WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Review on solubility inhancment techniq of gymnemic acid extreted from gymnemic sylvester

[1]Mr .Charudatta R. Rakhunde Sir, [2]Mr. Om Ganpat Korde

[1]Prof., Aditya institute of Pharmacy, chalisgaon, Dhule road, Tal. Chalisgaon, Dist. Jalagaon
[2]Student , Aditya institute of Pharmacy, Chalisgaon, Dhule road Tal. Chalisgaon, Dist. Jalagaon
Email : omkorde48@gmail.com

ABSTRACT :

Gymnema Sylvestre R. Br. (Asclepiadaceae) is a globally distributed herb. Its leaves are extensively utilized in Indian Proprietary medicines for managing diabetes and serving as a diuretic. The primary active compound extracted from the Gymnema Sylvestre plant is gymnemic acid. This plant is recognized for its advantageous properties, including digestive aid, anti-inflammatory effects, diuretic action, hypoglycemic effects, and antihelminthic properties. It is commonly employed in the treatment of dyspepsia, constipation, jaundice, hemorrhoids, cardiopathy, asthma, bronchitis, and leucoderma. A review of existing literature has uncovered significant pharmacological activities associated with the plant, such as antidiabetic, antiobesity, hypolipidaemic, antimicrobial, free radical scavenging, and antiinflammatory effects. This review aims to emphasize the diverse ethnobotanical and traditional applications, along with the phytochemical and pharmacological findings related to G. sylvestre.

Keywords: Gymnema sylvestre, ethnobotanical uses, pharmacognosy, pharmacological Activities, phytochemistry

2)INTRODUCTION

Gymnemic acids (GA) are a type of triterpenoid saponin glycosides primarily derived from the leaves of the medicinal plant Gymnema sylvestre, which belongs to the Asclepiadaceae family. GA is predominantly utilized in the treatment of diabetes mellitus. Currently, India faces a rapid increase in diabetes cases, with over 62 million individuals affected. It is projected that India will lead globally in diabetes prevalence in the coming years, followed by China and the United States. this condition is prevalent in today's society, with one in every two individuals suffering from it. Significant investments are being made in research to create new synthetic antihyperglycemic molecules; however, these synthetic alternatives often come with considerable side effects. Consequently, there is a strong emphasis on developing antihyperglycemic agents from natural sources. In this context, GA stands out as a highly promising natural compound (Pal et al. 2018, 2019). Although there are over 50 species of
Gymnema, only G. sylvestre is recognized as a significant source of the secondary metabolite GA, making it challenging to meet the demand for GA through natural cultivation alone (Pal and Saha 2019a, b). To bridge the gap between demand and production, biotechnology emerges as a viable solution. Plant tissue culture techniques can effectively produce larger quantities of GA in a shorter timeframe (Kaveeshwar and Cornwall 2014). This chapter primarily discusses the chemistry, applications, and biotechnological approaches for GA production.

Sources of Gymnemic Acids

The genus Gymnema comprises 103 species, with GA predominantly isolated from G. sylvestre R. Br. (Asclepiadaceae). This species is primarily located in the tropical regions of India and Southeast Asia. In the Unani system, the plant is referred to as gokhru, while in Hindi it is known as Gurmar, and in Sanskrit as meshashringi. The term gurmar translates to 'killer of sweet,' where 'gur' means sweet and 'mar' signifies kill (Thakur et al. 2012). The ethyl acetate extract of G. sylvestre has been found to contain formic acid, propionic acid, hentriacontane, and Quercitol. Additionally, the leaves are rich in pentatriacontane, chlorophylls A and B, phytin, resin, tartaric acid, inositol, lupeol, β-amyrin, and stigmasterol. GA is extracted as a black, brittle resin that turns green upon grinding. Its primary characteristic is the ability to suppress taste sensations on the tongue (Zarrelli et al. 2014). Gymnemic acid, a collection of naturally occurring compounds, is mainly found in the leaves of Gymnema sylvestre, a climbing shrub indigenous to the tropical areas of India, Africa, and Australia. This plant has a long history of use in traditional Ayurvedic medicine, particularly for managing diabetes.

Chemical Nature and Structure

Class: Triterpenoid saponins; Main Components: Gymnemic acids consist of a diverse array of saponins, which include Gymnemic acid I–XXX, gymnemagenin (the aglycone), and various glycosidic derivatives; Molecular Formula: The molecular formula differs based on the specific acid, typically around $C_{48}H_{76}O_{18}$ for certain variants; Solubility: These compounds exhibit moderate solubility in both water and ethanol.

Sources

The leaves of Gymnema sylvestre, recognized as the most potent source, serve as the primary ingredient in various extracts and formulations.

Pharmacological Activities

Anti-diabetic Effects: Mechanism: Gymnemic acids inhibit sugar receptors in the intestines, leading to decreased sugar absorption. They also enhance insulin secretion and support the regeneration of pancreatic beta cells. Anti-sweet Activity: Temporarily diminishes the perception of sweetness by binding to sweet taste receptors on the tongue, with effects lasting 1–2 hours post-consumption. Anti-obesity: Mitigates sugar cravings and assists in weight management by suppressing appetite. Lipid-lowering Effects: Research indicates that gymnemic acids may lower LDL cholesterol and triglyceride levels. Antioxidant and Antiinflammatory: Comprises bioactive compounds that neutralize free radicals and alleviate inflammation.

Applications

Utilized in dietary supplements aimed at regulating blood sugar levels. Included in herbal teas, capsules, and extracts that focus on enhancing metabolic health. Investigated for its possible application in modulating non-sugar sweet flavors and controlling appetite.

Safety and Side Effects

Typically regarded as safe when consumed in moderate amounts. Possible adverse effects include: hypoglycemia (particularly when used in conjunction with other medications that lower blood sugar), gastrointestinal discomfort, and rare allergic reactions.

Chemical Constituents of Gymnemic Acid

Gymnemic acid is not a single compound but rather a **group of closely related triterpenoid saponins**, all derived primarily from the **oleanane-type triterpenoid aglycone called gymnemagenin**. These compounds are present in *Gymnema sylvestre* and are responsible for many of the plant's biological activities

Here are the major categories and representative molecules:

1. Triterpenoid Aglycone:

Gymnemagenin

- The core structure (aglycone) of gymnemic acids
- Belongs to the oleanane-type pentacyclic triterpenoids
- Acts as the structural base for glycosylated derivatives

2. Glycosylated Derivatives (Gymnemic Acids)

These are gymnemagenin molecules with sugar moieties (glycosides) attached.

Some important gymnemic acids include:

Gymnemic Acid I to Gymnemic Acid XXX

- Differ by the number and type of sugar residues
- Examples:
  - **Gymnemic Acid I** – Contains glucuronic acid and acyl groups
  - **Gymnemic Acid IV** – Known for its sweet taste-suppressing activity
  - **Gymnemic Acid VII and XIII** – Have been particularly studied for anti-diabetic effects

3. Related Saponins and Compounds:

- **Gymnemosides (A–F)** – Other triterpenoid saponins isolated from *Gymnema sylvestre*
- **Conduritol A** – A polyhydroxylated cyclohexane compound with antidiabetic activity
- **Stigmasterol and β-sitosterol** – Plant sterols also found in the plant, though not part of gymnemic acids

Structure Features of Gymnemic Acids:

- **Triterpene core**: Oleanane structure (30-carbon skeleton)
- **Sugar chains**: Usually glucuronic acid, rhamnose, or other sugars
- **Functional groups**: Hydroxyl, carboxyl, and acyl groups contribute to polarity and biological activity

Phytochemical Evaluation of Gymnemic Acid

Phytochemical evaluation involves the extraction, identification, and quantification of bioactive compounds present in a plant or its extract. In the case of gymnemic acid, which is primarily found in the leaves of Gymnema sylvestre, phytochemical evaluation is critical for determining its purity, potency, and therapeutic potential.

Plant Source and Extraction

Plant: Gymnema sylvestre (leaves are the most concentrated source) Extraction Methods:

Solvent Extraction: Using ethanol, methanol, or water

Soxhlet Extraction: For efficient recovery of triterpenoid saponins
Ultrasound-Assisted Extraction (UAE) and Supercritical Fluid Extraction (SFE): For improved yield and selectivity

Preliminary Phytochemical Screening

The extract typically contains the following phytochemicals:

Phytochemical group	**Presence in Gymnema sylvestre Leaves**
Triterpenoid saponins	Presence in Gymnema sylvestre Leaves
Alkaloids	Minor
Flavonoids	antioxidant properties
Sterols	e.g., β-sitosterol, stigmasterol

Table no.2.1) Phytochemicals present in gymnemic sylvestere leaves

Quantitative Estimation
Total Saponin Content
Typically estimated using vanillin-sulfuric acid colorimetric assay
Expressed as mg of gymnemagenin equivalents per gram of extract
HPLC Analysis
High-Performance Liquid Chromatography (HPLC) is widely used to:
Quantify specific gymnemic acids (e.g., Gymnemic acid IV)
Detect and separate different glycosidic forms
UV-Vis Spectrophotometry
Can be used for broad quantification of saponins

5) MATERIAL AND METHODS

5.1)Plant description

G. sylvestre is a slow-growing, perennial woody vine found across India, particularly in dry forests at elevations up to 600 meters. It predominantly thrives in the tropical forests of Central and Southern India, with additional occurrences in Banda, Konkan, the Western Ghats, and parts of Western and Northern India. This plant is characterized as a large, somewhat hairy woody climber. Its leaves are opposite, typically elliptic or ovate, measuring between 1.25 to 2.0 inches in length and 0.5 to 1.25 inches in width. The flowers are small and yellow, arranged in axillary and lateral umbels within cymes; the follicles are terete and lanceolate, reaching lengths of up to 3 inches. The calyx lobes are elongated, ovate, obtuse, and hairy. The corolla is pale yellow, campanulate, and valvate, featuring a single corona with five fleshy scales that are adnate to the throat of the corolla tube between the lobes. The anther connective extends into a membranous tip, with two erect pollinia, and the plant has two unilocular carpels with multiple ovules in each locule. G. sylvestre is recognized for its strong antidiabetic properties and is utilized in folk, Ayurvedic, and homeopathic medicine. It is also employed in treating asthma, eye disorders, family planning, snakebites, urinary issues, gastrointestinal problems, hemorrhoids, chronic cough, respiratory difficulties, colic, heart conditions, constipation, dyspepsia, and hepatosplenomegaly. Furthermore, it exhibits antimicrobial, antihypercholesterolemic, anti-inflammatory properties, and acts as a deterrent to caterpillars. Literature reviews indicate that G. sylvestre is widely used for various health issues and is a key ingredient in numerous Ayurvedic formulations; however, limited scientific validation through animal studies and clinical trials has been conducted to confirm its efficacy. This review emphasizes the diverse folk and Ayurvedic applications, along with the pharmacognostical, phytochemical, and pharmacological research associated with G. sylvestre.

5.2)Pharmacognostical Studies

The leaves of G. sylvestre are extensively utilized in the management of diabetes and as a diuretic in Indian proprietary medicines, and they are commonly available in the herbal drug market of the country, often sold alongside the aerial parts under the name Gurmarbuti. Consequently, the macroscopic and microscopic characteristics of the aerial parts are detailed below:

5.3)Macroscopic Characteristics

The leaves of G. sylvestre exhibit a green coloration, while the stem is covered in fine hairs and has a light brown hue. Each leaf measures between 2 to 6 cm in length and 1 to 4 cm in width. The leaves are simple and petiolate, featuring a rounded to cordate base, entire margins, and an acute apex, with reticulate venation and a pubescent texture on both surfaces. The leaves emit a distinctive odor and possess a slightly bitter and astringent taste. Notably, they have the unique ability to temporarily paralyze the taste sensation for sweet substances for several hours.

Microscopic Characteristics

Petiole

The transverse section of the petiole exhibits a horseshoe shape. The epidermis is composed of a single layer of barrel-shaped, thick-walled cells, which are covered with uniseriate, multicellular, non-glandular trichomes. The cortex is made up of collenchyma, and there are three amphicribal vascular bundles. The well-developed phloem includes sieve tubes, companion cells, and phloem parenchyma. The xylem is comprised of vessels, tracheids, and tracheidal fibers. Starch grains are found in polygonal shapes, either simple or compound, and can be grouped in twos or more. Additionally, rosette crystals of calcium oxalate are predominantly located towards the center.

Lamina

The epidermal cells of the lamina exhibit a square shape, characterized by an outer convex wall and a thin cuticle. When observed in cross-section, the surface of the epidermal cells is interspersed with trichomes, which are uniseriate and multicellular, consisting of 2 to 5 cells, and are found abundantly on both surfaces. Beneath the adaxial epidermis, there exists a single layer of closely arranged palisade cells. The vascular bundles are amphicribal, and the mesophyll is composed of 3 to 5 layers of cells.

Powder

The powdered substance exhibits a faint yellowish-green hue, possesses a bitter flavor, and emits a pleasant aromatic scent. Microscopic analysis reveals the presence of thick-walled, uniseriate multicellular trichomes, anomocytic stomata, idioblasts containing rosette crystals of calcium oxalate, starch grains, and remnants of collenchymatous and parenchymatous cells, along with vessels, tracheids, tracheidal fibers, bast fibers, and sieve plates.

5.4)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% HNO_3 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 .

Purity Test

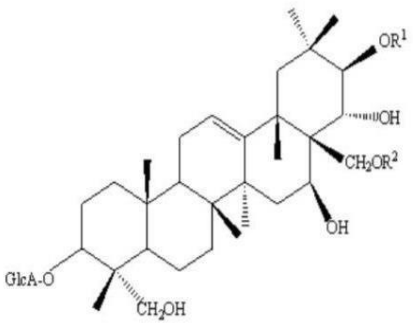
Purity test of G. sylvestre depicts the following characteristics: 1) Maximum moisture content should not more than 6 percent, 2) Total ash content should not more than 12 percent, 3) Heavy metal content in leaves or leaves extract should not more than 40 ppm and in the final dosage form, it should not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

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 [18-20]. 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-Dglucopyranosyl-(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-Dglucuronopyranoside, the potassium salt of longiospinogenin 3-O-beta-D-glucopyranosyl (1→3)-beta-D-glucopyranoside and the potassium salt of 29- hydroxylongispinogenin 3O-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-23-28pentahydroxyolean-12-ene. Gymnestrogenin, a new pentahydroxytriterpene from the leaves of G. sylvestre has been reported .

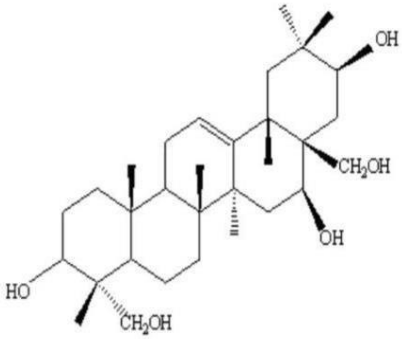
5.5)Mechanism of action of G. Sylvester (Gymnemic Acid)

The leaves of G. Sylvester have been identified to induce hypoglycemia in laboratory animals and have demonstrated efficacy in herbal medicine for the treatment of diabetes mellitus in adults. When the leaf extract of this plant is administered to a diabetic patient, it stimulates the pancreas, leading to an increase in insulin secretion. Additionally, these compounds have been observed to enhance the fecal excretion of cholesterol. Several potential mechanisms through which the leaf extract of G. Sylvester, or Gymnemic acid, exerts its hypoglycemic effects include: 1) promoting the regeneration of islet cells, 2) increasing insulin secretion, 3) inhibiting glucose absorption in the intestine, and 4) enhancing glucose utilization by elevating the activity of enzymes involved in insulindependent pathways, increasing phosphorylase activity, and decreasing gluconeogenic enzymes and sorbitol dehydrogenase.

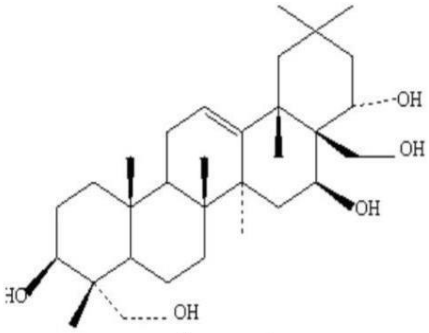


Gymnemic acid

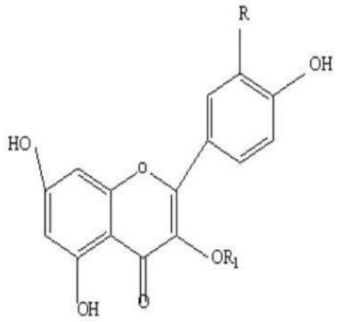
Gymnemic acid types	R^1	R^2
Gymnemic acid I	Tigloyl	Ac
Gymnemic acid II	2-methylbutyroyl	Ac
Gymnemic acid III	2-methylbutyroyl	H
Gymnemic acid IV	Tigloyl	H



Gymnestrogenin



Gymnemanol



R = H, R_1 = beta-O-Glcp-(1--> 4)- alpha-L-Rhap-(1-->6)-beta-O-Galp

Kaempferol 3-O-beta-D-glucopyranosyl-(1-->4)-alpha-L-rhamnopyranosyl- (1-->6)-beta-D galactopyranoside

Structures of some phytoconstituents isolated from Gymnema sylvestre

5.6)Uses

Traditional Uses

Susruta characterizes G. sylvester as a remedy for madhumeha (glycosuria) and various urinary disorders. It is noted for its bitter, astringent, acrid, thermogenic, anti-inflammatory, analgesic, digestive, liver tonic, emetic, diuretic, stomachic, stimulant, anthelmintic, laxative, cardiotonic, expectorant, antipyretic, and uterine tonic properties. This herb is beneficial for conditions such as dyspepsia, constipation, jaundice, hemorrhoids, renal and bladder stones, heart disease, asthma, bronchitis, amenorrhea, conjunctivitis, and leucoderma. Additionally, it is incorporated into several Ayurvedic formulations, including

Ayaskri, Varunadi kasaya, Varunadighrtam, and

Ethnobotanical Uses

India is home to more than four hundred distinct tribal and ethnic groups, each possessing unique traditions, folk languages, beliefs, and knowledge regarding the utilization of natural resources for medicinal purposes. Ethnobotanical surveys conducted by ethnobotanists have indicated the plant's significance. It has been observed that the Jungle Irulas, residing in the Nagari Hills of the North Arcot District, as well as in Bombay and Gujarat, have a customary practice of chewing a few green leaves of G. sylvestre each morning to maintain clear urine and mitigate glycosuria. Similarly, the bourgeois classes in Bombay and Gujarat also partake in chewing fresh leaves for these benefits. In Bombay and Madras, traditional healers known as 'Vaids' are recognized for recommending these leaves in the treatment of furunculosis and Madhumeha. Additionally, the juice extracted from the root is utilized to alleviate vomiting and dysentery, while a paste made from the plant is applied with maternal milk to treat oral ailments.

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.

5.7) General Pharmacological Activities

The lethal dose (LD50) of ethanolic and aqueous extracts of G. sylvestre, when administered intraperitoneally to mice, was determined to be 375 mg/kg. In an acute toxicity assessment involving mice, no significant behavioral, neurological, or autonomic effects were noted. The safety ratios (LD50/ED50)

were calculated to be 11 for normal rats and 16 for diabetic rats. The pharmacological properties of G. sylvestre are detailed below:

Antiobesity Study

G. Sylvestre is believed to aid in weight loss by potentially curbing sweet cravings and regulating blood sugar levels. Research indicates that the gurmarin peptide inhibits the perception of sweet and bitter tastes, thereby diminishing the desire for sweets. A standardized extract of G. Sylvestre, when combined with niacin-bound chromium and hydroxycitric acid, has been assessed for its anti-obesity effects by tracking variations in body weight, body mass index (BMI), appetite, lipid profiles, serum leptin levels, and the excretion of urinary fat metabolites. The findings suggest that this combination of Gymnema Sylvestre extract, hydroxycitric acid, and niacin-bound chromium may provide an effective and safe solution for weight loss, contributing to a decrease in excess body weight and BMI while supporting healthy blood lipid levels.

Antidiabetic Activity

The initial scientific validation of G. sylvestre's application in human diabetes occurred nearly a century ago, when it was shown that G. sylvestre leaves decrease glucose levels in urine among diabetics. In a study involving animals, Paliwal et al. found that gurmar leaf powder had beneficial and promising effects on blood glucose levels. No negative health impacts were noted in the subjects, leading to the conclusion that gurmar powder is effective in reducing both fasting and postprandial blood glucose levels. Additionally, Sugihar et al. examined the antihyperglycemic properties of a crude saponin fraction and five triterpene glycosides obtained from the methanol extracts of G. sylvestre

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 .

Antimicrobial Activity

The ethanolic extract of G. sylvestre leaves demonstrated significant antimicrobial properties against Bacillus pumilus, B. subtilis, Pseudomonas aeruginosa, and Staphylococcus aureus, while exhibiting no activity against Proteus vulgaris and Escherichia coli. Additionally, both the aqueous and methanolic extracts of G. sylvestre leaves displayed moderate efficacy against the three pathogenic Salmonella species: Salmonella typhi, S. typhimurium, and S. paratyphi. Among the two extracts, the aqueous extract exhibited superior activity against the Salmonella species. Furthermore, ethanolic, chloroform, and ethyl acetate extracts from the aerial parts of G. sylvestre have also been reported to possess antibacterial effects against P. vulgaris, E. coli, P. aeruginosa, Klebsiella pneumoniae, and S. aureus.

Anti-Inflammatory Activity

The aqueous extract derived from G. sylvestre leaves was examined for its antiinflammatory effects in rats at doses of 200, 300, and 500 mg/kg using the carrageenaninduced paw edema and cotton pellet methods. The extract at a dosage of 300 mg/kg resulted in a 48.5% reduction in paw edema volume within 4 hours post-administration, whereas the standard drug phenylbutazone achieved a 57.6% reduction compared to the control group's paw edema volume. Additionally, the aqueous extract at doses of 200 mg/kg and 300 mg/kg significantly reduced granuloma weight in comparison to the control group.

Free Radical Scavenging Activity

In vitro, the inhibitory effects of DPPH radicals and LDL oxidation were found with aqueous Extract of G. sylvestre. G. sylvestre require 32.1 µl, for scavenging 50% of the DPPH radicals.

5.8)Dosage Forms

G. sylvestre is offered in various forms including crude plant, powder, extract paste, and standardized solid. Additionally, it is available in capsules or tablets, often combined with other herbal ingredients. For adults, the recommended dosage in liquid form (extract) is between 25 to 75 ml per week, with optimal results expected after 6 to 12 months of consistent use. When prescribed in tablet form, a daily dosage of 8 to 12 g of leaf equivalent is advised. However, there is a lack of sufficient evidence regarding its use in the pediatric population, thus it is not recommended for children.

Suggested Combinations with Other Herbs

G. sylvestre may be used in conjunction with fenugreek, goat's rue, and neem leaves for managing diabetes, and with globe artichoke or blue flag for promoting weight loss. For hypercholesterolemia, G. sylvestre is advised to be taken alongside turmeric, hawthorn, Silybum, globe artichoke, and garlic.

6)Result And Discussion:-

In recent years, there has been a growing interest in the ethnobotanical and traditional applications of natural compounds, particularly those derived from plants, due to their established efficacy and general perception of safety for human consumption. These compounds warrant thorough examination through modern scientific methodologies, including physicochemical characterization, biological assessments, toxicity evaluations, and investigations into the molecular mechanisms of action of isolated phytochemicals, along with their clinical trials. Such classical approaches are essential in the quest for new lead molecules for the treatment of various diseases. Diabetes has emerged as a prevalent condition globally, prompting the synthesis of numerous new medications. Many Indian herbs are utilized in traditional medicine for diabetes management. Among these, Gymnema sylvestre holds significant importance as an antidiabetic medicinal plant and is also employed in the treatment of dyspepsia, constipation, jaundice, hemorrhoids, renal and vesicular calculi, cardiopathy, asthma, bronchitis, amenorrhea, conjunctivitis, and leucoderma. Additionally, future research should focus on scientifically evaluating the isolated principles from Gurmar using various innovative experimental models and clinical trials to elucidate their mechanisms of action and to identify other active constituents, thereby expanding its therapeutic applications.

7)CONCLUSION:

Gymnemic acid, an important bioactive component obtained from Gymnema sylvestre, demonstrates notable antidiabetic and therapeutic properties. Nevertheless, its limited solubility in water restricts its bioavailability and clinical use. This review examined various methods to enhance solubility, including solid dispersion, inclusion complexation, nanotechnology-based strategies, and the application of surfactants and co-solvents. Notably, nanoparticle formulations and cyclodextrin complexation have shown significant potential in improving dissolution rates and increasing systemic absorption. Ongoing research into innovative drug delivery systems and advanced formulation techniques is crucial for optimizing the therapeutic effects of gymnemic acid. By addressing solubility issues, the pharmaceutical applications of Gymnema sylvestre extracts can be greatly enhanced, facilitating more effective herbal interventions for metabolic disorders.

9)REFERENCE

1. Pal D, Saha S (2019a) Current status and prospects of chitosan–metal nanoparticles and their applications as nanotheranostic agents. In: Rai M, Jamil B (eds) Nanotheranostics. Springer Nature Switzerland AG. https://doi.org/10.1007/978-3-030-29768-8_5
2. Pal D, Saha S (2019b) Chondroitin: a natural biomarker with immense biomedical applications. RSC Adv 9(48):28061–28077
3. Pal D, Nayak A, Saha S (2018) Interpenetrated polymer network hydrogels of chitosan: applica-Tions in controlling drug release. In: Md I H Mondal (ed) Springer Series on "cellulose based Superabsorbent hydrogels, polymers and polymeric composite: a reference series". https://doi.Org/10.1007/978-3-319-76573-0_57_1
4. Pal D, Nayak AK, Saha S (2019) Cellulose based hydrogel (invited book chapter). In: Akhtar MS Et al (eds), Natural bio-active compounds. Springer Nature Singapore Pte Ltd, pp 285–332. https://doi.org/10.1007/978-981-13-7154-7_10
5. Kaveeshwar SA, Cornwall J (2014) The current state of diabetes mellitus in India. Australas Med J 7(1):45–48
6. Thakur GS, Sharma R, Sanodiya BS, Pandey M, Prasad GBKS, Bisen PS (2012) Gymnema Sylvestre: an alternative therapeutic agent for management of diabetes. J Appl Pharm Sci 2(12):001–006
7. Zarrelli A, Romanucci V, Gravante R, Marino CD, Fabio GD (2014) History of GA, a molecule That does not exist. Nat Prod Commun 9(10):1429–1432
8. K. Kritikar, B. Basu. Indian Medicinal Plants. International Book Distributors, Dehradun,1998, 1625.
9. A.K. Agnihotri, S. Khatoon, M. Agarwal, A.S. Rawat, S. Mehrota, P. Pushpangadan. Nat Prod Sci, 2004, 10 (4), 168 – 72.
10. Anonymous. Quality standards of Indian medicinal plants. Indian Council of Medical Research, New Delhi, 2003.
11. N.P. Sahu, S.B. Mahato, S.K. Sarkar, G. Poddar. Phytochemistry, 1996, 41(4): 1181-85.
12. 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.
13. H.G. Preuss, D. Bagchi, M. Bagchi, C.V. Rao, D.K. Dey, S. Satyanarayana. Diabetes Obes Metab, 2004, 6(3), 171-80.