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FLAVONOIDS FROM *ASTRAGALUS* GENUS

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ABSTRACT: In this review our main focus is on flavonoid groups which are one of the main active constituents found with other active constituents like saponins and polysaccharides, while poisonous groups are nitro-compounds, indolizidine alkaloids and the seleniferous derivatives in *Astragalus* genus. It is well established fact that flavonoid possess many biological activity such as antiallergic, anti-inflammatory, antitumor, antiviral, antioxidant anticancer including anticarcinogenic and prodifferentiative activities. Many flavonoids, including those which are phytoalexins, provide plants with a defense against viral infections. The estrogenic action of many isoflavones is well known and mixtures of flavonoids are commonly used commercially to reduce capillary fragility. *Astragalus* root is a very old and well known drug in traditional Chinese medicine and have been used to improve resistance to infections and to aid in immunological disorders and viral infections, and also used as hepatoprotective, heart tonic, nephritis and diabetes. This review reports all flavonoids isolated till date which is nearly about 131 from 60 species of *Astragalus* genus; these flavonoid are further characterized and classified into flavones, flavonols, flavanones, flavan-4-ols, isoflavones, isoflavans, petrocarpans and miscellaneous.

INTRODUCTION: *Astragalus* L. is the largest genus in the Legmninosae (Fabaceae) family and one of the largest genera of vascular plants on Earth, comprising ca. 2500 species of herbs or shrubs, mostly perennial, grouped into more than 100 subdivisions [1]. *Astragalus* is cosmopolitan, distributed in cool, temperate, arid and semiarid continental region of South-Western Asia (the largest centre of distribution with 1000-1500 spp.), Sino-Himalayan region (500 spp.), Western-North and South America (with 400-450 and 100 spp., respectively), Europe, North Africa and Australia [2].

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Astragalus plants are annual or perennial stemmed herbs or small shrubs (up to 150-200 cm), growing from underground roots. The leaves are alternate, imparipennate or paripennate, sometimes terminating in a spine. Flowers are leguminous, in racemic or axellary clusters, sessile or pedicellate. The fruit is a legume pod, usually dehiscent, with kidney shaped seeds [3].

In Western Asia *A. gummifer* is used as an emulsifier, stabilizer and thickening agent in pharmaceuticals and foodstuffs. A few species are edible (as raw and cooked roots of *A. canadensis* L., legumes of *A. caryocarpus*, seed of A. *edulis*, or leaves from *A. glycyphyllos* used as substitute for tea) [4], but a large number of *Astragalus* species are poisonous (e.g., *A. mollissimus* Torr.), especially for liverstock and wild animals. In many cases the toxins may be transferred to humans through meat or milk [5]. *Astragalus* root is a very old and well known drug in traditional Chinese

medicine and have been used to improve resistance to infections and to aid in immunological disorders and viral infections, and also used as hepatoprotective, heart tonic, nephritis and diabetes. Herbal practitioners may also suggest using this herb during treatment with chemotherapy as it stimulates the immune systems. The active constituents of *Astragalus* are saponins, flavonoids, and polysaccharides, while poisonous groups are nitro-compounds, indolizidine alkaloids and the seleniferous derivatives [6, 7].

In this review our main focus is on flavonoid groups which are one of the main active constituents found in *Astragalus* genus, because flavonoids possess many biological activity such as antiallergic, anti-inflammatory, antitumor, antiviral, antioxidant anticancer including anticarcinogenic and prodifferentiative activities. Many flavonoids, including those which are phytoalexins, provide plants with a defense against viral infections. The estrogenic action of many isoflavones is well known and mixtures of flavonoids are commonly used commercially to reduce capillary fragility [7a, 7b].

This review reports all flavonoid isolated till date which is nearly about 131 from 60 species of *Astragalus* genus, these flavonoid are further characterized and classified into flavones, flavonols, flavanones, flavan-4-ols, isoflavones, isoflavans, petrocarpans and miscellaneous.

MATERIALS AND METHODS:

The Flavonoid isolated and identified from *Astragalus* genus, were searched across the Medline (National Library of Medicine) and Science Direct databases, Pubmed, ACS, pols-one, Wiley chem. abstract, Springer link, RSC, Google and Google Scholar. The data were updated to 2015, using the search terms *Astragalus* Flavonoid, flavones, flavonols, flavanones, flavan-4-ols, isoflavones and petrocarpans from *Astragalus* genus, phytochemical, chemical constituents, from *Astragalus* as keywords. In addition, the reference lists of all papers identified were thoroughly reviewed.

RESULTS AND DISCUSSION:

List of Flavonoid(s) & their Structure(s) from *Astragalus* species: The purpose of this review is to present an overview of isolated flavonoids from species of *Astragalus* Genus, and there biological activity reported up to date 2015. This review reports 131 flavonoids from 60 species of *Astragalus* genus which are further characterized and classified into flavones (**Table 2**)-strc.no.1-18; flavonols (**Table 3**)-strc.no.19-77; flavanones (**Table 4**)-strc.no.78-81; flavan-4-ols (**Table 5**)-strc.no.82-83; isoflavones (**Table 6**)-strc.no.84-105; isoflavans (**Table 7**)-strc.no.106-118; petrocarpans (**Table 8**)-strc.no. 119-128 and miscelleneaous (**Table 9**)-strc.no.129-131. All of these are compiled in **Table 1** and **2** and **Fig. 1-7** [8-103].

TABLE 1: LIST OF FLAVONOIDS ISOLATED

Compound name & Strc.no.	Plant species	Ref.
Flavones		
Apigenin **(1)**	*A. ammodendron* Bunge	8
	A. macropterum DC.	9
	A. floccosifolius Summ.	10
	A. tracicus Griseb.	11
	Astragalus spp.	12
	A. bombycinus	13,14
	A. verrucosus	15,14
	A. propinquus	16,14
Apigenin 7-O-β-D-apio (1→2)-O-β-D-glc **(2)**	*A. cicer* L.	17
Apigenin 7-O-β-D-glucopyranoside **(3)**	*A. bombycinus*	13,14
Apigenin 7-O-gentobioside **(4)**	*A. bombycinus*	13,14
Apigenin 7-O-β-D-rutinoside **(5)**	*A. onobrychis* L.	18
Apigenin-8-C-glucoside (Vitexin) **(6)**	*Astragalus* spp.	12
	A. corniculatus	19,14
Baiealin **(7)**	*A. membranaceus* Bunge	20
Cosmosiin **(8)**	*A. ammodendron* Bunge	8
	A. caucasieus Pall.	21
	A. falcatus Lam.	21

	A. galegiformis L.	21
	A. kadshorensis Bunge	21
	A. maximus Willd.	21
	A. macropterum DC.	9
Cynaroside **(9)**	*Astragalus* spp.	12
	A. circassicus Grossh.	22
Isovitexin **(10)**	*Astragalus* spp.	12
Luteolin **(11)**	*Astragalus* spp.	12
	A.quisqualis Bunge	23
	A.kabadianus Lipsky	24
	A.coluteocarpus Boiss.	25
	A.sinicus L.	26
	A. bombycinus	13,14
	A. propinquus	16,14
Luteolin-8-C-glucoside [Orientin] **(12)**	*Astragalus* spp.	12
	A. corniculatus	19,14
Luteolin 7-O-β-D-glucopyranoside **(13)**	*A. bombycinus*	13,14
Salvigenin **(14)**	*A. propinquus*	16,14
Zapotinin **(15)**	*A. adsurgens* Pall.	27
5,7,2'-Trihydroxyflavone **(16)**	*A. cruciatus*	28,14
7-Hydroxyflavone **(17)**	*A. microcephalus*	29,14
5,2',4'-Trihydroxy-flavone-8-C-L-arabino pyranoside-7-O-β-Dglucopyranoside **(18)**	*A. bombycinus*	13,14
Flavonols		
[kaempferol 3-O-β-gal-3,4-di-(O-α-L-rha)] **(19)**	*A. caucasicus* Pall.	30
	A. caucasieus Pall.	21
	A. falcatus Lam.	21
	A. kadshorensis Bunge	21
	A. maximus Willd.	21
	A. galegiformis L.	21
Astragalin **(20)**	*A. galegiformis* L.	21,32,31,14
	A. torrentum Bunge	33
	A. foccosifolius Summ.	10
	A. subrobustus	34
	A. bornmullerianus B. Fedtsch.	35
	A. dipelta	36
	A. capliosus Boriss.	37
	A. sevangensis Grossh.	22
	A. circassicus Gross.	22
	A. bungeanus	22
	A. goktschaicus	22
	A. arguricus Bunge	22
	A. lasioglottis M. Bieb.	38
	A. brachycarpus M. Bieb.	39
	A. polygala Pall.	39
	A. testiculatus Pall.	40
	A. caucasieus Pall.	21
	A. falcatus Lam.	21
	A. kadshorensis Bunge	21
	A. maximus Willd.	21,41
	A. galegifolius L.	41
	Astragalus spp.	12
	A. adsurgens Pall.	27
	A. karakuschensis Gontsch.	42
	A. aitosensis M.B.	43
	A. complanatus R.Br.	44
	A. asper	45,14
	A. hamosus	46,14
Astragaloside **(21)**	*A. torrentum* Bunge	33

	A. onobrychis L.	18,38
	A. brachycarpus M. Bieb.	39
	Astragalus spp.	12
	A. dasyanthus Pall.	47
	A. publiflorus DC.	48
	A. quisqualis Bunge	49
	A. novoasanicus Klokov	50
Astrasikokioside I (kaempferol 3-O-α-L-rha (1 →6)-[α-L-rha(l→2)]-β-D-gal 7-O-α-L-rha **(22)**	*A. cornplanatus* R.Br.	51
Cacticin **(23)**	*A. kabadianus* Lipsky	24
	A. floccosifolius Summ	10
Cannabiscitrin **(24)**	*A. complanatus* R.Br.	52
Complanatin[rhamnocitrin 3-O-β-D-glc 4'-O-(3'-O-dihydrophaseoyl-)-β-D-glc) **(25)**	*A. cornplanatus* R.Br.	16
Complanatuside **(26)**	*A. cornplanatus* R.Br.	16, 52
Dactilin **(27)**	*A. galegformis* L.	53
	A. lasiogloftis M .Bieb.	38
Flagaloside C **(28)**	*A. galegiformis*	31,14
Flagaloside D **(29)**	*A. galegiformis*	31,14
5,7,4'-trihydroxy-3,3'-dimethoxyflavone **(30)**	*A. centralpinus* Braun-Blanquet	49
Hyperin (Quercetin 3-O-β-D-gal) **(31)**	*A. brachycarpus* M. Bieb.	54, 55
	A. karakuschensrs Gontsch.	42
	A. subrobustus	34
	A. coluleocarpus Boiss.	25
	A. rnocroplerum DC.	9
	A. eupeplus Bameby	56
	A. babofagi Popov	57
	A. sevangensis Grossh.	22
	A. circassicus Grossh.	22
	A. bungeanus	22
	A. goktschaicus	22
	A. arguricus Bunge	22
	A. quisqualis Bunge	23
	A. corniculatus	19,14
lsoquereitrin **(32)**	*A. membranaceus* Bunge	58
	A. karakuschensis Gontseh.	42
	A. onobrychis L.	18,38
	A. brachycarpus M. Bieb.	19
	A. adsurgens Pall.	27
	A. bornmullerianus B. Fedtseh.	35
	A. sevangensis Grossh.	22
	A. circassicus Grossh.	22
	A. bungeanus	22
	A. goktschaicus	22
	A. arguricus Bunge	22
Isorhamnetin **(33)**	*Astragalus* spp.	59
	A. austrosibirrcus Schischk	60
	A. mongholicus Bunge	61
	A. dasyanrhus Pall.	47
	A. membranaceus Bunge	45
	A. foccosfolius Summ.	10
	A. kabadianus Lipsky	24
	A. corniculatus	19,14
	A. hamosus	46,14
Isorhamnetin 3-O-β-D-glc **(34)**	*A. kabadianus* Lipsky	24
	A. adsurgens Pall.	62
	A. capriosus Boriss.	37
	A. jloccosrfolius Summ.	10

	A. cicer L.	17
	A. miser vat. Oblongfolius (Rydb.) Cronq.	63
	A. propinguus Schischkin	64
	A. pubfloms DC.	65
	A. karakuschensis Gontsch	42
	A. mongholrcus Bunge	66
	A. aitosensis M.B.	43
Isorharnnetin 3,7-di-O-β-D-glc **(35)**	*A. galegijomis* L.	53
Isorhamnetin 3-O-β-D-glc,7-O-α-rha **(36)**	*A. adsurgens* Pall.	62
	A. austrosrbirrcus Schischk	67
Kaempferide **(37)**	*A. complanatus* R.Br.	44
Kaempferide 3-O-α-L-ara **(38)**	*A. complanatus* R.Br.	44
Kaempferol **(39)**	*A. macropterum* DC.	9
	A. babatagi Popov	57
	A. eupeplus Bameby	56
	A. torrenhrm Bunge	33
	A. floccosfolius Summ.	10
	A. quisqualis Bunge	23
	A. ausnosibrricus Schischk	60
	A. bachycarpus M. Bieb.	68
	Ashagalus spp.	59
	A. ammodendron Bunge	8
	A. onobrychis L.	18
	A. himaloyanus Klotz	69
	A. membranaceus Bunge	45
	A. kabadranus Lipky	24
	A. coluteocopus Boiss.	25
	A. subrobustus	34
	A. bornmullerianus B. Fedtsc	35
	A. corniculatus	19,14
	A. asper	45,14
	A. galegformis	31,14
Kaempferol 3-O-β-xyl **(40)**	*A. caucasieus* Pall.	21
	A. falcarus Lam.	21
	A. kadshorensis Bunge	21
	A. maximus Willd.	21
	A. galegformis L.	21
Kaempferol 3,4'-di-O-β-glc **(41)**	*A. complanatus* R.Br.	52
Kaempferol 3-O-β-xyl-(l→2)-O-β-D-glc **(42)**	*A. complanatus* R.Br.	52
Kaempferol 3-O-α-A-rha-(l→2)-β-D-gal 7-O-α-A-rha **(43)**	*A. shikokianus*	51
Kaempferol 3-O-β-D-rutinoside7-O-α-L-rha **(44)**	*A. cicer* L.	17
Kaempferol 3-O-β-D-apio*f*-(l→2)-β-D-glc; 4'-O-β-D-glc **(45)**	*A. complanatus* R.Br.	52
Kaempferol 3-O-robinobioside **(46)**	*A. verrucosus*	15,14
7-O-Methyl-kaempferol-4'-β-D-galactopyrano side **(47)**	*A. hamosus*	46,14
Kumatakenin **(48)**	*A. centralpinus* Braun-Blanquet	49
Myricetin **(49)**	*A. complanatus* R.Br.	52
Myricetin 3-O-β-D-glc **(50)**	*A. complanatus* R.Br.	52
Myricetin 3-O-β-D-xyl-(l→2)-β-D-glc **(51)**	*A. complanatus* R.Br.	52
Myricomplanoside **(52)**	*A. complanatus* R.Br.	44
Narcissin **(53)**	*A. torrenfum* Bunge	33
	A. centralpinus Braun-Blanquet	49
	A. daryanthus Pall.	70
	A. propinguus Schischkin	64
	A. galegformis L.	32
	A. maximus Willd.	71
Neocomplanoside **(54)**	*A. complanatus* R.Br	44

Nicotiflorin **(55)**	*A. onobrychis* L.	18
	A. caucasieus Pall.	21
	A. falcam Lam.	21
	A. kadshorensis Bunge	21
	A. maximus Willd.	21
	A. galegformis L.	21
	A. ammodendmn Bunge	8
	A. adsurgens Pall.	62
Populnin **(56)**	*A. dipelta*	36
	A. floccosfolius Summ.	10
	A. polygola Pall.	39
Quercetin **(57)**	*A. macroprerum* DC.	9
	A. babatagi Popov	57
	A. eupeplus Bameby	56
	A. torrenfum Bunge	33
	A. captiosus Boriss.	37
	A. guisqualis Bunge	23
	A. bachycarpus M. Bieb.	68
	Astragalus spp.	59
	A. mongholicus Bunge	61
	A. onobrychis L.	18
	A. himaloyonus Klotz	69
	A. membranaceus Bunge	45
	A. kabadianus Lipsky	24
	A. coluteocarps Boiss.	25
	A. subrobusrus	34
	A. bornmullerianus B. Fedtasch	35
	A. asper	19,14
	A. corniculatus	45,14
Quercetin 3-O-robinobioside **(58)**	*A. capriosus* Boriss	72
Quercetin 3-O-rob 7-O-α-L-rha (Clovin) **(59)**	*A. shikokianus*	51
Quercetin-3-O-β-D-glucopyranoside **(60)**	*A. corniculatus*	19,14
	A. asper	45,14
Quercetin-3,7-di-β-D-glucopyranoside-4'-O-α-L-rhamnopyranoside **(61)**	*A. bombycinus*	13,14
Quercetin-3,7-di-O-β-D-glucopyranoside **(62)**	*A. bombycinus*	13,14
Quercetin 3-O-β-D-glucopyranoside-7-O-α-L-rhamnopyranoside **(63)**	*A. bombycinus*	13,14
Quercitrin **(64)**	*A. floccosfolius* Summ.	10
	A. sewngensis Grossh.	22
	A. circassicus Grossh.	22
	A. Bungeanus	22
	A. gokfschaicus	22
	A. arguricus Bunge	22
	A. babatagi Popov	57
	A. bornmullerranus B. Fedtsch.	35
Quercimeritrin **(65)**	*A. asper*	45,14
Rhamnetin **(66)**	*A. floccosfolius* Summ.	10
Rhamnetin 3-O-β-D-gal **(67)**	*A. floccoslfolius* Summ.	10
Rhamnocitrin **(68)**	*A. mongholicus* Bunge	61
Rhamnocitrin 3-O-β-D-glc **(69)**	*A. complanatus* R.Br	44,73 58,74
	A. membranaceus Bunge	
Rhamnocitrin 3-O-β-D-api*f*-(1→2)-PD-glc **(70)**	*A. complanatus* R.Br	52
Rhamnocitrin 3-O-β-D-api*f*-(1→2)-β-D-glc-4'O-β-D-glc **(71)**	*A. complanatus* R.Br	52
Rhamnoeitrin-3-O-(5-O-p-coumaroyl-β-D-api*f*-(1→2)-β-D-glc) **(72)**	*A. complanatus* R.Br	75
Rhamnocitrin 3-O-(5'-O-feruloyl-β-D-api*f*-(1→2)-β-D-glc) **(73)**	*A. complanatus* R.Br	75

Robinin **(74)**	*A. caucasieus* Pall.	21
	A. falcatus Lam.	21
	A. kadshorensis Bunge	21
	A. maximus Willd.	21
	A. galegformis L.	21
	A. shikokianus	51
Rutin (Quercetin 3-rutinoside) **(75)**	*A. macroprerum* M3.	9
	A. eupeplus Bameby	56
	A. babatagi Popov	57
	A. torrentum Bunge	33
	A. jloccosfolius Summ.	10
	A. quisqualis Bunge	23
	A. onobrychis L.	18
	A. himalayanus Klotz	69
	A. kabadianus Lipsky	24
	A. coluteocarpus Boiss.	25
	A. bornmullerianus B. Fedtsch.	35
	A. sevangensis Grossh.	22
	A. circassicus Grossh.	22
	A. bungeanus	22
	A. goktschaicus	22
	A. arguricus Bunge	22
	A. captiosus Boriss.	37
	A. adrurgem Pall.	27
	A. iasioglo Mis.Bieb.	38
	A. aitosensis M.B.	43
	A. propinpus Schischk*in*	64
	A. asper	45,14
	A. cruciatus	28,14
	A. verrucosus	15,14
Tamarixin **(76)**	*A. mongholicus* Bunge	66
Trifolin **(77)**	*A. brachycarpus* M. Bieb.	68
	A. caucasieus Pall.	21
	A. falcatus Lam.	21
	A. kadshorensis Bunge	21
	A. maximus Willd.	21,41
	A. galegfiolius L.	21
	A. subrobustus	34
	A. dipelta	36
	A. sevangensis Grossh.	22
	A. circassicus Grossh.	22
	A. bungeanus	22
	A. goklschaicus	22
	A. arguricus Bunge	22
	A. torrentum Bunge	33
	A. adrurgens Pall.	62
Flavanones		
3',7-dihydroxyflavanone **(78)**	*A. centralpinus* Braun-Blanquet	49
Naringenin **(79)**	*A. sinicus* L.	26
Eriodyctiol-7-O-glucoside **(80)**	*A. corniculatus*	19,14
Liquiritigenin **(81)**	*A. membranaceus*	76,14
Flavan-4-ol		
4',5-dimethoxy-7-hydroxyflavan-4-o1 **(82)**	*A. centralpinus* Braun-Blanquet	49
(3R,4R)-3-(2-Hydroxy-3,4-dimethoxyphenyl)-chroman-4,7-diol-7-O-β-D glucopyranoside **(83)**	*A. membranaceus*	44,14
Isoflavones		
Acicerone **(84)**	*A. cicer* L.	77,78,79

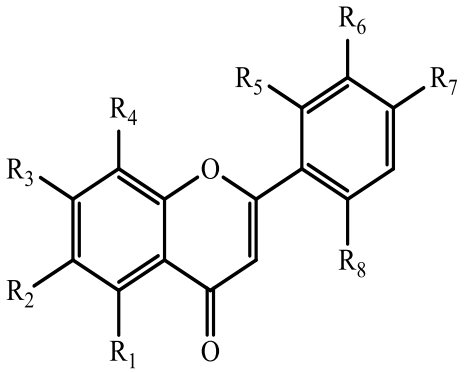
Afrorrmosin **(85)**	*A. membranaceus* Bunge	27
Ammopiptanoside A **(86)**	*A. membranaceus*	80,14
Biochanin A **(87)**	*A. cicer* L.	78
Calycosin **(88)**	*A. membranaceus* Bunge	81,20,82,83,84,85
	A. mongholicus	52,14
	A. cicer L.	78
	A. complanatus R.Br.	52
Calycosin 7-O-β- glucoside **(89)**	*A. complanatus* R.Br.	52,73
	A. membranaceus Bunge	86,20,87
Calycosin 7-O-β-D-{6''-[(E)-but-2-enoyl]}-glucoside **(90)**	*A. membracaceus*	80,14
Calycosin 7-O-β-D-(6''-acetyl)-glucoside **(91)**	*A. membracaceus*	80,14
Cajanin **(92)**	*A. cicer* L.	77,78,79
Daidzein **(93)**	*A. sinicus* L.	26
	A. bombycinus	88
	A. verrucosus	15
7,3'-dihydroxy-8,4'-dimethoxyisoflavone **(94)**	*A. membranaceus* Bunge	20
8,3'-dihydroxy-7,4'-dimethoxyisoflavone **(95)**	*A. membranaceus* Bunge	20,85
Formononetin **(96)**	*A. membranaceus* Bunge	81,20,21,83,89,90,85
	A. mongholicus	52
	A. cicer L.	78
	A. clusii Boiss.	91
Odoration **(97)**	*A. membranaceus* Bunge	81
Odoration 7-O-β-glc **(98)**	*A. membranaceus* Bunge	20
	A. mongholicus	52
Ononin **(99)**	*A. complanatus* R.Br.	52,73
	A. membracaceus	80,14
	A. verrucosus	15,14
	A. microcephalus	92,14
	A. mongholicus	93,14
	A. membranaceus	44,14
Pratensein **(100)**	*A. verrucosus*	15,14
	A. membranaceus var. mongholicus	94,14
Pratensein 7-O-β-D-glucopyranoside **(101)**	*A. membranaceus var. mongholicus*	94,14
Pseudobaptigenin **(102)**	*A. cicer* L.	78
6''-Acetylononin **(103)**	*A. membranaceus*	80,14
7,5'-Dihydroxy-3'-methoxy-isoflavone-7-O-β-D-glucopyranoside **(104)**	*A. membranaceus var. mongholicus*	94,14
7-Hydroxy-3',5'-dimethoxyisoflavone **(105)**	*A. peregrinus*	95,14
Isoflavans		
Astraeiecran **(106)**	*A. cicer* L.	96,77,78,79
(3R)·8,2'-dihydroxy-7,4'-dimethoxy isoflavane **(107)**	*A. membranaceus* Bunge	97,85
2'-hydroxy-5' ,6'-dimethoxy- 7-O-,8-D-glc **(108)**	*A. membranaceus* Bunge	83
Isomucronulatol **(109)**	*A. mongholicus* Bunge	98
	A. membracaceus	80,14
Isomucronulatol 7-O-β-D-glc **(110)**	*A. cicer* L.	96
	A. membracaceus	80,14
Isomucronulatol 5'-hydroxy-2',5'-di-O-β-D-glc **(111)**	*A. membranaceus* Bunge	99,85
	A. mongholicus Bunge	98
lsomueronulatol 7,2'-di- O-β-glc **(112)**	*A. mongholicus* Bunge	98
(3R)-7,2',3'-trihydroxy-4'-methoxyiso flavane **(113)**	*A. membranaceus* Bunge	97
(R)-3-(5-Hydroxy-2,3,4-trimethoxyphenyl)-chroman-7-ol **(114)**	*A. membranaceus*	80,14
7-O-methylisomueronulatol **(115)**	*A. membranaceus* Bunge	100
	A. mongholicus Bunge	98
(3S)-8-methoxyvestitol **(116)**	*A. alexadrinus* Boiss.	101
	A. trigonus DC.	101
Mucronulatol **(117)**	*A. cicer* L.	96,77,78,79

Spherosin **(118)**	*A. adsurgens* Pall. *A. orbiculatus* Ledeb. *A. alexadrinus* Boiss. *A. trigonus* DC.	27 102 101 101
Pterocarpans		
Maackiain **(119)**	*A. cicer* L. *A. membranaceus* Bunge *A. mongholicus* Bunge *A. trojanus Stev.*	77,78,79 77,78,79 77,78,79 77,78,79
Medicarpin **(120)**	*A. cicer* L.	78
(6aR, l laR)-10-hydroxy-3,9,10 dimeth oxypterocarpan **(121)**	*A. membranaceus* Bunge	100
(6aR, l laR)- 3,9,10-trimethoxypterocarpan **(122)**	*A.membranaceus* Bunge *A.mongholicus* Bunge	98 100
(–)-Methylinissolin 3-O-β-D-(6'-acetyl)glucoside **(123)**	*A. membranaceus*	80,14
(–)-Methylinissolin 3-O-β-D-{6'-[(E)-but-2-enoyl]}-glucoside **(124)**	*A. membranaceus*	80,14
(–)-Methylinissolin 3-O-β-D-glucoside **(125)**	*A. membranaceus*	80,14
Licoagroside D **(126)**	*A. membranaceus*	80,14
Vesticarpan **(127)**	*A. membranaceus*	80,14
(–)-Methylinissolin **(128)**	*A. membranaceus*	80,14
Miscelleneaous		
Sulfuretin **(129)**	*A. microcephalus*	29,14
Isoliquiritigenin **(130)**	*A. membranaceus*	76,14
Pendulone **(131)**	*A. membranaceus*	80,14,103

TABLE 2: LIST OF *ASTRAGALUS* SPECIES FROM WHERE FLAVONOIDS WERE ISOLATED

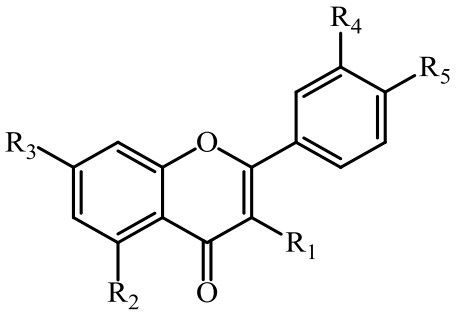
***Astragalus* Species**		
A. adsurgens Pall.	*A. corniculatus*	*A. miser* Hook.
A. aitosensis M.B.	*A. cruciatus*	*A. mongholicus* Bunge
A. alexadrinus Boiss.	*A. dasyanthus* Pall.	*A. mongholicus* Bunge
A. ammodendron Bunge	*A. dipelta* Bunge	*A. novasanicus* Klokov
A. arguricus Bunge	*A. eupeplus* Bameby	*A. onobrychis* L.
A. asper	*A. falcatus* Lam.	*A. orbiculatus* Ledeb.
A. austrosibiricus Schischk	*A. floccosifolius* Sumn.	*A. polygala* Pall.
A. babatagi Popov	*A. galegiformis* L.	*A. propinquus* Schischkin
A. bachycarpus M. Bieb.	*A. goktschaicus*	*A. pubiflorus* DC.
A. bombycinus	*A. himalayanus* Klotz	*A. quisqualis* Bunge
A. bommuellerianus B. Fedtsch.	*A. hamosus*	*A. sevangensis* Grossh.
A. bungeanus Boiss.	*A. kabadianus* Lipsky	*A. shikokianus*
A. captiosus Boriss.	*A. kadshorensis* Bunge	*A. sinicus* L.
A. caucasicus Pall.	*A. karakuschensis* Gontsch.	*A. subrobustus*
A. centralpinus Braun-Blanquet	*A. lasioglottis* M. Bieb.	*A. testiculars* Pall.
A. cicer L.	*A. macropterum* DC.	*A. torrentumi* Bunge
A. circassicus Grossh.	*A. maximus* Willd.	*A. tracicus*
A. clusii Boiss.	*A. membranaceus* Bunge	*A. trigonus DC.*
A. coluteocarpus Boiss.	*A. membranaceus* Bunge	*A. verrucosus*
A. complanatus R.Br.	*A. microcephalus*	*Astragalus spp.*

Structures of flavonoids isolated:



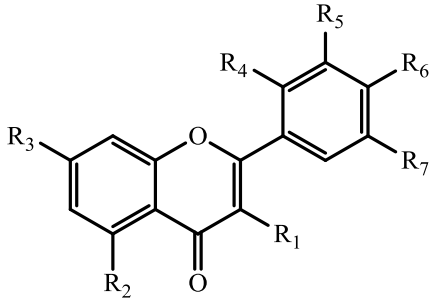
1 R_1=R_3=R_7=OH; R_2=R_4=R_5=R_6=R_8=H
2 R_1=R_7=OH; R_2=R_4=R_5=R_6=R_8=H; R_3=O-glc^{2}-api
3 R_1=R_7=OH; R_2=R_4=R_5=R_6=R_8=H; R_3=O-glc
4 R_1=R_7=OH; R_2=R_4=R_5=R_6=R_8=H; R_3=O-glc^{1}-^{6}glc
5 R_1=R_7=OH; R_2=R_4=R_5=R_6=R_8=H; R_3=O-rut
6 R_1=R_3=R_6=OH; R_2=R_5=R_7=R_8=H; R_4=C-glc
7 R_1=R_2=OH; R_3=glcUA; R_4=R_5=R_6=R_7=R_8=H
8 R_1=R_7=OH; R_2=R_4=R_5=R_6=R_8=H; R_3=O-glc
9 R_1=R_6=R_7=OH; R_2=R_4=R_5=R_8=H; R_3=O-glc
10 R_1=R_3=R_7=OH; R_2=C-glc; R_4=R_5=R_6=R_8=H
11 R_1=R_3=R_5=R_6=OH; R_2=R_4=R_7=R_8=H
12 R_1=R_3=R_5=R_6=OH; R_2=R_7=R_8=H; R_4=C-glc
13 R_1=R_6=R_7=OH; R_2=R_4=R_5=R_8=H; R_3=O-glc
14 R_1=OH; R_2=R_3=R_7=OMe; R_4=R_5=R_6=R_8=H
15 R_1=OH; R_2=R_5=R_8=OMe; R_3=R_4=R_6=R_7=H
16 R_1=R_3=R_5=OH; R_2=R_4=R_6=R_7=R_8=H
17 R_1=R_2=R_5=R_4=R_6=R_7=R_8=H; R_3=OH
18 R_1=R_5=R_7=OH; R_2=R_6=R_8=H; R_3=O-glc; R_4=Ara

FIG.1: FLAVONES (STRC.NO.1-18)



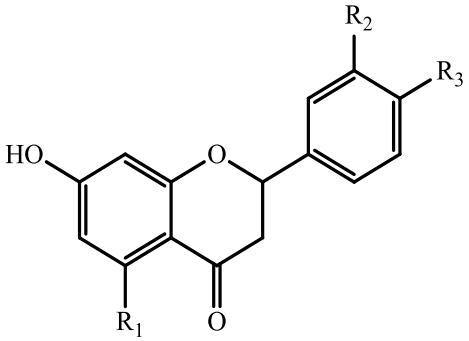
19 R_1=O-gal$^{3\cdot4}$·di-rha; R_2=R_3=R_4=R_5=OH
20 R_1=O-glc; R_2=R_3=R_4=R_5=OH
21 R_1=O-glc-^{6}glc; R_2=R_3=R_5=OH; R_4=OMe
22 R_1=O-gal$^{3\cdot4}$·di-rha; R_2=R_5=OH; R_3=O-rha; R_4=H
23 R_1=O-rha; R_2=R_3=R_5=OH; R_4=OMe
26 R_1=R_5=O-glc; R_2=OH; R_3=OMe; R_4=H
27 R_1=R_5=O-glc; R_2=R_3=OH; R_4=OMe
28 R_1=O-xyl^{1}-^{3}rha^{1}-^{6}gal; R_2=R_3=R_4=R_5=OH
29 R_1=O-xyl^{1}-^{3}xyl; R_2=R_3=R_5=OH; R_4=OMe
30 R_1=R_4=OMe; R_2=R_3=R_5=OH
31 R_1=O-gal; R_2=R_3=R_4=R_5=OH
32 R_1=O-glc; R_2=R_3=R_4=R_5=OH
33 R_1=H; R_2=R_3=R_5=OH; R_4=OMe
34 R_1=O-glc; R_2=R_3=R_5=OH; R_4=OMe
35 R_1=R_3=O-glc; R_2=R_5=OH; R_4=OMe
36 R_1=O-glc; R_2=R_5=OH; R_3=rha; R_4=OMe
47 R_1=R_2=R_4=OH; R_3=OMe; R_5=O-gal
48 R_1=R_3=OMe; R_2=R_5=OH; R_4=H
53 R_1=rha^{6}-glc; R_2=R_3=R_5=OH; R_4=OMe
54 R_1=O-(6-acetyl)-glc; R_2=R_3=R_5=OH; R_4=H
55 R_1=O-rut; R_2=R_3=R_4=R_5=OH
56 R_1=R_4=H; R_2=R_5=OH; R_3=O-glc
57 R_1=H; R_2=R_3=R_4=R_5=OH
58 R_1=O-gal^{6}-rha; R_2=R_3=R_4=R_5=OH
59 R_1=O-gal^{6}-rha; R_2=R_4=R_5=OH; R_3=O-rha
60 R_1=O-glc; R_2=R_3=R_4=R_5=OH
61 R_1=R_2=R_4=R_5=OH; R_3=O-glc
62 R_1=R_3=O-glc; R_2=R_4=R_5=OH
63 R_1=O-glc; R_2=R_4=R_5=OH; R_3=O-rha
64 R_1=O-rha; R_2=R_3=R_4=R_5=OH
65 R_1=R_3=O-glc; R_2=R_4=R_5=OH
66 R_1=H; R_2=R_4=R_5=OH; R_3=OMe .

37 R_1=R_4=H; R_2=R_3=OH; R_5=OMe
38 R_1=O-ara; R_2=R_3=OH; R_4=H; R_5=OMe
39 R_1=R_4=H; R_2=R_3=R_5=OH
40 R_1=O-xyl; R_2=R_3=R_5=OH; R_4=H
41 R_1=R_5=O-glc; R_2=R_3=OH; R_4=H
42 R_1=O-glc^2-xyl; R_2=R_3=R_5=OH; R_4=H
43 R_1=O-glc^2-rha; R_2=R_5=OH; R_3=O-rha; R_4=H
44 R_1=O-rut; R_2=R_5=OH; R_3=O-rha; R_4=H
45 R_1=O-glc^2-api; R_2=R_3=OH; R_4=H; R_5=O-glc
46 R_1=O-gal^6-rha; R_2=R_3=R_4=OH; R_5=H
67 R_1=O-gal; R_2=R_4=R_5=OH; R_3=OMe
68 R_1=H; R_2=R_5=OH; R_3=OMe; R_4=H
69 R_1=O-glc; R_2=R_5=OH; R_3=OMe; R_4=H
70 R_1=O-glc^2-api; R_2=R_5=OH; R_3=OMe; R_4=H
71 R_1=O-glc^2-api; R_2=OH; R_3=OMe; R_4=H; R_5=O-glc
72 R_1=R_2=R_5=OH; R_3=OMe; R_4=O-glc^2-api-coumaroyl
73 R_1=R_2=R_5=OH; R_3=OMe; R_4=O-glc^2-api-feruloyl
74 R_1=O-gal$_2$-rha; R_2=R_5=OH; R_3=O-rha; R_4=H
75 R_1=O-rut; R_2=R_3=R_4=R_5=OH
76 R_1=O-glc; R_2=R_3=R_4=OH; R_5=OMe
77 R_1=O-gal; R_2=R_3=R_5=OH; R_4=H

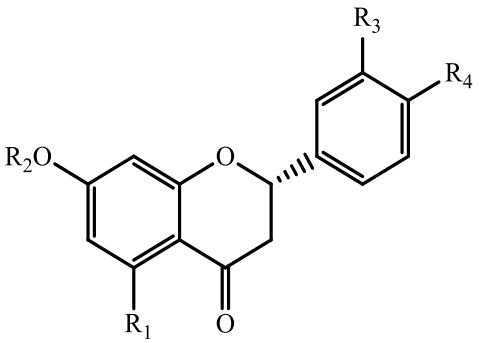


24 R_1=R_7=H; R_2=R_3=R_5=R_6=OH; R_4=O-glc
25 R_1=R_2=R_3=R_5=R_6=R_7=H; R_4=O-dihydrophaseoyl)-glc
49 R_1=R_4=H; R_2=R_3=R_5=R_6=R_7=OH
50 R_1=O-glc; R_2=R_4=R_5=R_6=OH; R_3=R_7=H
51 R_1=O-glc^2-xyl; R_2=R_3=R_4=R_5=R_6=OH; R_7=H
52 R_1=R_7=H; R_2=R_3=R_5=OH; R_4=OMe; R_6=O-glc

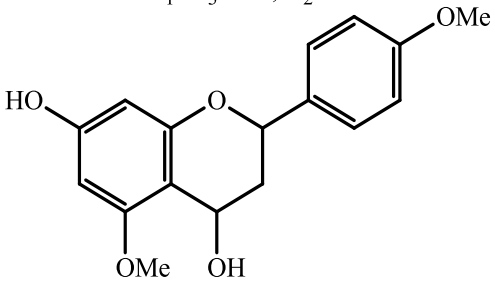
FIG.2: FLAVONOLS (STRC.NO.19-77)



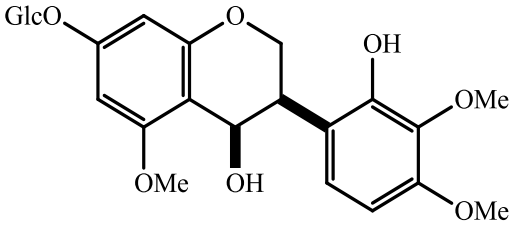
78 R_1=R_3=H; R_2=OH
79 R_1=R_3=OH; R_2=H



80 R_1=R_3=R_4=OH; R_2=O-glc
81 R_1=R_2=R_3=H; R_4=OH

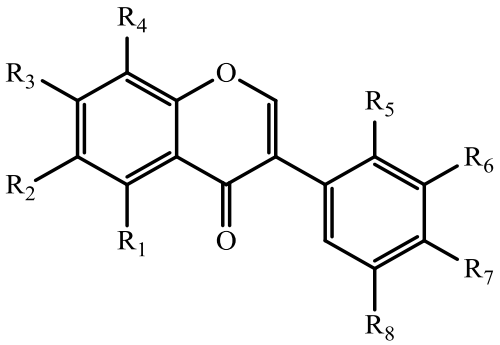


82



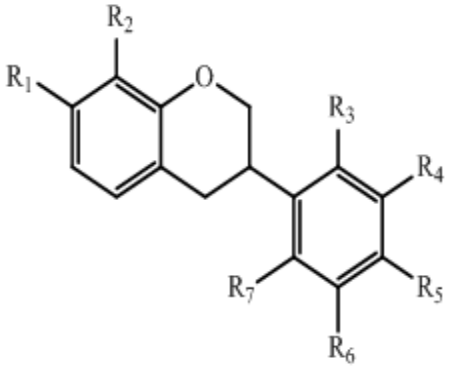
83

FIG.3: FLAVANONES & FLAVAN-4-OL (STRC.NO.77-83)



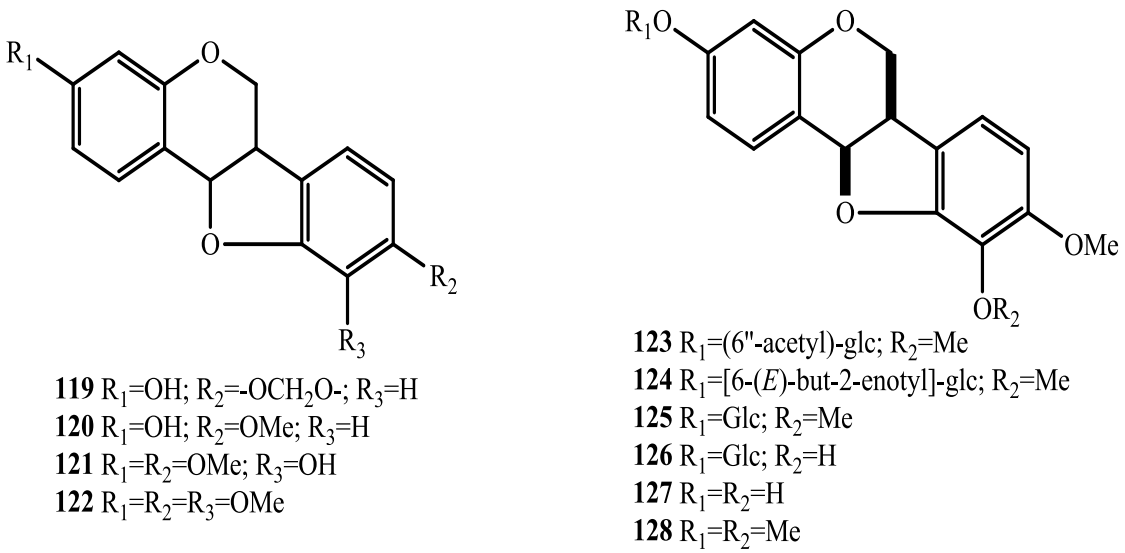
84 R_1=R_4=R_5=R_7=R_8=H; R_2=OH; R_3=OMe; R_6=-OCH_2O-
85 R_1=R_4=R_5=R_6=R_8=H; R_2=R_7=OMe; R_3=OH
86 R_1=R_2=R_4=R_5=R_8=H; R_3=O-[6-(*E*)-but-2-enotyl]-glc; R_6=OH; R_7=OMe
87 R_1=R_3=OH; R_2=R_4=R_5=R_6=R_8=H; R_7=OMe
88 R_1=R_2=R_4=R_5=R_8=H; R_3=R_6=OH; R_7=OMe
89 R_1=R_2=R_4=R_5=R_8=H; R_3=O-glc; R_6=OH; R_7=OMe
90 R_1=R_2=R_4=R_5=R_6=R_8=H; R_3=O-[6-(*E*)-but-2-enotyl]-glc; R_7=OMe
91 R_1=R_2=R_4=R_5=R_8=H; R_3=O-(6"-acetyl)-glc; R_6=OH; R_7=OMe
92 R_1=R_5=OH; R_2=R_4=R_6=R_8=H; R_3=R_7=OMe
93 R_1=R_2=R_4=R_5=R_6=R_8=H; R_3=R_7=OH
94 R_1=R_2=R_6=R_8=H; R_3=R_5=OH; R_4=R_7=OMe
95 R_1=R_2=R_6=R_8=H; R_3=R_7=OMe; R_4=R_5=OH
96 R_1=R_2=R_4=R_5=R_6=R_8=H; R_3=OH; R_7=OMe
97 R_1=R_4=R_6=R_8=H; R_2=R_7=OMe; R_3=R_5=OH
98 R_1=R_4=R_6=R_8=H; R_2=R_7=OMe; R_3=O-glc; R_5=OH
99 R_1=R_2=R_4=R_5=R_6=R_8=H; R_3=O-glc; R_7=OMe
100 R_1=R_6=OH; R_2=R_3=R_4=R_5=R_8=H; R_7=OMe
101 R_1=R_6=OH; R_2=R_4=R_5=R_8=H; R_3=O-glc; R_7=OMe
102 R_1=R_2=R_4=R_5=R_7=R_8=H; R_3=OH; R_6=-OCH_2O-
103 R_1=R_2=R_4=R_5=R_6=R_8=H; R_3=O-(6"-acetyl)-glc; R_7=OMe
104 R_1=R_2=R_4=R_5=R_7=H; R_3=O-glc; R_6=OMe; R_8=OH
105 R_1=R_2=R_4=R_5=R_7=H; R_3=OH; R_6=R_8=OMe

FIG.4: ISOFLAVONES (STRC.NO.84-105)



106 R_1=OH; R_2=R_4=R_5=R_7=H; R_3=OMe; R_6=-OCH_2O-
108 R_1=O-glc; R_2=R_4=R_5=H; R_3=OH; R_6=R_7=OMe
115 R_1=R_4=R_5=OMe; R_2=R_6=R_7=H; R_3=OH
116 R_1=R_3=OH; R_2=R_5=OMe; R_4=R_6=R_7=H
117 R_1=R_4=OH; R_2=R_6=R_7=H; R_3=R_5=OMe
118 R_1=OH; R_2=R_6=R_7=H; R_3=R_4=R_5=OMe
107 R_1=R_5=OMe; R_2=R_3=OH; R_4=R_6=R_7=H
109 R_1=R_3=OH; R_2=R_6=R_7=H; R_4=R_5=OMe
110 R_1=OH; R_2=R_6=R_7=H; R_3=O-glc; R_4=R_5=OMe
111 R_1=OH; R_2=R_6=H; R_3=R_7=O-glc; R_4=R_5=OMe
112 R_1=R_3=O-glc; R_2=R_6=R_7=H; R_4=R_5=OMe
113 R_1=R_3=R_4=OH; R_2=R_6=R_7=H; R_5=OMe
114 R_1=R_3=OH; R_2=R_6=R_7=H; R_4=R_5=OMe

FIG.5: ISOFLAVANS (STRC.NO.106-118)



119 R_1=OH; R_2=-OCH_2O-; R_3=H
120 R_1=OH; R_2=OMe; R_3=H
121 R_1=R_2=OMe; R_3=OH
122 R_1=R_2=R_3=OMe
123 R_1=(6"-acetyl)-glc; R_2=Me
124 R_1=[6-(*E*)-but-2-enotyl]-glc; R_2=Me
125 R_1=Glc; R_2=Me
126 R_1=Glc; R_2=H
127 R_1=R_2=H
128 R_1=R_2=Me

FIG.6: PTEROCARPANS (STRC.NO.119-128)

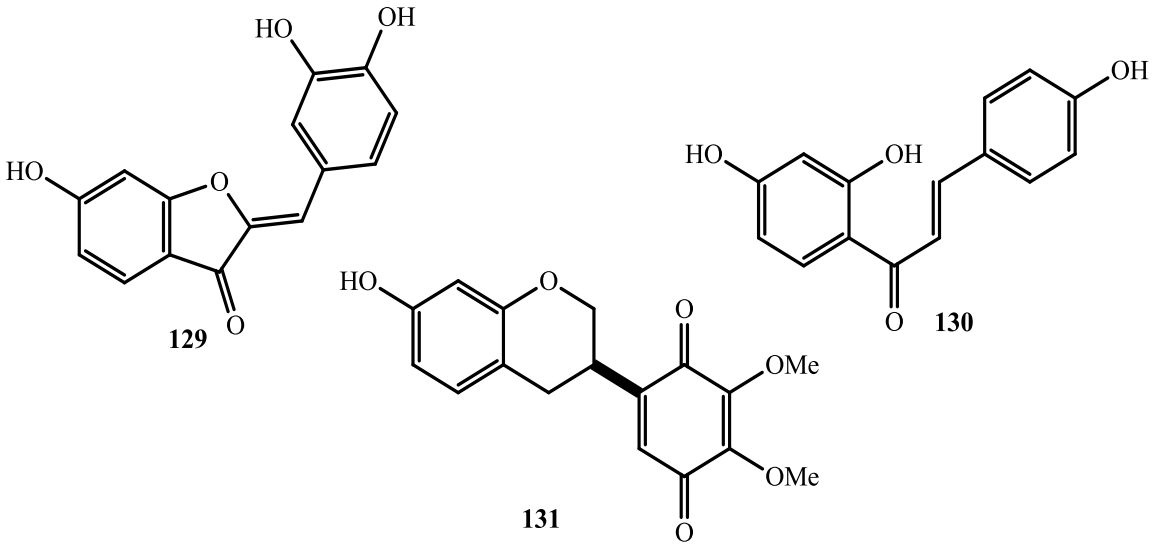


FIG.7: MISCELLENEAOUS (STRC.NO.129-131)

Biological Activities of the *Astragalus* Genus:

Flavonoids from *Astragalus* spp. show a significant antiexudative effect [104], while flavonoid complex from *A.centralpinus* possess a marked spasmolitic action and account for a moderate, but long-standing reduction of the arterial pressure. The total flavonoids content from *A. lasioglottis* show a high biological activity decreasing the cholesterol and triglyceride levels in animals with experimental hyperlipidemia [105]. Isoflavonoids are best known for being estrogenic, antimicrobial or insecticidal [106]. They are involved with diverse biological activities, including disease resistance, and, potentially, photosensibilization [78]. Calycosin 88, and formononetin 96, as isoflavones isolated from the roots of *A. membranaceus*, inhibit lecithin peroxidation which was induced both by hydroxy radical generation by interation of haemoglobin and hydrogen peroxide and by superoxide anion generation by xanthine/xanthine oxidase [83, 82].

Afrorrmosin 85, calycosin 88 and odoratin 96, isolated from the same source have antioxidative activity and prevent lipid peroxidation (all the tested isoflavones have a methoxy group at 4' position) [81]. Other isoflavonoids do not show inhibitory effects on lecithin peroxidations. These results demonstrated that hydroxyl group at the 7 and 3' positions on isoflavones, which have a methoxy group on the C-4', are necessary for the antioxidant properties, because isoflavones which

have a methoxyl group at the 6 and 4' positions, have no inibitory effects on LPOs [82].

On the other hand, the experimental data showed that the total flavonoids of *Astragalus* and calycosin 88 could inhibit the proliferation of K562 cells [107]. The total flavonoids of *A. mongholicus* are the active components, which benefit cardiovascular disease attributed to the potent antioxidant activity in improving the atherosclerosis profile [108]. Isoflavones, calycosin 88, and formononetin 96, from the *Astragalus* root, could promote dimethyl arginine dimethylaminohydrolase-2 protein and mRNA expressions in Madin Darby Canine Kidney (MDCK) II cells, and up regulate the neuronal nitric oxide synthase levels [109]. Calycosin-7-O-β-D-glucoside 89, from *A. membranaceus* showed anti-lipid peroxidative activities [110].

CONCLUSION: The present review deals with up to date literature on flavonoids isolated from *Astragalus* genus as well as different biological activities exhibited by the isolated flavonoid constituents. We are quite optimistic that this review article will surely stimulate present day researcher to undertake more systematic research work on this important genus for isolation of flavonoids so as to discover other significant more biological activities of the plants.

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