroxy xanthone and (c) 4-hydroxy xanthone

S. japonica and *S. ciliata*¹⁵ have been reported. The first xanthone O-glycoside, norswertianin-1-O-glucosyl-3-O-glucoside has been isolated from *S. perennis*¹⁶. The xanthones isolated and characterized from various *Swertia* species so far are listed in Table 1.

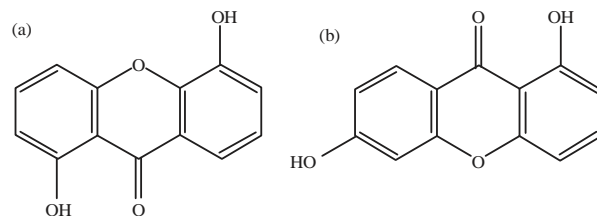


Fig. 3(a-b): Structure of dioxygenated xanthone, (a) 1,5 di-hydroxy xanthone and (b) 1,6 di-hydroxy xanthone

Table 1: Isolated xanthone from *Swertia* species

Plant's	Xanthones	References
<i>S. mussotii</i>	3,7,8-trimethoxyxanthone 1-O-(β-D-glucopyranoside) 1,8-dihydroxy-3-methoxyxanthone 7-O-[α-L-rhamnopyranosyl (1-2)-β-D-xylopyranoside] 1,8-dihydroxy-3,4-dimethoxyxanthone 7-O-[β-D-glucopyranoside] 1,8-dihydroxy-3-methoxyxanthone 7-O-[β-D-glucopyranoside] 1-hydroxy-3,4-dimethoxyxanthone 7-O-[β-D-glucopyranoside]	Mao <i>et al.</i> ¹⁷
<i>S. macrosperma</i>	1-hydroxy-3,7,8-trimethoxy-xanthone 1,3,7,8-tetrahydroxyxanthone-8-O-beta-D-glucopyranoside Norswertianolin Swertianolin	Wang <i>et al.</i> ¹⁸
<i>S. ciliata</i>	Mangiferin (2-C-β-D-glucopyranosyl-1,3,6,7-tetrahydroxyxanthone)	Chauhan and Dutt ¹⁹
<i>S. cordata</i>	1-hydroxy-2,3,7-trimethoxyxanthone 1-hydroxy-2,3,4,7-tetramethoxyxanthone	Karan <i>et al.</i> ²⁰
<i>S. paniculata</i>	1,5-dihydroxy-3-methoxyxanthone-8-O-b-D-glucopyranoside (swertianolin)	Pant <i>et al.</i> ²¹
<i>S. corymbosa</i>	1,5, 8-trihydroxy-3-methoxyxanthone	Saraswathy and Ariyanathan ²²
<i>S. punicea</i>	1,5-dihydroxy-8-O-β-D-glucopyranosyl-3-methoxyxanthone 2-C-β-D-glucopyranosyl-1,3,6,7-tetrahydroxyxanthone (mangiferin)	Zhang <i>et al.</i> ²³
<i>S. davidi</i>	1,3,5,8-tetrahydroxy xanthones	Zhang <i>et al.</i> ²⁴
<i>S. chirayita</i>	2-C-β-D-glucopyranosyl-1,3,6,7-tetrahydroxyxanthone	Suryawanshi <i>et al.</i> ²⁵
<i>S. japonica</i>	6'-O-α-L-arabinopyranosylswertiamarin 3'-O-β-D-glucopyranosylswertiamarin 4'-O-β-D-glucopyranosylswertiamarin 3'-O-β-D-galactopyranosylswertiamarin 6'-O-α-D-galactopyranosylswertiamarin 6'-O-α-D-manopyranosylswertiamarin 6'-O-β-D-fructofuranosylpyranosylswertiamarin 5'-O-β-D-glucopyranosylamaroswerin	Kikuchi and Kikuchi ²⁶
<i>S. alata</i>	1,8-dihydroxy-3,7-dimethoxyxanthone 1,7,8-trihydroxy-3-methoxyxanthone 1-hydroxy-3,7,8-trimethoxyxanthone	Karan <i>et al.</i> ²⁷
<i>S. bifolia</i>	1-hydroxy-3,5-dimethoxyxanthone 1,7-dihydroxy-3,8-dimethoxyxanthone 1,8-dihydroxy-3,7-dimethoxyxanthone 1-hydroxy-3,7,8-trimethoxyxanthone	Ji ²⁸
<i>S. nervosa</i>	1,7-dihydroxy-3,8-dimethoxyxanthone 1,8-dihydroxy-3,7-dimethoxyxanthone 1-hydroxy-3,7,8-trimethoxyxanthone	Bhatia <i>et al.</i> ²⁹
<i>S. speciosa</i>	6-hydroxy-3,5-dimethoxy-1-[(primverosyl)oxy] xanthonea)	Negi <i>et al.</i> ³⁰
<i>S. ciliata</i>	1,8-dihydroxy-3-methoxyxanthone-7-O-glucopyranoside	Inayat-Ur-Rahman <i>et al.</i> ³¹

Terpenoids: There are many different classes of naturally occurring compounds. Terpenoids also form a group of naturally occurring compounds majority of which occur in plants, a few of them have also been obtained from other sources. Terpenoids are volatile substances which give plants and flowers their fragrance. They occur widely in the leaves and fruits of higher plants, conifers, Citrus and Eucalyptus³². By the modern definition: "Terpenoids are the hydrocarbons of plant origin of the general formula (C₅H₈)_n as well as their oxygenated, hydrogenated and dehydrogenated derivatives". Terpenoids are classified according to containing number of carbon atoms³³ are listed in Table 2.

Individual compounds are more frequently used than the oil as such in medicinal preparations. Some widely used terpenoids in herbal preparation are:

- Terpenoids : Uses
- Camphor : Counter irritant
- Bornyl isovalerate : Sedative
- Menthol : In cough drops
- Terpinyl hydrate : Expectorant
- Chamazulene : Anti-inflammatory agent³⁴
- β-caryophyllene : Non-steroidal anti-inflammatory agents

Terpenoids with basic steroidal frameworks have been isolated from different *Swertia* species and are collected and listed in Table 3.

Iridoid and seco-irridoid glycosides: Iridoids are considered a typical monoterpenoid compounds, based on a methylcyclopentan-[C]-pyran skeleton, often fused to a

Table 2: Classification of terpenes

No. of carbon atom	No. of value	Class
10	2	Monoterpenoids (C ₁₀ H ₁₆) (Fig. 4)
15	3	Sesquiterpenoids (C ₁₅ H ₂₄) (Fig. 5)
20	4	Diterpenoids (C ₂₀ H ₃₂) (Fig. 6)
25	5	Sesterpenoids (C ₂₅ H ₄₀)
30	6	Troterpenoids (C ₃₀ H ₄₈)
40	8	Tetraterpenoids (C ₄₀ H ₆₄)
>40	>8	Polyterpenoids (C ₅ H ₈) _n

Table 3: Isolated terpenoids from *Swertia* species

Plant's name	Isolated terpenoids	References
<i>S. macrosperma</i>	Oleanolic acid, β-sitosterol and daucosterol	Wang <i>et al.</i> ¹⁸
<i>S. purpurascens</i>	Queretic acid, oleanolic acid and β-sitosterol-D-glycoside	Sajwan <i>et al.</i> ³⁵
<i>S. corymbosa</i>	Lupeol and friedelin epi-friedelinol	Cao <i>et al.</i> ³⁶ and Ramesh <i>et al.</i> ³⁷
<i>S. speciosa</i>	Taraxer-14-en-3-one	Rana and Rawat ³⁸
<i>S. chirayita</i>	Chiratanol	Ji ²⁸
<i>S. bifolia</i>	β-daucosterol	Ji ²⁸
<i>S. japonica</i>	Hederagenin, maslinic acid, erythrodiol-3-O-palmitate and 3β-hydroxy-11-oxoolean-12-ene-28-oic acid	Kikuchi and Kikuchi ³⁹
<i>S. mileensis</i>	Glycoside mileensis	Di <i>et al.</i> ⁴⁰
<i>S. yunnanensis</i>	Thysanolactone	Zi <i>et al.</i> ⁴¹
<i>S. ciliata</i>	β-sitosterol	Inayat-Ur-Rahman <i>et al.</i> ³¹
<i>S. punicea</i>	Glycoside and 2,6-dimethyl-2E,6E-octadienoic acid-1,6'-lactone-8-β-D-glucopyranoside	Ming <i>et al.</i> ⁴²

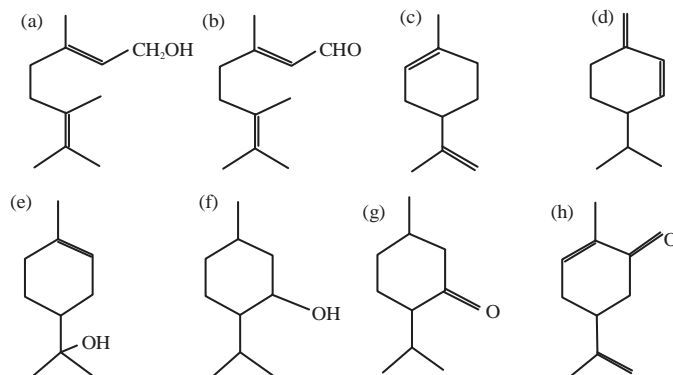


Fig. 4(a-h): Structure of monoterpenoids, (a) Geraniol, (b) Citral, (c) Limonene, (d) β-phellandrene, (e) α-terpineol, (f) Menthol, (g) Menthone and (h) Carvone

six-membered oxygen ring consisting of ten, nine or in rare cases, eight carbon atoms^{43,44}. More than 2500 iridoid compounds have been described in nature, with structural

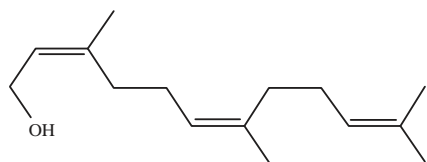


Fig. 5: Structure of sesquiterpenoids (Farnesol)

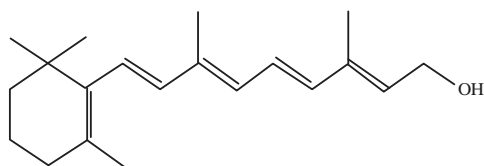


Fig. 6: Structure of diterpenoids (Vitamin A)

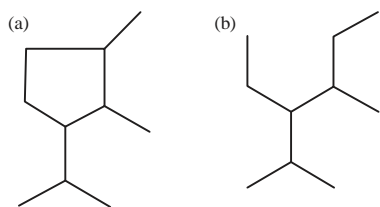


Fig.7(a-b): Structure of iridane and secoiridane nucleus, (a) Iridane nucleus and (b) Secoiridane nucleus

differences related mainly to the degree and type of substitution in the cyclopentane ring skeleton⁴⁵. The bitter principles of the genus *Swertia* can be classified into three groups:

- Iridoid glycosides
- Secoiridoid glycosides
- Biphenyl glycosides

Iridoid and secoiridoids are a class of compounds having iridane and secoiridane nucleus (Fig. 7). The irridoid and seco-irridoid glycosides isolated and characterized from various *Swertia* species so far are listed in Table 4.

Flavonoids and flavonoid glycosides: Flavonoids are a large and complex group of compounds containing a three ring structure with two aromatic centers (rings A and B) and a central oxygenated heterocyclic ring (C)^{51,52}. The six major classes of flavonoids are flavones, flavonols, flavonones, catechins (flavanols) anthocyanidins and isoflavones^{51,53-56}. Flavonoids have several proven medicinal properties, such as anti-inflammatory, anti-oxidant, anti cancer, antibacterial and antiviral properties^{52,57-59}. Flavonoids have been isolated from different *Swertia* species and are collected and listed in Table 5.

Lignans and alkaloids: The lignans comprise a class of natural plant products which are derived from cinnamic

Table 4: Isolated irridoid and seco-irridoid glycosides from *Swertia* species

Plant's name	Irridoid and seco-irridoid glycosides	References
<i>S. ciliata</i>	Amarogentin and amaroswerin	Chauhan and Dutt ¹⁹
<i>S. longifolia</i>	Gentiopicroside and loganic acid	Hajimehdipoor <i>et al.</i> ⁵
<i>S. punicea</i>	Amarogentin	Wang <i>et al.</i> ⁴⁶
<i>S. delavayi</i>	Swertiamarin	Xia <i>et al.</i> ⁴⁷
<i>S. binchuanensis</i>	Gentiopicroside	Xia <i>et al.</i> ⁴⁷
<i>S. nervosa</i>	Swertiamarin	Guo <i>et al.</i> ⁴⁸
<i>S. chirata</i>	Sweroside	Suryawanshi <i>et al.</i> ²⁵
<i>S. pseudochinensis</i>	Amaroswerin	Li <i>et al.</i> ⁴⁹
<i>S. japonica</i>	6'-O- α -Dmannopyranosylswertiamarin and 6'-O- β -D-fructofuranosylswertiamarin	Kikuchi and Kikuchi ³⁹
<i>S. cordata</i>	Swertiamarin	Bhandari <i>et al.</i> ⁵⁰

Table 5: Isolated flavonoids and flavonoid glycosides from *Swertia* species

Plant's name	Isolated flavonoids	References
<i>S. mussoitii</i>	Isoorientin	Li <i>et al.</i> ⁶⁰
<i>S. franchetiana</i>	Swertisin and isoswertisin	Tian <i>et al.</i> ⁶¹
<i>S. decora</i>	Quercetin	Xiao <i>et al.</i> ⁶²
<i>S. przewalskii</i>	Luteolin	Pan <i>et al.</i> ⁶³
<i>S. punicea</i>	Isovitexin	Ming <i>et al.</i> ⁴²
<i>S. longifolia</i>	Gentisein	Handa ⁶⁴
<i>S. hookerii</i>	3,4,5,7-tetra-O-methyl-3-O-stearylquercetin	Ghosal <i>et al.</i> ⁶⁵
<i>S. japonica</i>	Swertijaponin	Kubota <i>et al.</i> ⁶⁶
<i>S. perennis</i>	Isovitexin	Hostettmann and Jacot-Guillarmod ⁶⁷

Table 6: Isolated lignans and alkaloids from *Swertia* species

Plant's name	Isolated lignans and alkaloids	References
<i>S. japonica</i>	glycoside 7R,7'R,8S,8'S-(+)-neo-olivil-4-O-β-D-glucopyranoside	Kikuchi and Kikuchi ²⁶
<i>S. yunnanensis</i>	Gentianine	Zi <i>et al.</i> ⁶⁸
<i>S. purpurascens</i>	Gentiocrucine	Sharma ⁶⁹
<i>S. chirata</i>	Enicoflavine	Sharma ⁷⁰
<i>S. elegans</i>	Sweetinine	Balandrin and Kinghorn ⁷¹
<i>S. japonica</i>	Gentianine	Yamahara <i>et al.</i> ⁷²
<i>S. marginata</i>	Gentianamine	Rakhamatullaev <i>et al.</i> ⁷³

Table 7: Isolated miscellaneous compound from *Swertia* species

Plant's name	Isolated compounds	References
<i>S. macrosperma</i>	Sinapaldehyde, balanophonin, decentapicrin and coniferl aldehyde	Wang <i>et al.</i> ¹⁸
<i>S. longifolia</i>	Gentiolactone and uridine	Hajimehdipoor <i>et al.</i> ⁵
<i>S. mussoitii</i>	Polysaccharides	Li ⁷⁴
<i>S. chirata</i>	m-hydroxybenzoic acid, deacetylcentapicrin and vanillic acid	Cai <i>et al.</i> ⁷⁵
<i>S. japonica</i>	3-butenyl 6'-O-α-L-arabinopyranosyl-β-dglucopyranoside	Kikuchi and Kikuchi ²⁶
<i>S. franchetiana</i>	1-oxoisochroman-5-carboxaldehyde	Wang <i>et al.</i> ⁷⁶
<i>S. chirata</i>	Nonacosanyl-hentriacontanoate	Pant <i>et al.</i> ²¹
<i>S. japonica</i>	(-)-semburin and (-)-isosemburin	Kadota <i>et al.</i> ⁷⁷
<i>S. punicea</i>	Epieustomoside	Ming <i>et al.</i> ⁴²

acid derivatives and which are related biochemically to phenylalanine metabolism. They fall into five major subgroups and the nomenclature in use is either consistent between the groups or even within a subgroup. Many lignans show physiological activity, such as the tumor-inhibiting podophyllotoxins. This specific activity leads to interference with cell division by two different mechanisms in animals including humans.

Alkaloids often contain one or more rings of carbon atoms, usually with a nitrogen atom in the ring. Many have declared pharmacological activity⁵⁸. Most alkaloids have a strong bitter taste and are very toxic, for these reasons they are used by plant to protect themselves against herbivory and attacks by microbial pathogens and invertebrate pests⁵⁸.

Several alkaloid containing medicinal herbs are reported to have been used by the early man as pain relievers as recreational stimulants or in religious ceremonies to enter a psychological state to achieve communication with ancestors or God. Lignans, alkaloids have been isolated from different *Swertia* species and are collected and listed in Table 6.

MISCELLANEOUS

Some miscellaneous compound isolated from different *Swertia* species and is collected and listed in Table 7.

CONCLUSION

This systematic review contains specific time bound data completion of isolated xanthenes and other class of natural compounds from genus *Swertia* and fairly useful for research aspirates working on this genus. From the above discussion,

it is clear that the family Gentianaceae is an important plant family with respect to its ethnomedicinal importance. It is widely used in traditional health care system. So, this importance builds a pressure on the plant regarding its use. So, practical steps are needed for its conservation which include *ex situ* and *in situ* conservation. Much more work should be done on studies phytochemistry and essential oils. The structures and composition of different chemical components present in it should be determined for recognizing its further activities. This type of information is required for drug production from this plant for treating various diseases.

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