ADVANCES IN SCIENCE AND TECHNOLOGY

ISBN: 978-81-970663-0-6| Year: 2024 | pp: 96 - 105 |

# *Gymnema Sylvestre* (Gurmar) For Diabetes Mellitus: A Review

**Miss. Asavari Sambhaji Bhosale**

B Pharm [final year], Dr. shivajirao kadam college of pharmacy kasabe digraj, sangli, Maharashtra.

**Email:**

*Article DOI Link: https://zenodo.org/uploads/14230895*

*DOI: 10.5281/zenodo.14230895*

**Abstract**

From ancient times, plants have been an exemplary source of medicine. India has about 45000 plant species and among them, several thousands have been claimed to possess medicinal property. there are about 800 plants which have been reported to show antidiabetic potential. the present review provides in depth information about the potential and bioactive compounds present in *Gymnema sylvestre* (Gurmar)

***Keywords:*** *Gymnema sylvestre, Diabetes,* hypoglycemic activity, gymnemic acid

**Introduction:**

Diabetes mellitus, one of the most common endocrine metabolic disorders has caused significant morbidity and mortality due to microvascular (retinopathy, neuropathy, and nephropathy) and macrovascular (heart attack, stroke, and peripheral vascular disease) complication.[1]. Currently available therapies for diabetes includes insulin and various oral antidiabetic agents like sulfonylureas, biguanides, and glinides. the hypoglycemic effect of these plant used as antidiabetic remedies has been confirmed, and the mechanism of hypoglycemic activity of this plant has been studied.[2]

Different types of diabetes mellitus can be classified under following two categories:

**Type 1:** is insulin dependent diabetes mellitus in which the body does not produces any insulin. it accounts for 5-10 %of diabetes.[3]

**Type 2:** is a non-insulin dependent diabetes mellitus, in which the body does not produces enough or improper use of secreted insulin is most common form of disease, accounting for 90-95 % of diabetes.[4]

**Type 3:** gestational diabetes, it can be form due to hormonal changes during pregnancy leading to insulin resistance [5]

**Symptoms of diabetes mellitus:**

1. Increased thirst
2. Slow healing cuts and sores
3. Fatigue
4. Blurred vision
5. Frequents urination

6. Unexplained weight loss [6]

**Treatments of diabetic mellitus:**

- Patient education concerning the disease
- Physical exercise
- Diet and
- Hypoglycemic agents

As a very common chronic disease, diabeties is becoming the third killer of health of mankind along with cancer, cardiovascular and cerebrovascular diseases of its high prevalence, morbidity and mortality. Thus, medicinal plants have an ever-emerging role to play in treatment or management of lifelong prolonging disease like diabeties mellitus.[7]

***Gymnema sylvestre*:**

*Gymnema sylvestre* is perennial woodyvine native to asia (inciuding the arabian peninsula), Africa and Australia it has been used in ayurvedic medicine common names include gymnema, Australian cowplant, and peripioca of the woods, and hindi term gurmar, which means 'sugar destroyer '. The leaves and extract contain gymnemic acid the major bioactive constituents that interact with taste receptor on the tongue to temporarily suppress the taste



***Fig .1 Gymnema sylvestre*** [8]

**Scientific classification:**

Kingdom: plantae

Clade : angiosperm

Clade : eudicots

Clade : asterides

Order : gentianales

Family : apocynaceae

Genus : G*ymnema*

Species : *sylvestre*

Table no:1: Scientific classification of G.Sylvestre [9]

**Gymnema benefits:**

1. It has anti-inflammatory action
2. Lower the sugar craving
3. Increases the insulin production
4. Lowers the sugar absorption
5. Block the lipid absorption
6. Reduce blood pressure
7. Help in weight loss [10]

**Side effects of *gymnema*:**

It is generally considered safe for use, there are risks associated with this popular herbal supplements. It includes symptoms of hypoglycemia

- Headache
- Dizziness
- Nausea [10]

**Contraindications:**

There are situations in which the supplements should be avoided due to the lack of safety research. this incule the use of *G.sylvestre* :

- During pregnancy or breastfeeding
- In children and infants

- In peoples with diabetes
- Before surgery [10]

**Origin and historical facts:**

**Origin:** *Gymnema sylvestre* is native to the tropical forests of India, Africa, and Australia.

**Historical usage:** traditionally used in ayurvedic medicine for over 2000 years, gymnema sylvestre was primarily employed to treat diabetes.

The plants name gurmar translates to sugar destroyer reflecting its ability to suppress the taste of sweetness and manage blood sugar level

**Medicinal uses:** besides its role in managing diabetes, it has been used to treat various ailments including malaria, snake bites and digestive issues.

It has also been explored for its potential to support weight loss and lower cholesterol.[11]

**Key characteristics:**

**Diabeties mellituis:** known as a sugar killer for its ability to reduce sugar level in urine.

**Urinary system:** profuse urination with high sugar content, causing significant weakness.

**Skin:** burning sensation all over the body and the presence of diabetic carbuncles.

**Thirst:** extreme thirst, often seen in diabetic patients.

**Sexual weakness:** notable decrease in sexual power.[12]

**Modalities:**

**Aggravation:** symptoms are worsened by excessive sugar intake and physical exertion.

**Amelioration:** symptoms are improved by hydration and rest.

**Relationship with another drug:**

**Compare:** similar remedies include syzygium jambolanum, which is also used for its anti-diabetic properties and lycopodium, which addresses digestive and urinary issues.[12]

**Dose:**

Potency of choice: typically used in mother tincture 3x and 6 potencies, depending on the patient's symptoms and response to treatment.[12]

**Microscopic characteristics:**

**1. Petiole:**

Transverse section of petiole is horse shoe shaped. The epidermis is barrel shaped single layered, thick walled covered with uniseriate, multicellular, non-glandular trichomes. The cortex is collenchymatous and vascular bundles are amphicribal and three in number. Well-developed phloem consists of sieve tubes, companion cells and phloem parenchyma. The xylem consists of vessels, tracheids and tracheidal fibres. The starch grains are polygonal, simple or compound in two or many groups. The rosette crystals of calcium oxalate are present more towards the centre [13-15].

**2. Lamina:**

The epidermal cells of lamina are square shaped with outer convex wall and thin cuticle. When viewed transversally, epidermal cell surface is interrupted with trichomes, which are uniseriate, multicellular with 2 to 5 celled, present in abundance on both the surfaces. Single layered closely arranged palisade cells are present just below the adaxial epidermis. Vascular bundles are amphicribal and the mesophyll is 3-5 celled thick [13-15].

**3. Stem:**

The transverse section of stem is circular in outline. The epidermis is barrel shaped and thick walled. Trichomes are multicellular, uniseriate and 185-485 µ long and 9-25 µ broad. The cork is 3 to 5 layered thick, and cortical cells are latterly elongated and collenchymous. The phloem well developed consists of large sieve plates, companion cells and phloem parenchyma. The xylem is in the form of a continuous cylinder transverse by narrow medullary rays. The endodermis is conspicuous and the pericycle is broad [13-14].

**4. Powder:**

The powdered material is slight yellowish green in colour, bitter in taste with pleasant aromatic odour. On microscopic examination, it shows thick walled, uniseriate multicellular trichomes, anomocytic stomata, idioblast with rosette crystals of calcium oxalate, starch grains, remnants of collenchymatous and parenchymatous cells; vessels, tracheids, tracheidal fibres, bast fibres and sieve plates [9, 13-14].

**5. Identification Tests:**

When powder is treated separately with 1 N aqueous NaOH and 50% KOH, shows green fluorescence under UV 254 nm and orange colour with 50% HNO3 in daylight. General identification tests for G. sylvestre hydro-alcoholic extracts are as given below: The dilute solution suppresses the sweet taste buds, it gives copious foam appearance when shaken with water and on addition of dilute acid, it forms a voluminous precipitate [9, 15-16].

**6. Purity test:**

*G. sylvestre* depicts the following characteristics: 1) Maximum moisture content should not more than 6 percent, 2) Total ash content should not more than 12 percent, 3) Heavy metal content in leaves or leaves extract should not more than 40 ppm and in the final dosage form, it should not more than 10 ppm [13,17].

**7. Phytochemistry:**

The leaves of *G. sylvestre* contain triterpene saponins belonging to oleanane and dammarene classes. Oleanane saponins are gymnemic acids and gymnemasaponins, while dammarene saponins are gymnemasides [18-21].

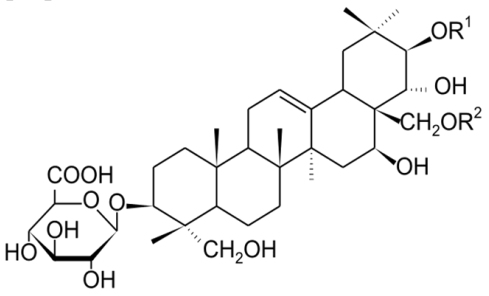
The leaves also contain resins, albumin, chlorophyll, carbohydrates, tartaric acid, formic acid, butyric acid, anthraquinone derivatives, inositole alkaloids, organic acid (5.5%), parabin, calcium oxalate (7.3%), lignin (4.8%), cellulose (22%) The gymnemic acids contain several acylated (tiglolyl, methylbutyroyl etc.) derivatives of deacylgymnemic acid (DAGA) which is a 3-O-β-glucouronide of gymnemagenin (3β, 16β, 21β, 22α, 23, 28-hexahydroxy-olean-12-ene). The individual gymnemic acids (saponins) include gymnemic acids I-VII, gymnemosides A-F, gymnemasaponins. The presence of gymnemic acids, (+) quercitol, lupeol, (-) amyrin, stigma sterol etc. have been reported from G. sylvestre. A new flavonol glycoside namely kaempferol 3-O-beta-D-glucopyranosyl-(1-->4)- alpha-Lrhamnopyranosyl-(1-->6)-beta-D-galactopyranoside has also been found in aerial parts of *G. sylvestre* [22-25].

Three new oleanane type triterpene glycosides i.e. beta-O-benzoylsitakisogenin 3-O-beta-D-

glucopyranosyl (1-->3)-beta-D-glucuronopyranoside, the potassium salt of longiospinogenin 3-O-beta-D-glucopyranosyl (1-->3)-beta-D glucopyranoside and the potassium salt of 29- hydroxylongispinogenin 3-O-beta-D-glucopyranosyl (1-->3)-beta-D-glucopyranoside along with sodium salt of alternoside II were isolated from an ethanol extract of the leaves of *G. sylvestre* [26]. Four new triterpenoid saponins, gymnemasins A, B, C and D isolated from the leaves of *G. sylvestre* were identified as 3-O-[beta-D-glucopyranosyl(1-->3)-beta-Dglucopyranosyl]-22-O-tiglyol-gymnemanol,3-O-[beta-D-glucopyranosyl(1-->3)-beta-D-glucuro - nopyranosyl]- gymnemanol, 3-O-beta-D-glucuronopyranosyl-22-O-tigloyl-gymnemanol and 3- O-beta-D-glucopyranosyl-gymnemanol respectively. The aglycone, gymnemanol, which is a new compound, was characterized as 3 beta-16 beta-22 alpha-23-28-pentahydroxyolean-12-ene. Gymnestrogenin, a new pentahydroxytriterpene from the leaves of *G. sylvestre* has been reported [27, 28].

**Mechanism of action of *G. Sylvester* (Gymnemic Acid):**

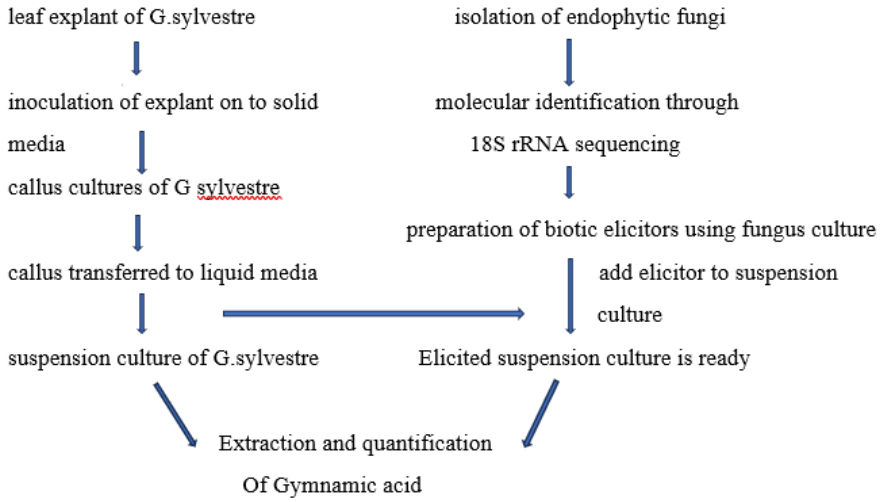
*G. Sylvester* leaves have been found to cause hypoglycemia in laboratory animals and shown a use in herbal medicine to treat diabetes mellitus in adults. When leaf extract of plant, administered to a diabetic patient, there is stimulation of the pancreas by virtue of which there is an increase in insulin release. These compounds have also been found to increase fecal excretion of cholesterol [29, 30]. There are some possible mechanisms by which the leaves extract of *G. Sylvester* or (Gymnemic acid) possess its hypoglycemic acid effects are: 1) It promotes regeneration of islet cells, 2) It increases secretion of insulin, 3) It causes inhibition of glucose absorption from intestine, 4) It increases utilization of glucose as it increase the activities of enzymes responsible for utilization of glucose by insulin-dependent pathways, an increase in phosphorylase activity, decrease in gluconeogenic enzymes and sorbitol dehydrogenase [2]. Uses Traditional Uses Susruta describes *G. sylvester*, as a destroyer of madhumeha (glycosuria) and other urinary disorder. It is also reported to be bitter, astringent, acrid, thermogenic, anti-inflammatory, anodyne, digestive, liver tonic emetic, diuretic, stomachic, stimulant, anthelmenthics, laxative, cardiotonic, expectorant, antipyretic and uterine tonic. It is useful in dyspepsia, constipation and jaundice, haemorrhoids, renal and vesicle calculi, cardiopathy, asthma, bronchitis, amenorrhoea, conjunctivitis and leucoderma [12, 31-32]. The drug is also used in the composition of ayurvedic preparations like Ayaskri, Varunadi kasaya, Varunadighrtam, Mahakalyanakaghrtam [33]




***Structure: gymnemic acid***

***Referance:https://www.shutterstock.com/image-photo/gymnema-sylvestre-plant-leaves-flowers-beneficial-781421848***

**Extraction and quantification of gymnemic acid:**




**Marketed preparation of *Gymnema Sylvestre*:**




***Fig.2: Supplementry preparation***







***Fig.4: Gymnema sylvestre in liduid extract and tableted form***
***Referance: https://images.app.goo.gl/CLbzrizSRzkQdEjV9 (for fig 2,3,4)***




***Fig.3: Powdered form***

**Application of *G. sylvestre*:**

**1. Ethanobotanical uses:**

There are over four hundred different tribal and other ethnic groups in India. Each tribal group is having their own tradition, folk language, beliefs and knowledge about the use of natural resources as medicines. The plant is reported to be useful in ethnobotanical surveys conducted by ethnobotanists. It has been documented that the Jungle Irulas inhabitants of Nagari Hills of the North Arcot District, Bombay and Gujarat from India have the habit of chewing a few green leaves of G. sylvestre in the morning in order to keep their urine clear and to reduce glycosuria. Bourgeois classes of Bombay and Gujarat also chew fresh leaves for the same effect. In Bombay and Madras, 'Vaids' are known to recommend the leaves in the treatment of furunculosis and madhumeha. The juice obtained from root is used to treat vomiting and in dysentery and plant paste is applied with mother milk to treat mouth ulcer. [7, 13, 34].

**2. Pharmacological Uses:**

Following the folk and traditional uses of the plant, it has been investigated scientifically to validate the potential of plant in cure of variety of ailments.

**3. In General Pharmacological Activities:**

The LD50 of ethanolic and water extract of *G. sylvestre* administered intraperitoneally in mice was found to be 375 mg/kg [35]. In an acute toxicity study in mice, no gross behavioral, neurologic, or autonomic effects were observed. The safety ratio (LD50/ED50) was 11 and 16 in normal and diabetic rats, respectively [36]. The pharmacological activities of *G. sylvestre* are desribed below:

**Antiobesity Study:**

*G. Sylvestre* helps to promote weight loss possibly through its ability to reduce cravings for sweets and control blood sugar levels. It has been reported that the gurmarin peptide block the ability to taste sweet or bitter flavors and thus reduces sweet cravings [37-38]. A standardized *G. sylvestre* extract in combination with niacin-bound chromium and hydroxycitric acid has been evaluated for antiobesity activity by monitoring changes in body weight, body mass index (BMI), appetite, lipid profiles, serum leptin and excretion of urinary fat metabolites. This study showed that the combination of *Gymnema Sylvestre* extract and hydroxycitric acid, niacin bound chromium can serve as an effective and safe weight loss formula that can facilitate a reduction in excess body weight and BMI while promoting healthy blood lipid levels [39].

**Antidiabetic Activity:**

The first scientific confirmation of *G. sylvestre* use in human diabetics came almost a century back when it was demonstrated that the leaves of *G. sylvestre* reduce urine glucose in diabetics [40]. In an animal study, Paliwal et al have investigated that gurmar leaf powder had positive and encouraging effects over blood glucose levels. No adverse effect was observed on the health status of the subjects and thus, it can thus be concluded that gurmar powder is effective in lowering the fasting as well as postprandial blood glucose levels [3]. Moreover, Sugihar et al have investigated the

antihyperglycemic action of a crude saponin fraction and five triterpeneglycosides derived from the methanol extracts of *G. sylvestre* [41]. Ankit Saneja et al Der Pharmacia Lettre 2010: 2 (1) 275-284

**Hypolipidaemic Activity:**

The administration of leaf extracts to hyperlipidaemic rats for two weeks have been found to show reduction in elevated serum triglyceride (TG), total cholesterol (TC), very low-density lipoprotein (VLDL) and low-density lipoprotein (LDL) – cholesterol in dose dependent manner. The efficiency of this drug was almost similar to that of a standard lipid lowering agent clifibrate [42, 4].

**Antimicrobial Activity:**

The ethanolic extract of *G. sylvestre* leaves showed good antimicrobial activity against Bacilluspumilis, *B. subtilis, Pseudomonas aeruginosa* and *Staphylococcus aureus* and no activity was found against *Proteus vulgaris* and *Escherichia coli* [43]. The aqueous and methanolic extract of *G. sylvestre* leaves also showed moderate activity against the three pathogenic *Salmonella* species (*Salmonella typhi, S. typhimurium and S. paratyphi*). Out of the two extracts used, aqueous extract showed higher activity against the *Salmonella* species [44]. *Ethanolic, Chloroform* and *Ethyl acetate* extracts of the aerial parts of *G. sylvestre* also reported to have antibacterial effects against *P. vulgaris, E. coli, P. aeroginosa, Klebsella pneumoniae* and *S. aureus* [45].

**Anti-Inflammatory Activity:**

The aqueous extract of G. sylvestre leaves was investigated for evaluation of anti-inflammatory activity in rats at a dose 200, 300 and 500 mg/kg in carrageenin-induced paw oedema and cotton pellet method. The aqueous extract at 300 mg/kg decreased the paw oedema volume by 48.5% within 4 h after administration, while the standard drug phenylbutazone decreased the paw oedema volume by 57.6% when compared with the paw oedema volume of control. The aqueous extract at the dose of 200 mg/kg and 300 mg/kg produced significant reduction in granuloma weight, when compared to control group [46].

**4. Homoeopathic application:**

**Primary use:** *Gymnema sylvestre* is prominently used as a remedy in cases where there is a profuse passage of sugar loaded urine. it is also employed in treating snake bites and alleviating symptoms related to excessive thirst, burning skin, and sexual weakness.

***Referances:***


1. The Wealth of India: A Dictionary of Indian Raw materials and Industrial products. Council of Scientific and Industrial Research, New Delhi, 1956, 276-77.
2. P. Kanetkar, R. Singhal, M. Kamat. J Clin Biochem Nutr, 2007, 41, 77-81.
3. R. Paliwal, S. Kathori, B. Upadhyay. Ethno-Med, 2009, 3(2), 133-135.
4. P.R. Rachh, M.R. Rachh, N.R. Ghadiya, D.C. Modi, K.P. Modi, N.M. Patel, M.T. Rupareliya. Int J Pharmacol, 2010, 1-4. S.E. Potawale, V.M. Shinde, L. Anandi, S. Borade, H. Dhalawat, R.S. Deshmukh. Pharmacologyonline, 2008, 2, 144-157
5. K.R. Keshavamurthy, S.N. Yoganarasimhan. Flora of Coorg – Karnataka, Vimsat publishers, Banglore, 1990, 282.

6. K. Kritikar, B. Basu. Indian Medicinal Plants. International Book Distributors, Dehradun, 1998, 1625.
7. H. Zhen, S. Xu, X. Pan. Zhong Yao Cai, 2001, 24 (2), 95-7.
8. S. Yadav, J.K. Grover, V.Vats. J Ethanopharmacol, 2002, 81(1), 81-10.
9. S. Gurav, V. Gulkari, N. Durgkar, A. Patil. Pharmacog rev, 2007, 1 (2), 338-343.
10. C. S. Kumar, D.V.L. Sarada, R. Rengasamy. Indian J Sci Tech, 2008, 1 (3),1-5
11. K.M. Nadkarni. Indian Materia Medica. Popular prakashan, Bombay, 1993, 596-9.
12. A.K. Agnihotri, S. Khatoon, M. Agarwal, A.S. Rawat, S. Mehrota, P. Pushpangadan. Nat Prod Sci, 2004, 10 (4), 168 – 72.
13. Madhurima, S.H Ansari, P. Alam, S. Ahmad, Md. S. Akhtar. J Herb Med Toxicol, 2009, 3(1), 73-80. Ankit Saneja et al Der Pharmacia Lettre 2010: 2 (1) 275-284.
14. Anonymous. Quality standards of Indian medicinal plants. Indian Council of Medical Research, New Delhi, 2003.
15. Anonymous. Pharmacopoeia of India. Govt. of India, Ministry of Health, Controller of publication, New Delhi, 1996.
16. V. Rajpal. Testing and extraction methods of medicinal plants, Vol. 1, 2006, 140-150
17. G.P. Dateo, L.Long. Afr J Agric Food Chem, 1973, 21, 899-903.
18. V.A. Khramov, A.A. Spasov, M.P. Samokhina. Pharm Chem J, 2008, 42 (1), 29-31
19. K. Yoshikawa, M. Nakagawa, R. Yamamoto, S. Arihara, K. Matsuura. Chem Pharma Bull, 1992, 40, 1779-82.
20. J.E. Sinsheimer, G.S. Rao. J. Pharm. Sci., 1970, 59 (5), 622-628.
21. Y. Kuzuko, A. Kayoko, A. Shigenoby, M. Kouji. Tetrahedron lett, 1989, 30 (9): 1130-1106.
22. I M. Hong, K.Fumiyuki, T.Yoshisuke. Chem Pharm Bull, 1992, 40 (6): 1366-1375.
23. Y. Masayuki, M. Toshiyuki, K. Masashi, L. Yuhao, M. Nubotoshi, Y. Johji. Chem Pharm Bull, 1997, 45 (10), 1671-76.
24. Y. Masayuki, M. Toshiyuki, K. Masashi, L. Yuhao, M. Nubotoshi, Y. Johji. Chem Pharm Bull, 1997, 45 (10), 1671-76.
25. X. Liu, W. Ye, B. Yu, S. Zhao, H.Wu, C. Che. Carb Res, 2004, 339 (4), 891-95.
26. W. Ye, X. Liu, Q. Zhang, C.T. Che, S. Zhao. J Nat Prod, 2001, 64(2): 232-35.
27. N.P. Sahu, S.B. Mahato, S.K. Sarkar, G. Poddar. Phytochemistry, 1996, 41)
28. W. Stocklin., Helv Chim Acta, 1968, 51(6), 1235-42.
29. P.V. Kanetkar, K.S. Laddha, M.Y. Kamat. Gymnemic acids: A molecular perspective of its action on carbohydrate metabolism. Poster presented at the 16th ICFOST meet organized by CFTRI and DFRL, Mysore, India, 2004.
30. S.J. Persaud, H.A. Majed, A. Raman, P.M. Jones. J Endocrinol, 1999, 163, 207-212.
31. P. Vaidyaratnam. Indian Medicinal Plants. Orient Longman Publisher, Madras, 1995, 107-9.
32. R.N. Chopra, S.L. Nayar, I.C. Chopra. Glossary of Indian

Medicinal Plants. Council of Scientific and Industrial Research, New Delhi, 1992, 319-22.
33. P.P. Joy, J. Thomas. Medicinal plants. Kerala Agriculture University, Aromatic and Medicinal Plants Research Station, 1998, 16.
34. N.R. Ekka, V.K. Dixit. Int J Green Pharmacy, 2007, 1,1-4.
35. D.S. Bhakuni, M.L. Dhar, M.M. Dhar, B.N. Dhawan. Ind J Exp Biol, 1971, 9, 91-102.
36. R.R. Chattopadhyay. J Ethnopharmacol, 1999, 67, 367-72.
37. A. Pierce. Gymnema Monograph: Practical guide to natural medicine, Stonesong Press Book, New York, 1999, 324-26.
38. A. Pierce. Gymnema Monograph: Practical guide to natural medicine, Stonesong Press Book, New York, 1999, 324-26 [38] Y. Ninomiya, T. Imoto. Am J Physiology, 1995, 268 (4), 1019-25.
39. H.G. Preuss, D. Bagchi, M. Bagchi, C.V. Rao, D.K. Dey, S. Satyanarayana. Diabetes Obes Metab, 2004, 6(3), 171-80. [40] K.G. Charpurey. Indian Medical Gazette. New Delhi, 1926,155.
40. K.G. Charpurey. Indian Medical Gazette. New Delhi, 1926,155.
41. Y. Sugihara, H. Nojima, H. Marsuda, T. Murakami M Yoshikawa, I. Kimura. J Asian Nat Res, 2000, 2(4), 321-27
42. A. Bishayee, M. Chatterjee. Phyt Res, 1994, 8(2), 118-20.
43. R.K. Satdive, P. Abhilash, P.F. Devanand. Fitoterapia, 2003, 74,699-701
44. C. Pasha; S. Sayeed; S. Ali; Z. Khan. Turk J Biol, 2009, 33, 59-64.
45. J.P. Paul, K. Jayapriya. Pharmacologyonline, 2009, 3, 832-836.
46. J.K. Malik, F.V. Manvi, K.R Alagawadi, M. Noolvi. Int J Green Pharm, 2008, 2(2), 114-15.
47. R Ohmori, T Iwamoto, M Tago, T. Takeo, T. Unno, H Itakura. Lipids, 2005, 40 (8), 849-53. Ankit Saneja et al Der Pharmacia Lettre 2010: 2 (1) 275-284
48. Anon. ymous. American Herbal Products Association. Use of Marker compounds in manufacturing and labeling botanically derived dietary supplements, Silver Spring, MD, American Herbal Products Association, 2001.
49. B. Kerry. Gymnema: a key herb in the management of diabetes. (Phytotherapy Review & Commentary). National Institute of Herbalists, National Herbalists Association of Australia.