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Chemical Constituents and Biological Importance of Swertia: A Review

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ABSTRACT

Swertia, commonly known as 'Chirata' in indigenous systems of medicine, are used for treatment of a variety of ailments. Literature survey revealed that much phytochemical analysis has been done on genus Swertia by several groups. In this study, we had planned to document the active chemical constituents of valuable medicinal plants of genus Swertia. The major bioactives of Swertia are xanthones, however, other secondary metabolites such as flavonoids, iridoid glycosides and triterpenoids are also active constituents of this genus. These secondary metabolites played significant role in biological activities such as hepatoprotective, antihepatotoxic, antimicrobial, anti-inflammatory, anticarcinogenic, antileprosy, hypoglycemic, antimalarial, antioxidant, anticholinergic, CNS depressant and mutagenicity.

Key words: Swertia, Gentianaceae, xanthones, chiretta, biological activities

INTRODUCTION

Swertia (family Gentianaceae) is a large genus of herbs distributed in the mountainous regions of tropical area at an altitude of 1200-3600 m. The herbal drug "chiretta" obtained from the dried plants of swertia species. The whole plants of Swertia are medicinal but roots are the most powerful parts (Anonymous, 1976). These are useful as a tonic without aroma or astringency. In Indian medical system chiretta is used as remedy for bronchial asthma, liver disorders, chronic fever, anemia, stomachic and diarrhoea. Chiretta is also used in dying cotton cloth and in liquor industry as bitter ingredients. In Ayurveda, *S. chirayita* is used as antipyretic, anthelminitic, antiperiodic, laxative and in asthma and leucorrhoea. In Yunani system the plant is used as astringent, tonic, stomachic, lessens inflammation, sedative to pregnant uterus and chronic fevers (Kirtikar and Basu, 1984).

S. chirayita has an established domestic (India) and international market which is increasing at a rate of 10% annually. In spite of the increasing demand by herbal industry the plant is still collected from wild. It is sparsely cultivated and negligible efforts have gone into developing proper agro-techniques of plant. It is harvested for the drug industry (Bentley and Trimen, 1880). *S. chirayita* is also used in British and American pharmacopoeias as tincture and infusions (Joshi and Dhawan, 2005). *S. angustifolia* resembles to *S. chirayita* very closely but differs from it in having thinner root, small wings and ridges on the stem. The dried plants of *S. angustifolia* and *S. paniculata* are used as substitute for *S. chirayita*. About 22,000 kg of the drug are said to be collected and sold annually in Himanchal Pradesh while the annual demand for chiretta in

India is reported to be 37,300 kg. Plants belonging to these families are found in all parts of world. They have been widely used in folk medicine. Simple polyoxygenated xanthones have been isolated from most of them. Xanthone derivatives, flavonoids, iridoid glycosides, triterpenoids and dimeric xanthones have been isolated from the genus Swertia (Tan *et al.*, 1991; Zhou *et al.*, 1989). The genus Swertia exhibit variety of biological activity such as hepatoprotective, antihepatotoxic, antimicrobial, anti-inflammatory, anticarcinogenic, antileprosy, hypoglycemic, antimalarial, antioxidant, anticholinergic, CNS depressant and mutagenicity. The pharmacological properties of Swertia have raised great interest. The purpose of this review to collect all the possible information regarding the chemical constituents and biological effects of the genus Swertia, thus will help to the researchers and scientists to take action for future study in this discipline.

CHEMICAL CONSTITUENTS

Xanthones are main secondary metabolites of Swertia species. Structures of xanthones are related to that of flavonoids and their chromatographic behaviors are also similar. Although flavonoids are frequently encountered in nature, xanthones have been found in limited number of families. They always occur in Gentianaceae and Guttiferae. Xanthones are sometimes found as the parent polyhydroxylated compounds but most xanthones are mono or poly methyl ethers or are found as glycosides (Hostettmann and Miura, 1977). Unlike iridoids, xanthones are apparently not present in all plant species investigated in the family Gentianaceae. This is documented by the systematic study of Hostettmann-Kaldas *et al.* (1981). The natural xanthones have been isolated mainly from about 150 plants associated with four families; Guttiferae, Gentianaceae, Moraceae and Polygalaceae. According to Vieira and Kijjoa (2005), 278 natural xanthones were reported from total of 515 xanthones. In this period, the xanthones from higher plants appear to be associated mainly with the families Clusiaceae (55 species in 12 genera) and Gentianaceae (28 species in 8 genera). Isolated compounds and biological activities of Swertia species are listed in Table 1. Xanthones isolated from nature are classified into six main groups; simple xanthones, xanthone glycosides, prenylated xanthones, xanthonolignoids, bis-xanthones and miscellaneous xanthones. These are further subdivided according to the degree of oxygenation into non-, mon-o, di-, tri-, tetra-, penta- and hexa-oxygenated substances (Mandal *et al.*, 1992b; Sultanbawa, 1980; Demirkiran, 2007).

Xanthones and their glycosides (Fig. 1) have been isolated from Swertia species. Mangiferin is the most common C-glycosides in *S. chirayita*, *S. mussotii*, *S. cordata*, *S. macrosperma* and *S. connata*. Xanthone O-glycosides (swertianolin) from *S. japonica* and *S. ciliata* (Plouvier *et al.*, 1967) have been reported. The first xanthone O-glycoside, norswertianin-1-O-glucosyl-3-O-glucoside has been isolated from *S. perennis* (Hostettmann and Wagner, 1977). The isolated chemical constituents, ethno-pharmacology as well as the biological activities and pharmacological applications of Swertia species, covering the literature up to 2003 are compiled by Brahmachari *et al.* (2004). Xanthones in *Swertia chirata, S. speciosa* and *S. paniculata* were determined by HPLC (Negi *et al.*, 2009a, 2010a, b). Mineral elements, based on their concentration can play different roles in human health and plant life. Nine elements (Zn, Cu, Mn, Fe, Co Na, K, Ca and Li) in *S. chirayita* and *S. speciosa* have been analyzed by atomic absorption spectrometry (Negi *et al.*, 2009b, 2010c). Kaempferol, catechin, epicatechin and Polyphenol Contents were also isolated and identified from *Swietenia macrophylla, Rhus coriaria* and *Rhus typhina* (Falah *et al.*, 2008; Kossah *et al.*, 2010). Extracts of *G. senegalensis* are rich in flavonoid content and showed anti-inflammatory activity (Sombie *et al.*, 2011). Leaf and stem of *Swertia chirata* showed significant antimicrobial activities against some Gram-positive and Gram-negative bacteria

Table 1: Isolated compounds and activity of different parts of Swertia species

Name of plant	Plant part	Isolated compounds	Activity	References
S. chirayita	Whole plant		Hepatoprotective	Balasundari *et al*. (2006)
Syn S. chirata			Antibacterial and antifungal	Awasthi *et al*. (2005)
	Whole plant		Antihepatotoxic	Karan *et al*. (1999a)
	Whole plant		Antihepatotoxic	Karan *et al*. (1999b)
			Antileprosy	Asthana *et al*. (2001)
		Chirat-16-en-3 β-24-diol, 1,5,8-trihydroxy-3-methoxyxanthone-8-O- βD-glucopyranoside		Chakravarti *et al*. (2001)
			Antiinflammatory	Banerjee *et al*. (2000)
			Anticarcinogenic	Saha *et al*. (2004)
			Hypoglycemic	Saxena *et al*. (1996)
		1,7,8-Trihydroxy-3-methoxyxanthone (swertianin), 1,8-dihydroxy-3,5-dimethoxyxanthone (Swerchirin), 1-hydroxy-3,5,8-trimethoxyxanthone, 1,5,8-trihydroxy-3-methoxyxanthone, 1,5,6-trihydroxy -3-methoxyxanthone and 1,3,6,7-tetrahydroxyxanthone-C2- β-D-glucoside,	Antimalarial	Mandal and Chatterjee (1994)
	Aerial parts	(-) Syringaresinol, magniferin, 1,5,8-trihydroxy-3-methoxyxanthone, 1-hydroxy-3, 5,8-trimethoxyxanthone, 1-hydroxy-3,7,8-trimethoxyxanthone, amarogentin, sweroside	Hepatoprotective	Chakravarty *et al*. (1994)
		Swerchirin	Blood sugar lowering	Saxena *et al*. (1993)
	Whole plant		Antiinflammatory	Mandal *et al*. (1992a)
			Hypoglycemic	Chandrasekar *et al*. (1990)
		1,8-Dihydroxy-3,5-dimethoxyxanthone (swerchirin)	Hypoglycemic	Bajpai *et al*. (1991)
		β-Sitosterol, feriedelin, swertinin, swertianin, swerchirin and isobellifolin		Mishra and Joseph (1983)
			Blood sugar lowering	Mukherjee and Mukherjee (1987)
			Antifeedant	Malic *et al*. (1985)
		Gentianin, gentiocrucin and enicoflavin		Sharma (1982)
		1,5,8-Trihydroxy-3-methoxy, 1,5,8-trihydroxy-3-methoxy, 1,3,5,8-tetrahydroxy, 1,3,7,8-tetrahydroxy, 1,8-dihydroxy-3,5-dimethoxy, 1,8-dihydroxy-3,7-dimethoxy and 1-hydroxy-3,5,8-trimethoxyxanthone		Ghosal *et al*. (1973)
	Whole plant		Anthelmintic	Iqbal *et al*. (2006)
	Whole plant		Antimicrobia	Alam *et al*. (2009)
	Whole plant		Analgesic	Alam *et al*. (2010)
S. speciosa	Aerial parts	1-Hydroxy-8glucosyloxy-3,5-dimethoxyxanthone, 1,8-dihydroxy-3,7-dimethoxyxanthone and 3-methoxy-1,5,8-trihydroxyxanthone		Khetwal and Bisht (1988)
		1,7-Dihydroxy-3-methoxyxanthone, 1,3-dihydroxy -7-methoxyxanthone, 1,8-dihydroxy-3,5-Dimethoxyxanthone, 1-hydroxy-3,7-dimethoxyxanthone, 1,7,8-trihydroxy-3-methoxyxanthone and mangiferin		Rastogi and Mehrotra (1979)

Table 1: Continued

Name of plant	Plant part	Isolated compounds	Activity	References
S. paniculata	Roots	1,8-Dihydroxy-3,5-dimethoxyxanthone (swerchirin), 1,5,8-triahydroxy-3-methoxyxanthone (bellidifolin), 7-methoxy apigenin-6-C-β-D-glucopyranoside (swertisin), flavone-C-glycoside and luteolin -6-C-β-D-glucopyranoside (homoorientin)		Verma and Khetwal (1985)
	Whole plant	Hederagenin, polyoxygenatedxanthone and xanthone-O-glycosides		Prakash *et al*. (1982)
		β-Sitosterol, ursolic acid, bellidifolin and hydroxytetramethoxyxanthone		Rastogi and Mehrotra (1979)
S. japonica	Whole plant	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 and 5''-O-β-D-Glucopyranosylamaroswerin		Kikuchi and Kikuchi (2004)
	Whole plant	Swertiajaposide A, 3-butyl6'-O-α-L-arabinopyranosyl-β-D-glucopyranoside,7R,7'R,8 S,8'S-(+)-neo-olivil-4-O-β-D-glucopyranoside		Kikuchi and Kikuchi (2005)
			Hepatoprotective	Hase *et al*. (1997)
		Methylbellidifolin, methylswertianin, swertianin, bellidifoline, norswertianin and desmethylbellidifolin	Antioxidant	Ashida *et al*. (1994)
			Hypoglycemic	Basnet *et al*. (1994)
	Whole plant		Anticholinergic	Yamahara *et al*. (1991)
	Roots	Bellidifolin, methylbellidifolin, swertianolin, amarogentin and amaroswerin		Ishimaru *et al*. (1990a)
	Roots	5-(3'-Glucosyl)-benzoyloxygentisic acid, 2,6 -dimethoxy-4-hydroxyphenol-1-glucoside		Ishimaru *et al*. (1990b)
	Aerial parts	Gentianine and 5-hydroxymethylisochroman -1-one		El-Sedawy *et al*. (1989)
		7-epi-(Di-m-hydroxylbenzoyl)-logenic acid (senburiside II)		Ikeshiro and Tomita (1987)
			Antihepatotoxic	Hikino *et al*. (1984)
	Whole plant	7-epi-(m-Hydroxylbenzoyl)-2'-sinapoyl-loganic acid (senburiside I)		Ikeshiro and Tomita (1985)
		7-epi-(m-Hydroxylbenzoyl)loganic acid (swertiaside)		Ikeshiro and Tomita (1984)
		Biphenoiside A, biphenoiside B and		Ikeshiro *et al*. (1983)
		5-O-β-Glucopyranoside of bellidifolin		Sakamoto *et al*. (1982)
		Semburin and isosemburin		Sakai *et al*. (1981)
S. pseudochinensis			Hepatoprotective	Li *et al*. (2005)
S. mussotii		Swertiamarin, mangiferin, swertisin, oleanolic acid , 1,5,8-trihydroxy-3-methoxyxanthone, 1,8-dihydroxy-3,7-dimethoxyxanthone and 1,8-dihydroxy-3,5-dimethoxyxanthone		Yang *et al*. (2005)

Table 1: Continued

Name of plant	Plant part	Isolated compounds	Activity	References
	Whole plant	1,3, 8-Trihydroxy-7-methoxyxanthone, 2,8-dihydroxy-1,6-dimethyoxyxanthone, 1,8-dihydroxy-2,6-dimethoxyxanthone, 1,2,8-trimethoxyxanthone, 1,3,5,6-tetrohyroxyxanthone, 1,8-dihydroxy-3,7-dimethoxyxanthone, β-daucosterol, clerosterol 3 β-O-[6'-O-hydro-benzene- β-D-glucoside], ursolicacid and 3 β,28-dihydroxylup-20 (29) -ene, erythrocentaurin		Zhang *et al*. (2009)
S. davidi		Demetylbellidifolin		Jiang *et al*. (2004)
	Whole plant	2,5-Dimethoxyl-1, 4-dicarboxyl benzene (VIII), 1,5,8-trihydroxyl-3,4-dimethoxyl xanthone (IX) and 1,8-dihydroxyl-3-(3'-hydroxyl-butoxy) xanthone (X).	Antioxygenated	Tan *et al*. (2003)
S. mileensis		2'-O-Acetyl-4'-O-transferuloylswertiamarin, 2'-O-acetyl-4'-O-cisferuloylswertiamarin, 2'-O-acetyl-4'-O- trans-p-coumaroylswertiamarin, 2'-O-acetyl-4'-O-cis-p-coumaroylswertiamarin and 4'-O-cis-p-coumaroylswertiamarin		Kikuzaki *et al*. (1996)
S. alata	Aerial parts	3-Methoxy1,7,8-trihyfroxanthone, 1,8-dihydroxy-3,5-dimethoxyxanthone and 1,8-dihydroxy-3,7-dimethoxyxanthone,		Khetwal *et al*. (1997)
	Whole plant	Oleanolic acid, swertisin, swertiamarin and bellidifolin March 19, 2011		Khan *et al*. (1979)
S. ciliata		Norswertianolin, swertianolin and isoswertianolin	CNS depressant	Rastogi and Mehrotra (1979)
	Aerial parts	1-Hydroxy-3,5,7,8-tetramethoxyxanthone and bellidifolin		Rastogi and Mehrotra (1979)
		Oleanolic acid, sitosterol, swertisin and swertiamarin		Rastogi and Mehrotra (1979)
S. corymbosa			Antimicrobial	Ramesh *et al*. (2002)
S. calycina	Whole plant	Swerchirin		Ya *et al*. (1999)
			Antifungal	Rodriguez *et al*. (1995)
S. punctata	Roots	1-O-Primeverosyl-3,8-dihydroxy-5-methoxyxanthone, 1-O-gentiosyl-3,7-dimethoxy-8-hydroxyxanthone, Isobellidifolin, methylbellidifolin, isoswertianin, methylswertianin and norswertianin-1-O-β-D-glucosid		Menkovic *et al*. (2002)
S. punicea	Whole plant	6'-O- β-D-Glucopyranosylsweroside (Swertiapunimarin), sweroside, oleanolic acid, swertiamarin, methylswertianin, β-Sitosterol and daucosterol		Tan *et al*. (1993)
	Whole plant	Puniceaside A, B, C, D and E	Neuroprotective	Du *et al*. (2010)
	Whole plant	1,3,5,8-Tetrahydroxy-7-(1',3',6',7'-tetrahydroxy-9'-oxo-4'-xanthyl) xanthone2'-C- β-D-glucopyranoside		Tan *et al*. (1992)
	Whole plant	1,5,8-Trihydroxy-3-methoxy-7(1',3',6',7'-tetrahydroxy-9'-oxo-xanthyl) xanthone 2'-C-β-D-glucopyranoside		Tan *et al*. (1991)

Table 1: Continued

Name of plant	Plant part	Isolated compounds	Activity	References
	Aerial parts	Decussatin, gentiacaulein-1,8-dihydroxy-2,4,6-trimethoxyxanthone, methyl swertianin and 1-hydroxy-3,5,7,8-tetramethoxyxanthone		Fukamiya *et al*. (1990)
	Whole plant		Anti-diabetic	Tian *et al*. (2010)
	Whole plant	Swertiapuniside		Tan *et al*. (1992a)
S. cordata		1-Hydroxy-3,5,7,8-tetramethoxyxanthone and 1,7-dihydroxy-3,5,8-trimethoxyxanthone		Atta-ur-Rahman *et al*. (1994)
	Aerial parts	Ursolic acid and mangiferin		Khan and Haqqani (1981)
S. franchetiana		1,5,8-Trihydroxy-3-methoxy-7-(5',7',3'',4''-tetrahydroxy-6'-C-β-D-glucopyranosyl-4'-oxy-8'-flavyl)-xanthone (Swertifrancheside)		Wang *et al*. (1994)
	Whole plant	Senburiside II, senburiside IV, senburiside I, swertiamarin, gentiopicroside and sweroside		Wang *et al*. (2005a)
	Whole plant	7-O-[β-D-xylopyranosyl-(1→2)-β-D-xylopyranosyl] -1,7,8-trihydroxy-3-methoxyxanthone, 7-O-[α-L-rhamnopyranosyl-(1→2)-β-D-xylopyranosyl]-1,7, 8-trihydroxy-3-methoxyxanthone, 8-O-β-D-glucopyranosyl-1,3,5,8-tetrahydroxyxanthone, 1-O-β-D-glucopyranosyl-1-hydroxy-3,7,8-trimethoxyxanthone, 1-O-[β-D-xylopyranosyl-(1→6)-β-D-glucopyranosyl]-1-hydroxy-2,3,5-trimethoxyxanthone and 1-O-[β-D-xylopyranosyl -(1→6)-β-D-glucopyranosyl]-1-hydroxy-3,5-dimethoxyxanthone		Wang *et al*. (2005b)
S. angustifolia	Whole plant	Angustiamarin, angustioside, sweroside, swertiamarin and epi-eustomoside		Luo and Nie (1992)
S. macrosperma	Whole plant	Caffic acid disaccharide ester, mangiferin, bellidifodin and bellidifodin-8-O- β-D-glucopyranoside		Zhou and Liu (1990)
	Whole plant	1,3,5,8-Tetrahydroxy-7-(1',3',5',8'-tetrahydroxy-2'-xanthonyl)xanthone (Swertiabisxanthone-I)		Zhou *et al*. (1989)
S. herba		Amarogentin, amaroswerin	Mutagenicity	Kanamori *et al*. (1986)
		Methylbellidifolin, methylswertianin, swertianin, desmethylbellidifolin and 5,8-dimethylbellidifolin		Kanamori *et al*. (1984)
S. petiolata	Aerial parts	1-Glycosyloxy-3-hydroxy-5,8-dimethoxyxanthone, 1,8-dihydroxy-3,5-dimethoxyxanthone and 1,3-dihydroxy-3- methoxyxanthone		Khetwal *et al*. (1990)
	Aerial parts	1,3-Dihydroxy-5,8-dimethoxyxanthone and 2-hydroxydimethylterephthalate		Kulanthaivel and Pelleter (1988)
		2,3-seco-2→3-Lactone,1β,3β-epoxy-hop-17(21) ene (Swertialactone C), and 2,3-seco-2→3 lactone, 1β,3β-epoxy-hop-16-ene (Swertialactone D)		Bhan *et al*. (1987)
	Whole plant	3β-Hydroxylup-13(18)-ene, 3β-hydroxylup-12-ene-28-oic acid and ursolic acid		Bhana *et al*. (1988)

Table 1: Continued

Name of plant	Plant part	Isolated compounds	Activity	References
S. iberica	Roots	1,3,8-Trihydroxy-7-methoxyxanthone and 1,2,3-trioxy-7,8-dimethoxyxanthanone		Denisova *et al.* (1980)
S. bimaculata		1,3-Dihydroxy-4,5-dimethoxyxanthone		Rastogi and Mehrotra (1979)
S. dilatata		Gentiacaulein, bellidifolin, methylbellidifolin, decussatin, swertianin, methylswertianin and norswertianin		Rastogi and Mehrotra (1979)
S. perennis		1,8-Dihydroxy-3,7-dimethoxyxanthone		Rastogi and Mehrotra (1969)
S. longifolia	Aerial parts	Isobellidifolin, bellidin, gentisein and 1,5-dihydroxy-3-methoxy-6-0-premeverosyl xanthone		Hajimehdipour *et al.* (2003)
	Aerial parts	1,8-Dihydroxy-3,5-dimethoxyxanthone, 1,8-dihydroxy -2,6-dimethoxyxanthone and 2,8-dihydroxy-1, 6-dimethoxyxanthone		Hajimehdipoor *et al.* (2006)
		Ursolic acid and bellidifolin		Rastogi and Mehrotra (1979)
		Tetraoxygenated and pentaoxygenated xanthones		Rastogi and Mehrotra (1979)
S. decussata		1-Hydroxy-3,7,8-trimethoxy, 1,8-dihydroxy-3, 7 -dimethoxy, 1,7-dihydroxy-3,8-dimethoxy and 1,7,8-trihydroxy-3-methoxyxanthones		Rastogi and Mehrotra (1969)
	Whole plant	1,7,8-Trihydroxy-3-methoxyxanthone (swertianin) and 1,3,7- trihydroxy-8-methoxyxanthone	Antioxidant	Patro *et al.* (2005)
	Whole plant	1-Hydroxy-3,7,8-trimethoxy, 1,8-dihydroxy-3,7 -dimethoxy, 1,7-dihydroxy-3,8-dimethoxy and 1,7,8-trihydroxy-3-methoxyxanthones	Antioxidant	Chintalwar and Chattopadhyay (2006)
		1,7,8-Trihydroxy-3-methoxyxanthone		Rastogi and Mehrotra (1969)
Swertia delavayi	Whole plant	Oleanolic acid, gentiopcroside, swertiamarin, daucosterol, swertiadecoraxanthone-II, isovitexin and isoorientin		Xia *et al.* (2008)
Swertia pubescens Franch	Whole plant	Isoorientin, gentiopicroside, glucose and oleanolic acid		Zhang *et al.* (1996)
Swertia tetraptera	Whole plant	Oleanolic acid, 1,3-dihydroxy-4,7-dimethoxyxanthone, 1-hydroxy-2,3,5-trimethoxyxanthone and beta-sitosterol. 1,3-dihydroxy-4,7-dimethoxyxanthone		Niu *et al.* (1991)
Swertia corymbosa	Whole plant		Antimicrobial	Ramesh *et al.* (2002)
Swertia mileensis	Aerial parts	Acyl secoiridoid glucosides, swertiamarin, 2'-O-acetylswertiamarin and amarogentin,		Kikuzaki *et al.* (1996)
	Whole plant	Swerilactones A and B	Anti-HBV	Geng *et al.* (2009)
	Whole plant	Swerilactosides A,B and C		Geng *et al.* (2010)

(Alam *et al.*, 2009). Several isolated chemical constituents viz, coumarins, flavonoids, phytosterol, phenols, tenins, alkaloids, triterpenes, anthraquinons and biological activities of Toona species were documented by Negi *et al.* (2011).

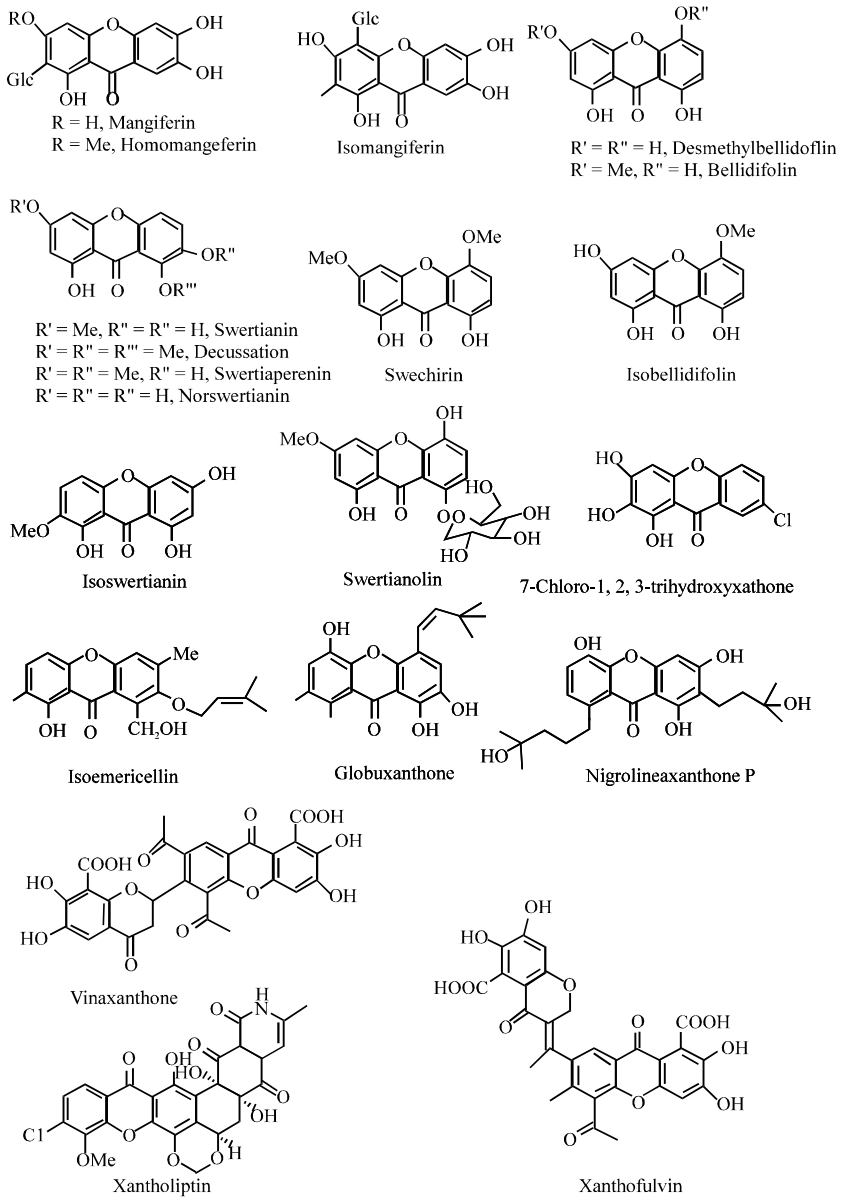

Fig. 1: Structures of some isolated xanthones from Swertia

BIOLOGICAL PROPERTIES

Plants belonging to the family Gentianaceae, are best known for their bitter taste and used in traditional remedies against loss of appetite, fever and are still included in many "tonic" formulations (Gaur, 1999). Some specific activities have been reported for xanthones and iridoids from Gentianaceae. Iridoids such as swertiamarin have anticholinergic propertiy (Bhattacharya *et al.*, 1974). For sweroside and gentiopicroside hepatoprotective activities have been reported (Kondo *et al.*, 1994) and both compounds are being used as antihepatitis drugs. Xanthones (especially mangiferin) are reported to give CNS stimulation (Bhattacharya *et al.*, 1972). They

should also have anti-inflammatory activity (Mandal *et al.*, 1992a). For bellidifolin and swerchirin a strong hypoglycemic activity has been reported by Saxena *et al.* (1993) and Basnet *et al.* (1994). *S. paniculata* is used in the Indian System of Medicine as a bitter tonic and in the treatment of some mental disorders (Prakash *et al.*, 1982). *S. hookeri* extract is used in the treatment of microbial infections and as a mood elevator (Ghosal *et al.*, 1980). Swertifrancheside isolated from *S. franchetiana* was found to be potent inhibitor of the DNA polymerase activity of human immunodeficiency virus-1 reverse transcriptase (HIV-1RT). Naturally occurring xanthones have emerged out as an important class of organic compounds in view of their remarkable pharmacological and other biological activities. It has now been observed that a number of plant products which are in regular use as chemotherapeutic agents contain xanthones as active constituents. Mangiferin was the first xanthone to be investigated pharmacologically and has been found to exhibit a broad spectrum of biological activities. It shows monoamine oxidase inhibition, cardiotonic, convulsant and choleretic activities (Ghosal *et al.*, 1973; Bhattacharya *et al.*, 1972). Pronounced anti-inflammatory activity has also been observed in mangiferin. Oral and topical compounds containing mangiferin are useful for the treatment of diseases caused by herpes virus. Mangiferin has been found to protect the liver of the rats from high altitude hypoxia. On the other hand Ghosal *et al.* (1975) have observed the opposite CNS depressant effect for xanthone-O-glycosides in mice and rats. The extract of most of Swertia species showed mutagenic activities. The antimalarial drug AYUSH-64 contains *S. chirayita* as one of the ingredients. Xanthones of *S. chirayita* are reported to produce CNS depression (Ghosal *et al.*, 1973). The total extract of *S. chirayita* showed significant antifeedant activity against *Jute semilooper* (Malic *et al.*, 1985). Norswertianolin, an O-glycoside has been reported to produce antitubercular activity. The O-glycosides of *S. purpurescens* are known to produce CNS depression in albino rate and mice (Ghosal *et al.*, 1974). 1,8-Dihydroxy-3,5-dimethoxyxanthone (swerchirin), isolated from the hexane fraction *of Swertia chirayita,* has a very significant blood sugar lowering effect in fasted, fed, glucose loaded and tolbutamide pre-treated albino rats.

CONCLUSION

As a conclusion, the present study has shown that mainly xanthones from genus Swertia are responsible for several types of biological activities. Apart from these flavonoids, iridoid glycosides and triterpenoids are also secondary metabolites isolated from this genus which also contribute their role in biological activities.

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