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SECONDARY METABOLITES OF THE CHOOSEN GENUS IRIS SPECIES

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Abstract

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Genus Iris contains more than 260 species which are mostly distributed across the North Hemisphere. Irises are mainly used as the ornamental plants, due to their colourful flowers, or in the perfume industry, due to their violet like fragrance, but lot of iris species were also used in many part of the worlds as medicinal plants for healing of a wide spectre of diseases. Nowadays the botanical and biochemical research bring new knowledge about chemical compounds in roots, leaves and flowers of the iris species, about their chemical content and possible medicinal usage. Due to this researches are Irises plants rich in content of the secondary metabolites. The most common secondary metabolites are flavonoids and isoflavonoids. The second most common group of secondary metabolites are flavones, quinones and xanthones. This review brings together results of the iris research in last few decades, putting together the information about the secondary metabolites research and chemical content of iris plants. Some clinical studies show positive results in usage of the chemical compounds obtained from various iris species in the treatment of cancer, or against the bacterial and viral infections.

genus iris, secondary metabolites, flavonoids, isoflavonoids, flavones, medicinal plants, chemical compounds

The genus *Iris* L. contains about 260 species which are distributed in temperate regions across the Northern Hemisphere, occurring mostly in Eurasia and North America. Some *Iris* species are found in wetland environments, most species occur in desert, semi-desert or dry, rocky habitats. Species of the genus *Iris* are recognized by their basal fan of unifacial leaves; colorful perianth of three horizontal sepals and three upright petals that are basally fused into a tube; style branches that are fused at the base, petaloid distally and extend beyond the small flap-like, transverse stigma as a bifid crest; and three stamens that are opposite to the sepals and petaloid style (WILSOM, 2001). The most common grown plants, and plants with medicinal use from the genus Iris, are listed in Tab. I.

From plants which belong to genus *Iris* were isolated isoflavonoids (WU and XU, 1992; MORITA *et al*., 1972), quinones (SEKI *et al*., 1994) and iridal-type triterpenoids (KRICK *et al*., 1983). This corresponds with the research of Farag *et al*. (1999) which states that Iris species are known to be rich in isoflavonoids and flavonoids content in addition to C-glycosylxanthones and quinones content in some taxa. Williams (1997) prove the distribution of 17 glycosylflavones in 14 *Iris* species. Harborne and Williams (2000) also characterized the family *Iridaceae* as rich in content of secondary metabolites. They indicate that many varied phytochemicals have been described from this family. Isoflavones was first recorded in *Iris florentina*, but they have recently been detected also in *Iris pseudopumila*. Almost all common classes of flavonoids are also present in the iris plants. The anthocyanins in flowers are generally distinctive at the generic level. Quinonoid and xanthone pigments have systematically interesting distribution patterns. Distinctive chemicals in *Iris* rhizome oils are useful economically. Also other phytochemicals such as nonprotein amino acids and special storage carbohydrates have restricted distribution patterns. Williams *et al*. (1986) wrote that xanthones are widely and characteristically

I: *Most important species from the genus Iris, their usage, origin and environmental demands (Dykes, 1974; AUSTIN, 2005; WADDICK and ZHAO, 1992; CAILLET, 2000)*

Species	Usage	Origin	Environment, underground organs
I. acutiloba subsp. acutiloba C. A. Meyer.	garden	Transcaucasia.	Dryland, rhizomes
I. afghanica Wendelbo.	garden	North-eastern Afghanistan.	Dryland, rhizomes
I. aitchisonii (Baker) Boiss. 1882	garden	Afghanistan, Pakistan.	Dryland, bulbs
I. albertii Regel.	garden	Turkestan, Kazakhstan, Asiatic Russia.	Dryland, rhizomes
I. albicans Lange.	garden	Saudi Arabia, Yemen.	Dryland, rhizomes
I. alexeenkoi Grossh.	garden	Eastern Transcaucasia, Russia.	Dryland, rhizomes
I. aphylla L., 1753	garden	Central and Eastern Europe.	Dryland, rhizomes
I. attica Boiss. & Heldr.	garden	Greece, Yugoslavia, western Turkey.	Dryland, rhizomes
I. aucheri (Baker) Sealy.	garden	Northern Iraq, south-eastern Turkey, northern Syria, western Iran.	Dryland, bulbs
I. bakeriana Fos.	garden	Southern Turkey, northern Iraq, western Iran.	Dryland, bulbs
I. belouinii Boiss. & Corn. 1915	garden	Morocco.	Dryland, rhizomes
I. biliottii Fos. 1887	garden	Black Sea, Turkey.	Dryland, rhizomes
I. boissieri Henriq. 1885	garden	Northern Portugal, Spain.	Dryland, bulbs
I. bracteata Watson. 1885	garden	Oregon & California.	Wetland, rhizomes, beardless irises
I. brevicaulis Raf. 1817	garden	Mississippi River Basin.	Wetland, rhizomes, beardless irises
I. bucharica Fos. 1902	garden	North-eastern Afghanistan, Tajikistan.	Dryland, bulbs
I. bulleyana Dykes. 1910	garden	South-western China.	Wetland, rhizomes, beardless irises
I. clarkei Baker. 1892	garden	Nepal, Sikkim, Bhutan, north-eastern India, Yunnan, Tibet, upper Burma.	Wetland, rhizomes, beardless irises
I. confusa Sealy. 1937	garden	South-western China.	Dryland, rhizomes
I. croatica Horvat. 1962	garden	Croatia.	Dryland, rhizomes
I. crocea Jacq. 1936	garden	Kashmir.	Wetland, rhizomes, beardless irises
I. cycloglossa Wendelbo.	garden	Western Afghanistan.	Dryland, bulbs
I. cypriana Baker & Fos. 1888	garden	Cyprus.	Dryland, rhizomes
I. danfordiae (Baker) Boiss.	garden	Turkey.	Dryland, bulbs
I. delavayi Micheli. 1895	garden	South-western China.	Wetland, rhizomes, beardless irises
I. dykesii Stapf. 1932	garden	Origin unknown.	Wetland, rhizomes, beardless irises
I. formosana Ohwi.1934	garden	Taiwan.	Dryland, rhizomes
I. forrestii Dykes. 1910	garden	China and northern Burma.	Wetland, rhizomes, beardless irises
I. fosterana Aitch. & Baker.	garden	North-eastern Iran, Turkmenistan, north-western Afghanistan.	Dryland, bulbs
I. fulva Ker-Gawl. 1812	garden	Mississippi River Valley.	Wetland, rhizomes, beardless irises
I. furcata Bieb.	garden	Caucasus mountains between Black Sea and Caspian Sea.	Dryland, rhizomes
I. gatesii Fos.	garden	South-eastern Turkey, north-eastern Iraq.	Dryland, rhizomes
I. giganticaerulea Small. 1929	garden	Coastal Louisiana, Texas, Mississippi.	Wetland, rhizomes, beardless irises
I. gracilipes Gray. 1915	garden	Japan, China.	Dryland, rhizomes
I. graeberiana Van Tubergen ex Sealy.	garden	Central Asia	Dryland, bulbs
I. graminea L., 1753	garden	Central and southern Europe, Spain to Russia; Crimea, Caucasus.	Wetland, rhizomes, beardless irises
I. hartwegii Baker. 1876	garden	California.	Wetland, rhizomes, beardless irises
I. hexagona Wal. 1788	garden	Florida, Georgia, South Carolina.	Wetland, rhizomes, beardless irises
I. histrio Reichb.	garden	Southern Turkey, Syria, Lebanon.	Dryland, bulbs
I. histrioides (G. F. Wilson) S. Arnott. 1892	garden	North central Turkey around Amasya.	Dryland, bulbs
I. hoogiana Dykes.	garden	Turkestan.	Dryland, rhizomes
I. chrysographes Dykes. 1911	garden	China, Burma.	Wetland, rhizomes, beardless irises
I. iberica Hoffm. 1808	garden	Caucasus.	Dryland, rhizomes

Species	Usage	Origin	Environment, underground organs
I. imbricata Lindl.	garden	Caspian Sea, Iran, eastern Transcaucasia.	Dryland, rhizomes
I. innominata Henderson. 1930	garden	Oregon & California.	Wetland, rhizomes, beardless irises
I. juncea Poir., 1789	garden	Southern Spain, Sicily, North Africa.	Dryland, bulbs
I. junonia Schott & Kotschy.	garden	Southern central Turkey, endemic in Cilician Taurus.	Dryland, rhizomes
I. kashmiriana Baker.	garden	Kashmir, Afghanistan, Iran, possibly introduced.	Dryland, rhizomes
I. kerneriana Ascher. & Sint.	garden	Northern Turkey.	Wetland, rhizomes, beardless irises
I. korolkowii Regel.	garden	Central Asia, Tien Shan, Pamir-Altai Mountains, north-eastern Afghanistan.	Dryland, rhizomes
I. lactea Pallas., 1776	garden	North-eastern Afghanistan, Kazakhstan, Russian central Asia, Tibet, China, Mongolia, Korea.	Wetland, rhizomes, beardless irises
I. laevigata Fischer., 1839	garden	Eastern Asia, Japan.	Wetland, rhizomes, beardless irises
I. latifolia Miller., 1792	garden	North-western Spain, French and Spanish Pyrenees.	Dryland, bulbs
I. lazica Alboff.	garden	Black Sea, south-western Caucasia.	Wetland, rhizomes, beardless irises
I. lilacina Borbas.	garden	Origin unknown.	Wetland, rhizomes, beardless irises
I. longipedicellata Czecz., 1932	garden	Central Turkey.	Wetland, rhizomes, beardless irises
I. longipetala Herb., 1840	garden	California.	Wetland, rhizomes, beardless irises
I. lutescens Lam.	garden	North-eastern Spain, southern France Italy.	Dryland, rhizomes
I. magnifica Vved.	garden	Central Asia.	Dryland, bulbs
I. maracandica Vved.	garden	Central Asia: Tadjikistan, Pamir- Altai Mountains.	Dryland, bulbs
I. marsica Ricci & Colas., 1973	garden	Central Italy, Abruzzes National Park.	Dryland, rhizomes
I. mesopotamica Dykes., 1913	garden	Southern Turkey, Syria, probably Israel.	Dryland, rhizomes
I. milesii Fos., 1883	garden	Himalayas.	Dryland, rhizomes
I. monnieri De Candolle., 1808	garden	Rhodes, not proven.	Wetland, rhizomes, beardless irises
I. munzii R. C. Fost., 1938	garden	California.	Wetland, rhizomes, beardless irises
I. nelsonii Randolph., 1967	garden	Louisiana.	Wetland, rhizomes, beardless irises
I. orchioides Carriere.	garden	Central Asia.	Dryland, bulbs
I. orientalis Miller., 1768	garden		Wetland, rhizomes, beardless irises
I. paradoxa Steven.	garden	Armenia, Iran, Turkey.	Dryland, rhizomes
I. persica L., 1753	garden	Southern and south-eastern Turkey, northern Syria, northern Iraq.	Dryland, bulbs
I. phragmitetorum Handel-Mazzetti., 1925	garden	China.	Wetland, rhizomes, beardless irises
I. planifolia (Miller) Fior. & Paol.	garden	Southern Spain, Portugal, Sardinia, Sicily, Crete, Morocco, Algeria, Libya.	Dryland, bulbs
I. pontica Zapal.	garden	Central & north-eastern Romania, western Ukraine, Caucasus.	Wetland, rhizomes, beardless irises
I. purdyi Eastw., 1897	garden	California.	Wetland, rhizomes, beardless irises
I. reichenbachii Heuff.	garden	Greece, Bulgaria, Romania.	Dryland, rhizomes
I. reticulata Bieb. Herm.	garden	Turkey, Iran, Iraq, former USSR, Caucasus, and Transcaucasia.	Dryland, bulbs
I. rosenbachiana Regel.	garden	Central Asia: Pamir-Altai Mountains.	Dryland, bulbs
I. ruthenica Ker-Gawl., 1808	garden	Eastern Europe and Asia.	Wetland, rhizomes, beardless irises
I. serotina Willk., 1861	garden	South-eastern Spain, possibly North Africa.	Dryland, bulbs
I. schachtii Markgraf.	garden	Central and western Turkey.	Dryland, rhizomes
I. sintenisii subsp. sintenisii Janka.	garden	Yugoslavia, Romania, south-western Russia, Bulgaria, Albania, Greece, Turkey.	Wetland, rhizomes, beardless irises
I. spuria L., 1753	garden	Europe, Algeria, Iran, central Asia.	Wetland, rhizomes, beardless irises

Species	Usage	Origin	Environment, underground organs
I. stolonifera Maxim.	garden	Central Asia: Pamir-Altai Mountains.	Dryland, rhizomes
I. suaveolens Boiss. & Reut.	garden	Balkans to north-western Turkey.	Dryland, rhizomes
I. subbiflora Brot.	garden	Portugal, Spain.	Dryland, rhizomes
I. susiana L., 1753	garden	Turkey.	Dryland, rhizomes
I. tenuis Watson., 1882	garden	Clackamas County, Oregon.	Dryland, rhizomes
I. tenuissima subsp. *tenuissima* Dykes.	garden	California.	Wetland, rhizomes, beardless irises
I. timofejewii Woron., 1924	garden	Eastern Caucasus.	Dryland, rhizomes
I. tingitana Boiss. & Reut., 1852	garden	Morocco, Algeria.	Dryland, bulbs
I. trojana Kerner ex Stapf., 1887	garden	Asia Minor.	Dryland, rhizomes
I. typhifolia Kitagawa., 1934	garden	North-eastern China, Inner Mongolia.	Wetland, rhizomes, beardless irises
I. unguicularis subsp. *unguicularis* Poir.	garden	Algeria, Tunisia, possibly Morocco.	Wetland, rhizomes, beardless irises
I. variegata L., 1753	garden	Central and eastern Europe.	Dryland, rhizomes
I. vartanii Fos. Herm.	garden	Israel, Syria, Lebanon, Jordan.	Dryland, bulbs
I. verna L., 1753	garden	South-eastern United States.	Wetland, rhizomes, beardless irises
I. virginica L., 1753	garden	South-eastern United States.	Wetland, rhizomes, beardless irises
I. wattii Baker., 1892	garden	China, Burma.	Dryland, rhizomes
I. wilsonii C. H. Wright., 1907	garden	China.	Wetland, rhizomes, beardless irises
I. winogradowii Fomin. Herm.	garden	Abkhazia, Georgia (Central Asia).	Dryland, bulbs
I. xiphium L., 1753	garden	Spain, south-western France, Corsica, southern Italy, Portugal, Morocco, Algeria, Tunisia.	Dryland, bulbs
I. cristata Soland., 1789	garden, medicinal	Appalachian and Ozark Mountains.	Dryland, rhizomes
I. decora Wallich., 1830	garden, medicinal	Himalayas, south-western China, southern & western Tibet.	Dryland, storage roots Irises
I. douglasiana Herb., 1841	garden, medicinal	Oregon & California.	Wetland, rhizomes, beardless irises
I. ensata Thunb., 1794	garden, medicinal	Japan, northern China, eastern Asia.	Wetland, rhizomes, beardless irises
I. filifolia Boiss.	garden, medicinal	Southern Spain, Gibraltar, Morocco, Tangier.	Dryland, bulbs
I. foetidissima L., 1753	garden, medicinal	Western Europe, Morocco, Algiers, the Azores, the Canaries.	Wetland, rhizomes, beardless irises
I. germanica L., 1753	garden, medicinal	Possibly of Mediterranean origin, now widespread in cultivation.	Dryland, rhizomes
I. japonica Thunb., 1794	garden, medicinal	Japan, China.	Dryland, rhizomes
I. missouriensis Nutt., 1834	garden, medicinal	Western North America, Canada to Mexico.	Wetland, rhizomes, beardless irises
I. pallida Lam., 1789	garden, medicinal	Northern Italy, Slovenia, Croatia, Bosnia.	Dryland, rhizomes
I. pseudacorus L., 1753	garden, medicinal	Europe, western Siberia, Caucasus, Iran, Turkey, North Africa.	Wetland, rhizomes, beardless irises
I. pumila subsp. pumila L., 1753	garden, medicinal	Yugoslavia, eastern Europe, Russia.	Dryland, rhizomes
I. sanguinea Hornem. ex Donn., 1813	garden, medicinal	East of Lake Baikal to China, Korea, Japan.	Wetland, rhizomes, beardless irises
I. setosa Pallas ex Link., 1820	garden, medicinal	Eastern Asia, Yukon, Alaska.	Wetland, rhizomes, beardless irises
I. sibirica L., 1753	garden, medicinal	Italy, eastern Europe to Lake Baikal, Turkey, Caucasus.	Wetland, rhizomes, beardless irises
I. tectorum Maxim., 1871	garden, medicinal	Central and south-western China, Burma, Korea.	Dryland, rhizomes
I. tenax Douglas ex Lindl., 1829	garden, medicinal	Oregon and Washington.	Wetland, rhizomes, beardless irises
I. versicolor L., 1753	garden, medicinal	Eastern North America.	Wetland, rhizomes, beardless irises
I. bungei Maxim., 1880	medicinal	Northern China to eastern Mongolia.	Wetland, rhizomes, beardless irises

Species	Usage	Origin	Environment, underground organs
I. kemaonensis Wall., 1831	medicinal	India, Himalayas, Kashmir, south-western China, Tibet.	Dryland, rhizomes
I. macrosiphon Torrey., 1857	medicinal	California.	Wetland, rhizomes, beardless irises
I. potaninii Maxim., 1880	medicinal	Western China, central and eastern Tibet.	Dryland, rhizomes

present in the Bearded Irises, they do occur sporadically in other sections of *Iris* and also in other genera of the *Iridaceae*. In 1998 eighteen *Iris* species have been reported to produce 46 different isoflavonoid aglycones (IWASHINA and OOTANI, 1998), perhaps the largest number of isoflavonoids in a single genus of nonleguminous plants. The isoflavones are accumulate mainly in the rhizomes, but the research of Hanawa *et al*. (1991) show that the leaves of *Iris pseudacorus* treated with an abiotic stress agent, cupric chloride (CuC_{l2}), also produce isoflavonoids. Although this researches the *Iris germanica* is the species that is known for the highest accumulation of a large number of isoflavones (DHAR and KALLA 1972; PAILER and FRANKE 1973; ALI *et al*. 1983; ATTA-UR- RAHMAN *et al*., 2002). The most common chemical compounds, their usage and plants from which were they extracted are listed in Tab. II.

II: *Chemical compounds from plants from the genus Iris, their formula, common name, description, pharmaceutical use and occurrence (JIUJAY et al., 2011 a; JIUJAY et al., 2011 b; JIUJAY et al., 2011 c; JIUJAY et al., 2011 d; JIUJAY et al., 2011 e)*

Chemical compound name	Chemical formula of the compound	Description	Pharmaceutical use	Specie
Belamcandal	$C_{32}H_{48}O_6$	Vitreous oil	Irritant (throat mucosa)	*Iris japonica*
Dichotomitin	$C_{18}H_{14}O_8$	Yellowish rhomboid crystal		*Iris dichotoma, Iris potaninii* (underground part)
6,4'-dimethoxy-5-hydroxyflavone 7-glucoside	$C_{23}H_{24}O_{11}$	Yellow amorphous powder		*Iris carthaliniae*
4',5-Dimethoxy-3-hydroxy-6,7-methylenedioxyisoflavone	$C_{18}H_{14}O_7$			*Iris potaninii* (underground part)
7,4'-Dimethoxy-8,3',5'-trihydroxy-6-O-β-D-glucopyranosylisoflavone	$C_{23}H_{24}O_{13}$	Amorphous solid		*Iris potaninii* (underground part)
4',7-Di-O-methyldihydroquercetin 5,3,3'-Trihydroxy-7,4'-dimethoxyflavanone	$C_{17}H_{16}O_7$	Yellow amorphous powder	Cytotoxic	*Iris potaninii* (underground part)
Embinin	$C_{29}H_{34}O_{14}$		Xanthinoxidase inhibitor, aldose reductase inhibitor	*Iris japonica, Iris tectorum*
22,23-Epoxy-10-deoxy-21-hydroxyiridal	$C_{30}H_{50}O_4$			*Iris cristata*
22,23-Epoxy-21-hydroxyiridal	$C_{30}H_{50}O_5$			*Iris cristata*
22,23-Epoxyiridal	$C_{30}H_{50}O_4$			*Iris cristata*
Germanaism A Iriskashmirianin	$C_{24}H_{24}O_{12}$	White amorphous solid		*Iris germanica* (rhizome)
Germanaism B Nigricin	$C_{23}H_{22}O_{11}$	Amorphous solid		*Iris germanica* (rhizome)
Halophilol A	$C_{17}H_{18}O_5$	Amorphous powder	Cytotoxic	*Iris halophila* (seed)
Halophilol B	$C_{56}H_{42}O_{12}$	Brown amorphous powder	Cytotoxic inactive	*Iris halophila* (seed)
Iridal	$C_{30}H_{50}O_3$	Glassy solid	Antimalarial	*Iris germanica*
Iridalglycoside 5a	$C_{48}H_{80}O_{21}$			*Iris spuria*
Iridalglycoside 5b	$C_{42}H_{70}O_{16}$			*Iris spuria*

Chemical compound name	Chemical formula of the compound	Description	Pharmaceutical use	Specie
Iridalglycoside 6a	$C_{48}H_{80}O_{21}$			*Iris spuria*
Iridalglycoside 6b	$C_{48}H_{80}O_{21}$			*Iris spuria*
Iridalglycoside 6c	$C_{42}H_{70}O_{16}$			*Iris spuria*
Iridalglycoside 7	$C_{42}H_{72}O_{16}$			*Iris spuria*
Iridalglycoside 8	$C_{42}H_{72}O_{16}$			*Iris spuria*
Iridin	$C_{24}H_{26}O_{13}$		Diuretic	*Iris unguicularis, Iris dichotoma, Iris germanica* (rhizome), *Iris komonoensis, Iris florentina*
Iridotectoral A	$C_{30}H_{46}O_5$	White glassy substance		*Iris tectorum*
Iridotectoral B	$C_{30}H_{46}O_5$	White glassy substance		*Iris tectorum*
Iriflogenin	$C_{17}H_{12}O_7$		CyP1A inhibitor, QR inhibitor, DPPH scavenger	*Iris germanica* (rhizome), *Iris potaninii* (underground part)
Iriflophenone	$C_{13}H_{10}O_5$			*Iris potaninii* (underground part), *Iris florentina*
Irigenin	$C_{18}H_{16}O_8$		CyP1A inhibitor, QR inhibitor, DPPH scavenger	*Iris dichotoma* (dried rhizome), *Iris germanica* (rhizome), *Iris tectorum* (dried rhizome)
Irilin A	$C_{16}H_{12}O_6$			*Iris bungei* (underground part)
Irilin B	$C_{17}H_{14}O_6$			*Iris bungei* (underground part)
Irilin D	$C_{16}H_{12}O_7$	Amorphous powder		*Iris bungei* (underground part)
Irilone	$C_{16}H_{10}O_6$		CyP1A inhibitor, QR inhibitor, DPPH radical scavenger, germination inhibitor	*Iris germanica* (rhizome)
Irilone	$C_{22}H_{20}O_{11}$	Amorphous solid		*Iris germanica* (rhizome)
Irisflorentin	$C_{20}H_{18}O_8$			*Iris dichotoma*
Iriskashmirianin	$C_{18}H_{14}O_7$		CyP1A inhibitor, QR inhibitor, DPPH scavenger	*Iris germanica* (rhizome)
Irisoid A	$C_{17}H_{12}O_7$	Amorphous powder		*Iris bungei* (underground part)
Irisoid B	$C_{18}H_{14}O_7$	Yellow needles		*Iris bungei* (underground part)
Irisoid C	$C_{18}H_{14}O_7$	Amorphous powder		*Iris bungei* (underground part)
Irisoid D	$C_{17}H_{10}O_7$	Amorphous powder		*Iris bungei* (underground part)
Irisoid E	$C_{17}H_{10}O_8$	Amorphous powder		*Iris bungei* (underground part)
Irisolidone	$C_{17}H_{14}O_6$		CyP1A inhibitor, QR inhibitor, DPPH scavenger	*Iris germanica* (rhizome)
Irisolidone-7-O-α-D-glucoside	$C_{23}H_{24}O_{11}$		CyP1A inhibitor, QR inhibitor, DPPH scavenger	*Iris germanica* (rhizome)
Irisoquin A	$C_{23}H_{38}O_4$	Orange coloured powder		*Iris kumaonensis*
Irisoquin B	$C_{24}H_{40}O_4$			*Iris kumaonensis*
Irisoquin C	$C_{26}H_{44}O_4$			*Iris kumaonensis*
Irisoquin D	$C_{27}H_{46}O_4$			*Iris kumaonensis*
Irisoquin E	$C_{28}H_{48}O_4$			*Iris kumaonensis*
Irisoquin F	$C_{29}H_{50}O_4$			*Iris kumaonensis*

Chemical compound name	Chemical formula of the compound	Description	Pharmaceutical use	Specie
Irisquinone A	$C_{24}H_{38}O_3$	Yellow needles	Antineoplastic, immunoenhancer, cytotoxic	*Iris pseudacorus, Iris pallasii* var. *chinensis, Iris lactea* var. *chinensis*
Iristectorigenin B	$C_{29}H_{34}O_{17}$	Yellow amorphous powder		*Iris carthaliniae*
Iristectorin A	$C_{23}H_{24}O_{12}$			*Iris tectorum*
Iristectorin B	$C_{23}H_{24}O_{12}$			*Iris tectorum*
cis-α-Irone	$C_{14}H_{22}O$		Flavorant	*Iris florentina*
trans-α-Irone	$C_{14}H_{22}O$			*Iris florentina*
Isoiridogermanal	$C_{30}H_{50}O_4$			*Iris japonica* (root)
5-Methoxy-4'-hydroxy-6,7-methylenedioxyisoflavone	$C_{17}H_{12}O_6$			*Iris potaninii* (underground part)
2-Methylanthraquinone	$C_{15}H_{10}O_2$	Faint yellow needles	Insecticidal (termites and other insects)	*Iris tectorum*
4'-Methyltectorigenin 7-glucoside	$C_{23}H_{24}O_{11}$	Yellow amorphous powder		*Iris carthaliniae*
Myristic acid	$C_{14}H_{28}O_2$		Precursor to essence synthesis, COX-1 and COX-2 inhibitor	*Iris florentina*
Pallasone B Dihydroirisquinone	$C_{24}H_{40}O_3$			*Iris lactea* var. *chinensis* (Syn. *Iris pallasii* var. *Chinensis*)
Pallasone C	$C_{26}H_{42}O_4$			*Iris lactea* var. *chinensis* (Syn. *Iris pallasii var. Chinensis*)
Swertiajaponin	$C_{22}H_{22}O_{11}$		Hepatoprotective	*Iris sanguinea*
Tectoridin	$C_{22}H_{22}O_{11}$		Antioxidant, anti-inflammatory, anti-angiogenic, antiproliferative, antineoplastic	*Iris dichotoma* (dried rhizome), *Iris tectorum*
Tectorigenin	$C_{16}H_{12}O_6$		Antifunga, free radical scavenger, anti-inflammatory, anti-angiogenic, antiproliferative, antineoplastic	*Iris dichotoma* (dried rhizome), *Iris germanica, Iris tectorum* (dried rhizome)
Tectorigenin-4'-glucosyl(1→6)glucoside	$C_{28}H_{32}O_{16}$	Yellow amorphous powde		*Iris carthaliniae*
Tectoruside	$C_{21}H_{30}O_{13}$			*Iris tectorum* (rhizome)
5,3',4',5'-Tetramethoxy-6,7-methylenedioxyisoflavone	$C_{20}H_{18}O_9$			*Iris potaninii* (underground part)
Tlatancuayin	$C_{18}H_{14}O_6$			*Iris bungei* (underground part)
6,3',4'-Trimethoxy-7,8,5'-trihydroxyisoflavone	$C_{18}H_{16}O_8$	Amorphous powder		*Iris potaninii* (underground part)

Secondary metabolites in different iris species

KAWASE *et al. (*1968) prove that not just iris roots but also the iris leaves contain a complex mixture of C-glycosylflavones based on apigenin, luteolin, their 7-methyl ethers and their 7,4'-dimethyl ethers. Eight compounds as swertisin (apigenin 7-methyl ether 6-C-glucoside), which has previously been reported in *I. germanica,* (KAWASE and YAGISHITA, 1968) were reliably identified also in *I. japonica* (ARASAWA *et al.,* 1973). From iris leaves can be occasionally synthesized also isoflavones. Four isoflavones were found in leaves of *I. pseudopumila,* but as minor components (WILLIAMS, 1997).

Williams *et al.* (1997) confirmed presence of flavonoids, xanthones and isoflavones in leaf, flower and rhizomes of several cultivars of bearded irises. Eighteen glycoflavones and eight glucoxanthones were identified in the leaves and these compounds proved to be the most useful evolutionary markers. This information is confirmed also by other research which is dedicated to the presence of isoflavones in the rhizomes of two species of bearded irises *Iris germanica* and *Iris pallida*. The most characteristic of presented isoflavones was irigenin

(5,7,3'- trihydroxy-6,4',5'-trimethoxyisoflavone) which occurs in both *I. germanica* and *I. pallida* (INGHAM, 1983). Most of the other isoflavones have been characterized in *I. germanica* (HARBORNE, 1994). Also Embinin (apigenin 7,4'-dimethyl ether *6-C-(2"-rhamnosylglucoside)* and the swertiajaponin (luteolin 7-methyl ether 6-C-glucoside) also has been reported in *I. germanica* (KAWASE and YAGISHITA, 1968). Due to HARBORNE and WILLIAMS (1994) flavonoid aglycones have been found as major constituents on the leaf surface (external flavonoids). Free flavonoid aglycones were also found in *I. reichenbachii* and *I. pseudopumila*. Apigenin, chrysoeriol and acacetin were identified in *I. reichenbachii* and apigenin and chrysoeriol were identified in *I. pseudopumila* (WILLIAMS, 1997). Flavonoids also have been analyzed from the flowers and leaves of the *Iris japonica* (ARISAWA *et al*., 1973), *Iris pseudacorus* (WILLIAMS *et al*., 1986), *Iris gracilipes* (HAYASHI *et al*., 1984), *Iris setosa* (HAYASHI *et al*., 1989; IWASHINA and OOTANI, 1995), *Iris laevigata* (IWASHINA and OOTANI, 1996) and *Iris ensata* (IWASHINA *et al*., 1996). HAYASHI *et al*. (1980) also isolated several flavonoids from *I. rossii*, specifically it was the anthocyanin, delphinidin glycoside, the C-glycosylflavone, swertisin and the xanthone, mangiferin. Mangiferin can occur in *Iridaceae* in association with its structural isomer, isomangiferin. In *Iris*, a number of other mangiferin derivatives may be present, including 0-methyl ethers, like irisxanthone the 5-methyl ether, *O*-glycosides and acylated *O*glycosides. Mangiferin methyl ether is present in the *Iris pseudopumila, I. lutescens, I. marsica* and *I. bicapitata*. A second mangiferin derivative, acylglycoside, is present in the *I. reichenbachii* and in the *I. lutescens, I. marsica* and *I. albicans* (HARBORNE *et al*., 2000).

Also the flowers of *Iris* species contain interesting chemical compounds, mainly anthocyanins as delphanin, delphinidin 3-(p-coumarylrutinoside)-5-glucoside and the main co-pigments in the flowers may be the xanthones, mangiferin and isomangiferin (BATE-SMITH and HARBORNE, 1963; HARBORNE, 1967). Various glycoflavones have been characterized in petals or leaves of *I. germanica, I. nertshinskia, I. tectorum* and *I. japonica,* with C-glycosides based on apigenin 7-methyl ether and 7,4'-dimethyl either being common (HIROSE *et al.,* 1981; KAWASE and YAGISHITA, 1968; ARASAWA *et al.,* 1973). Harborne (1967) says that the anthocyanin colour in flowers of *I. germanica* has been identified as delphanin Edelphinidin 3-(p-coumarylrutinoside)-5-glucoside. WILLIAMS *et al.* (1997), say that trace amounts of pigment petunidin were detected in flowers of all species of irises except *I. pallida,* which suggested that the related petunidin glycoside was present. In earlier work on *Iris,* the presence of the C-glucoside of 1,3,6,7-tetrahydroxy xanthone, mangiferin in flowers and leaves was also reported. Its co-occurrence with three related derivatives, including the isomeric isomangiferin was also mentioned (BATE-SMITH and HARBORNE, 1963).

CRAWFORD *et al*. (1994) describe free radicals from the rhizomes of *I. germanica* as semiquinone radical anions. His product analysis of the alkaline extract indicated that the main components were a set of flavonoids including quercetin, irisolone, selenone and derivatives of irigenin. Research of ATTA-UR-RAHMAN *et al*. (2002) lead to discovery of five new di- and triglycosides, which were isolated from the rhizomes of *Iris germanica*. RAHMAN *et al*. (2003) describes in roots of *Iris germanica* nine isoflavonoids for example Quercetin 3,4'-dimethylether, Dalpatein, 5-methoxy-3-(4´-hydroxy)-6,7-methyenedioxy-4*H*-1-benzopyran-4-one, O-Methylgalangine, 3-O-Methylkaempferol and isopeonol which also have antiinflamatory propertiues. Phytochemical investigations of methanol extract of rhizome of *Iris germanica*, made by ASGHAR *et al* (2009) resulted in the isolation of one new compound, 6,6-ditetradecyl-6,7-dihydrooxepin-2(3H)-one and five known compounds, 1-(2-(6_-hydroxy-2_-methylcyclohex-1_-enyloxy)-5-methoxyphenyl) ethanone, 4-hydroxy-3- methoxyacetophenone, irisolone, irisolidone, and 2-acetoxy-3,6-dimethoxy-1,4-benzoquinone.

MUNESHIVA *et al*. (1973) found in the rhizomes of *Iris florentina,* which is basicly the white form of *Iris germanica,* also some isoflavonoids, irisflorentin and irifloside which were identificated as 5,3´,4´,5´-tetramethoxy-6,7-methylenedioxyisoflavone and 5,4´-dihydroxy-3´methoxy-6,7-methylene dioxyisoflavone-4´-β-D-glucoside.

The second most common *Iris* that occurs in the research of iris contituents is *Iris tectorum* which rhizomes, due to SHU *et al*. (2010) contains ten isoflavones as tectorigenin- 7-*O*- -glucosyl-4'-*O*- -glucoside, tectoridin, iristectorin B, iristectorin A, iridin, genistein, tectorigenin, iristectorigenin A, iristectorigenin B and irigenin. Two flavanones, one flavonol and one flavanonol were tentatively identified as hesperetin, 5, 7, 3'-trihydroxy-6, 4'-dimethoxyflavanone, rhamnocitrin and dihydrokaempferide respectively. The three phenolic acids were tectoruside, androsin and apocynin. Previous phytochemical investigations resulted in the isolation of several flavonoids (SHIBATA, 1927; MORITA *et al*., 1972a; MORITA *et al*., 1972 b; XU *et al*., 1999; SHAN, 2007; YUAN *et al*., 2008), iridal-type triterpenoids (SEKI *et al*., 1994 a; SEKI *et al*., 1994b; TAKESHI *et al*., 1999; TAKAHASI *et al*., 2000) and quinones (SEKI *et al*., 1994 c), from which several isoflavones and phenolic acids were found in *I. tectorum* in high content. In research of FANG *et al*. (2008) an extract of rhizomes of *Iris tectorum*, exhibited highest potency and led to the isolation of two flavonoids, 7-O-methylaromadendrin and tectorigenin, and four iridal-type triterpenes, iritectols A and B, isoiridogermanal and irido-

belamal A. Also isoiridogermanal was isolated from the most cytotoxic fractions (FANG, 2007).

Next in contents rich species is *Iris nigricans* which due to AL-KHALIL *et al*. (1995) contain xanthones, and the C-glycosides mangiferin, 7-O-methylmangiferin and a new compound 2-//-D-glucopyranosyl-l,3,5,8-tetrahydroxy-xanthone (nigricanside). The essential oils obtained from the fresh aerial parts of *Iris nigricans* was characterized by a high proportion of oxygenated monoterpenes, aliphatic hydrocarbons and their derivatives. The oil of *I. nigricans* rhizomes was dominated by monoterpene hydrocarbons of the pinane skeleton, represented by α- and β-pinenes (AL-JABER, 2012). Isoflavones named nigricin and nigricanin were also isolated from rhizomes of *I. nigricans* (AL-KHALIL *et al*., 1994). In addition, the ethanol extracts of *I. nigricans* rhizomes afforded seven xanthones (AL-KHALIL *et al*., 1995).

MUNESHIVA (1975) isolated new flavone named kanzakiflavone-1 from the rhizomes of *Iris ungulicularis*. MINAMI (1996) isolated from the aerial parts *Iris japonica* isoflavones, irisjaponins A and B, along with seven known isoflavones. Three new compounds, along with four known ones, have been isolated from the seeds of *Iris pallasii*. On the basis of spectroscopic methods and chemical evidence, the new compounds were shown to be 2-[(Z)-10- heptadecenyl]-4,6-dimethoxyphenol, 3,5-dimethoxy-[(Z)-10-heptadecenyl]benzene and 9,9b-di[(Z)-10-heptadecenyl]-4a,8-dihydroxy-2,7-dimethoxy-1,4-dioxo-1,4,4a,9b tetrahydrodi benzofuran (SEKI *et al*., 1995). Five peltogynoids, irisoids, have been isolated from the underground parts of *Iris bungei*. The structures of the new compounds were established on the basis of spectroscopic methods (CHOUDHARY *et al*., 2001). A novel dimeric 1,4-benzoquinone and resorcinol derivative, Belamcandaquinone N, and two known compounds, 3-hydroxyirisquinone and 5-[(Z)-10-heptadecenyl] resorcinol, were isolated from the seeds of *Iris bungei*. The 3-hydroxyirisquinone which was previous reported from the roots of *I. bungei* was detected in the seeds of *Iris lactea* and 5-[(Z)-10-heptadecenyl] resorcinol, i.e. irisresorcinol was reported from *Iris peudocorus* (LIN *et al*., 2011).

KOJIMA *et al*. (1997) isolated from the underground part of *Iris tenuifolia* six flavanones. The components which occurred, due to WILLIAMS (1997), in parts of *Iris pallida* were identified as embinin, swertisin, isovitexin and an apigenin-based C-glucoside. Three further well-known simple glycoflavones were recognized among these fractions: vitexin, orientin and isoorientin. Two new isoflavonoid biosides, tectorigenin 4-glucosyl (1→6) glucoside and iristectorigenin B 7-glucosyl(1→6) glucoside, a new isoflavonoid monoside, 4´methyltectorigenin 7-glucoside and a new flavone glucoside, 6,4´dimethoxy-5-hydroxyflavone 7-glucoside, together with tectoridin and tectorigenin 4-glucoside were isolated from rhizomes of *Iris carthaliniae (*FARAG *et al*, 1999*)*.

A new 12a-dehydrorotenoid 1, 11-dihydroxy-9, 10-methylenedioxy-12a-dehydrorotenoid, together with a new isoflavonoid glycoside tectorigenin-7-O-13-glucosyl-4'-O-I~-glucoside, were isolated and identified from the rhizomes of *I. spuria*. In addition, 4 known compounds, tectorigenin, tectorigenin-7-O-13-glucosyl (1 -~ 6) glucoside, tectoridin (a tectorigenin- 7-O-[3-glucoside) and tectorigenin-4'-O-β-glucoside were isolated and identified for the first time from this plant (SIGAB, 2004). Earlier work on the constituents of *I. spuria* rhizomes revealed the presence of various isoflavones, a 12a-hydroxyrotenoid (irispurinol) and a 5,8,2'-trihydroxy-7-methoxy flavanone as the major secondary metabolites (SHAWL *et al*., 1984; 1988a and 1988b).

SUMMARY

There is no doubt that the *Iridaceae* contain a heterogenous collection of flavonoid and related phenolic constituents. Many of these are potentially useful as taxonomic markers, but further detailed surveys are still needed to establish whether or not they are important for the classification of this diverse family (HARBORNE, 2000). Because the *Iridaceae* family has been used for many years to treat cold, flu, malaria, toothache and bruise (LIN *et al*., 2002). *Iris* species have an immense medicinal importance and are used in the treatment of cancer, inflammation, bacterial and viral infections (HANAWA *et al*., 1991). The most abundant protein isolated from *Iris* bulbs has been identified as 1-ribosomal inactivating protein (RIP) (DAMME *et al*., 1997; BATTELLI *et al*., 1997). The compounds isolated from these species were reported to have piscicidal, antineoplastic, antioxidant, anti-tumor, antiplasmodial, and antituberculosis properties (HIDEYUKI *et al*., 1995; MIYAKE *et al*., 1997; BONFILS *et al*., 2001). This for the irises has great potential in medicinal and pharmaceutical research and use. Roots of *Iris germanica* L. are in the traditional medicines mainly used in dropsies, anti-spasmodic, emmengogue, stimulants, as diuretic, aperient; gall bladder diseases. It is used against fever and enlargement of the liver. It is also valuable for catarrhal ailment of children. The juice of the roots of *I. germanica* is applied to sores and removal of freckles from the skin. It is employed as a ingredient of composition for purifying blood and for veneral diseases (The Wealth of India, 1959; HANAWA *et al*., 1991).

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