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Fenugreek Use: Biological Role of Fenugreek in Health of Human Being- A Review:

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Abstract

Fenugreek is a legume plant used as spices in throughout the world. Fenugreek, scientifically known as *Trigonella Foenum-graecum L.*, is a versatile legume crop with extensive cultivation in India. It holds significant value as an herb, spice, and traditional medicinal plant in the region.Fenugreek, scientifically known as Trigonella Foenum-graecum L., has a rich history of utilization in various traditional and medicinal practices. Its leaves and seeds have been employed extensively for therapeutic purposes, making it an ancient and valued herb. This review intends to provide an exhaustive examination of the scientific literature concerning fenugreek. This encompasses its botanical characteristics and chemical composition. The primary focus of this review centres around fenugreek's medicinal properties, which have been extensively studied and validated through in-vitro, in-vivo, and clinical research. The herb exhibits inclusive beneficial effects, such as anti-inflammatory, antioxidant, antimicrobial, gastroprotective actions, anticancer, and anti-analgesic activity. Various bioactive compounds present in fenugreek, including alkaloids, flavonoids, saponins, and steroidal sapogenins, contribute to its therapeutic potential. Fenugreek, has demonstrated significant antidiabetic properties in both animal studies and human trials. These effects have primarily been associated with the presence of saponins and its rich fiber content, rather than its main alkaloid component, trigonelline. Notably, fenugreek consumption has been linked to the elevation of plasma insulin levels within living organisms. Additionally, one of its key free amino acids, 4-hydroxyisoleucine, has shown the ability to stimulate insulin secretion when tested on isolated pancreas samples in vitro.

Keywords: Fenugreek, anti-inflammatory, gastroprotective, anti-analgesic,anti-diabetic.

1. Introduction:

Fenugreek is a cultivated plant that finds extensive use across different regions globally, valued for its role as an herb, spice, and traditional medicinal remedy. It belongs to the legume family and is an annual crop. Originally, the primary cultivation of this crop occurred in a region extending from Iran to northern India. However, in recent times, fenugreek cultivation has expanded to several other regions, including Greece, Ukraine, north and east Africa, and China. Its versatility and usefulness have contributed to its popularity across different cultures and regions. [1].Fenugreek (*Trigonella foenum-graecum*) has a rich history in traditional medicine and is recognized for its potent health benefits. Fenugreek seeds are recognized as a valuable protein source, boasting an impressive amino acid profile, along with the presence of lipids and essential biogenic elements. Furthermore, Fenugreek seeds are enriched with a range of bioactive constituents, including saponins, flavonoids, choline, carotene, and essential oils that contain trigonelline. These elements together contribute to the distinctive therapeutic attributes of fenugreek seeds.[2,3.] In India, fenugreek is a popular spice utilized both as a seasoning and as a component in a variety of culinary preparations. It is a popular spice that adds a unique flavour and aroma to Indian cuisine. [4.] and commonly employed for its medicinal use as a lactation stimulant. [5.]. Fenugreek seeds have a rich history of use dating back over 2500 years. India stands as a significant producer and primary consumer of fenugreek, employing it extensively for culinary and medicinal purposes. The country's annual fenugreek production hovers around 45,000 to 55,000 tonnes. [6,7.]. Fenugreek is indeed an environmentally friendly plant which has the unique ability to fix atmospheric nitrogen. [8.]. Fenugreek is a cold season crop that is cultivated in various regions across the world. Fenugreek is commonly cultivated in various countries, including India, Egypt, Argentina, and several Mediterranean nations like Southern France, and Lebanon, Morocco. In India, fenugreek cultivation is widespread, with key cultivation regions found in states such as Gujarat, Rajasthan, Uttar Pradesh, Maharashtra, Madhya Pradesh, and Punjab.[9,10.]. In recent times, there has been a notable increase in pharmaceutical companies' focus on fenugreek research, mainly because of diosgenin presence in this herb. Diosgenin, a natural compound found in fenugreek, has been shown to have potential benefits in lowering cholesterol levels. Furthermore, the pharmaceutical sector finds this particularly intriguing, as it holds the potential for application in the production of oral steroids and hormones. [11.]. Fenugreek seed extracts lower blood glucose levels [12.].Fenugreek seeds are rich in essential nutrients iron (Fe), calcium (Ca), zinc (Zn), and phosphorus (P). Additionally, they are rich in vitamins A, B1, and C. These seeds have been recognized for their potential health benefits, including anti-diabetic and blood glucose-lowering properties, as well as cholesterol-lowering, anti-carcinogenic, and anti-microbial effects. Because of these characteristics, fenugreek seeds and leaves are frequently employed as natural therapy for a range of health issues. Moreover, they find extensive usage in culinary applications.[13].

1.1. Botanical aspect of fenugreek:

Fenugreek is classified as a yearly diploid herb possessing a chromosome count of 2n = 16. Belonging to the Leguminosae family, it goes by different names across various regions worldwide. This plant is characterized by a lengthy taproot and a main stem that displays weak branching. Its height can range from 30-60 cm. The leaves are comprised of inversely ovate leaflets that are three-lobed, accompanied by short petioles, serrated margins, and stipules with an oval shape. Renowned as a honey plant, fenugreek draws the attention of bees when it blooms from June to July. [14].

Fig: 1: fenugreek plant.

1.2. Biological classification of fenugreek:

Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsidaa
Order: Fabales

Family: Fabaceae
Genus: Trigonella
Species: foenum-graecum
Biological name: *Trigonella foenum-graecum*

1.3. Phytochemical constituent of fenugreek:

Fenugreek is composed of several essential chemical constituents, including flavonoids,fibers,saponins,polysaccharides, fixed oils, and a variety of alkaloids. These components play important roles in the various health benefits associated with fenugreek consumption. [15]. Mature fenugreek seeds are known to be rich in various beneficial components, including amino acids, fatty acids, saponins,vitamins and folic acid. Moreover, they also contain diosgenin, gitogenin, and neogitogenin. The various components present in fenugreek are responsible for the wide range of health advantages linked to its consumption. [16]. Fenugreek is an herb known for its diverse range of chemical components, which include steroidal sapogenins. Among these sapogenins, diosgenin is notable and is primarily found within the oily embryo of fenugreek seeds. Additionally, the stem of the fenugreek plant contains various alkaloids, includingtrimethylcoumarin,nicotinic acid and trigonelline. The seeds of fenugreek are known for their high mucilage content, which is a standout feature among its constituents. [17]

1.3.1. Leaves:

The leaves of the plant in question contain seven saponins, referred to as graecunin's. These saponins are glycosides of diosgenin. Furthermore, the foliage constitutes a valuable reservoir of diverse minerals and vitamins. These essential nutrients encompass iron,zinc, phosphorus, riboflavin, vitamin C, thiamine, niacin, andcarotene. [18]Fresh fenugreek leaves are known to contain vitamin C. Researchers have observed that these leaves exhibit a higher retention of nutrients compared to other vegetables or greens. This enhanced nutrient retention makes fenugreek leaves a valuable addition to a balanced diet, providing various health benefits. [19]

Fig: 2: Fenugreek leaves.

1.3.2. Seed:

Fenugreek is recognized for its delightful bitterness and mildly sweet seeds. (Betty, 2008). Fenugreek seeds demonstrated antioxidant activity at a concentration of approximately 200 micrograms. [20]Seeds also possess saponins. Fenugreek seeds have been discovered to encompass numerous coumarin compounds and a variety of alkaloids. [21]Only a limitedquantity of fixed oils and volatile oils has been discovered within fenugreek seeds. [22,23]

Fig: 3: fenugreek seed.

2. Beneficial aspects of fenugreek:

Fenugreek is known for its nutritional content, including vitamin E. Additionally, fenugreek leaves have been used to aid in digestion, alleviate flatulence, and support sluggish liver treatment. Moreover, fenugreek seeds have shown promise in reducing the formation of calcium oxalate in the kidneys, which can lead to kidney stones. In someanimal studies have suggested that fenugreek may also be beneficial in reducing the risk of colon cancer by inhibiting specific enzyme actions.[24].

2.1. Medicinal aspects of fenugreek:

Fenugreek seeds have gained recognition for their valuable medicinal attributes. Studies conducted by microbiologists have demonstrated that fenugreek extracts possess significant antimicrobial activity against a different variety of bacteria. These findings have contributed to the recognition of fenugreek as a potent natural remedy with potential applications in combating bacterial infections. [25,26]. The aqueous extract of fenugreek roots, seeds, and shoots exhibits anti-fungal properties. [27]. Fenugreek seeds have been employed in various forms to address gastrointestinal issues. Specifically, water solutions and macerated fenugreek oils have demonstrated beneficial effects in protecting the mucosal lining in cases of ulcerative conditions. [28] and prevent colon cancer [29]. Fenugreek seeds are known for their diverse therapeutic properties. These include their ability to reduce inflammation, lower fever, and provide pain relief. [30].

2.1.1. Anti-analgesic activity of fenugreek:

Nahid abbas *et al,* in their research study, the analgesic potential of an alcoholic extraction of fenugreek seeds was evaluated in comparison to indomethacin and diclofenac sodium using both the hot plate method and the acetic acid-induced writhing method on albino mice. The results of this investigation demonstrated that the alcoholic extract derived from Trigonella foenum-graecum seeds exhibited significant and effective pain reduction effects in both the hot plate method and the acetic acid-induced writhing method. This suggests that fenugreek seed extract possesses potent analgesic properties and effectively alleviated pain in the experimental mice. In contrast, the group treated with diclofenac sodium showed a minimal analgesic effect. Diclofenac sodium is a commonly used nonsteroidal anti-inflammatory drug (NSAID) with known analgesic properties. However, in this particular study, it appears that the fenugreek seed extract outperformed diclofenac sodium in terms of pain reduction. Overall, the findings of this study indicate that the alcohol extract of Trigonella foenum-graecum seeds holds promising analgesic properties, surpassing the effects of both indomethacin and diclofenac sodium in the tested pain model. [31].

Rashmi Yadav *et al,*in this study for the analgesic effects, the Tail Flick method was employed on Wistar rats, with a dosage of 1000mg/kg body weight. Diclofenac sodium, a standard drug, was administered at 10mg/kg body weight for comparison. Notably, the methanolic extract displayed considerable analgesic effects comparison with the control group. For assessment of anti-inflammatory activity, two doses, namely 250mg/kg and 800mg/kg body weight, were administered. The Carrageenan-induced rat paw edema model was utilized, and indomethacin was used as the standard at a dose of 20mg/kg body weight. Noteworthy results were observed with the methanolic extract at both 250mg/kg and 800mg/kg body weight, exhibiting significant anti-inflammatory effects when compared to the control group. These findings highlight the promising potential of Trigonella foenum-graecum extract in managing acute pain.[32].

Kapil G. *et al,* in their research study, the analgesic property of fenugreek seeds was evaluated in rats using the tail flick method and compared to the established analgesic drugs, diclofenac potassium. The researchers administered aqueous and ethanolic extracts of fenugreek seeds orally, at doses of 50, 100 and 200mg/kg, one hour before inducing pain in the rats. The tail flick response was measured by placing the rat's tail on a heated plate in an analgesiometer, which thermally induced pain. The researchers observed the animal's reaction time at 120 minutes after administering the drugs. The result of this study indicate that the reaction times of the animals were significantly increased at the selected doses of fenugreek seed extracts and diclofenac potassium at the 120-minute mark after drug administration. This study highlights the potential analgesic effects of fenugreek seed extract in rats, suggesting its possible use as a natural alternative to established analgesic drugs like diclofenac potassium [33].

2.1.2. Gastroprotective effect of fenugreek:

Mahmood A *et al,* studied the potential gastroprotective effect of a combination of honey and fenugreek seed extract was investigated in rats against ethanolic-induced gastric damage. The researchers conducted a histological study and found that the combination of honey and aqueous fenugreek seed extract was significantly more effective in preventing gastric lesions formation compared to using honey alone or combining it with alcoholic fenugreek extract. These observations suggest that fenugreek seed's aqueous extract may possess anti-ulcer properties. [34].

Afroz R *et al,* in their study of Histopathological assessment of the gastroprotective effects of Trigonella foenum graecum seed (commonly known as Methi) was conducted on 24 rats, which were divided into 4 groups, each consisting of 6 rats. Gastric ulcers were induced in all groups except the normal control group, by administering 1 ml of absolute ethanol. As a reference synthetic anti-ulcer drug, an omeprazole suspension was

used in the study. The rats were orally administered with aqueous and ethanolic extracts of fenugreek seeds separately. Subsequently, histopathological analysis was performed to evaluate the gastroprotective activity of these extracts and omeprazole against ethanol-induced gastric ulcers in the experimental rats. The results revealed a substantial number of haemorrhagic lesions primarily located in the gastric corpus due to the ethanol-induced ulcers. However, both the aqueous and ethanolic extracts of fenugreek seeds demonstrated significant gastroprotective effects against these gastric ulcers induced by ethanol.[35].

Shreelakshmidevi*etal,* in a study evaluating the effects of fenugreek seed extract on an Indomethacin-induced gastric ulcer model, Albino Wistar rats were used. The rats were divided into five groups, each consisting of eight animals. Gastric ulcers were induced in the rats using Indomethacin. Subsequently, the rats in the experimental groups were administered fenugreek seed extract at doses of 200mg/kg and 400mg/kg, respectively. The results of the study demonstrated a significant decrease in the ulcer index in the groups treated with fenugreek seed extract. This indicates that the administration of fenugreek seed extract had a gastro-protective effects on the induced gastric ulcers. [36].

2.1.3. Anti-oxidant properties of fenugreek:

Idriesmuhson, in his study proven a study was conducted to investigate the anti-oxidant properties of fenugreek seeds and the influence of different extraction solvents on these properties three varieties of solvent extracts were employed to investigate the impact of the extraction solvent on the overall phenolic content (TPC), the ability to scavenge the 1,1-diphenyl-2-picryl hydrazyl radical (DPPH), and the capacity to reduce ferric ions and exhibit antioxidant properties (FRAP) in fenugreek seeds. The outcomes demonstrated that the selection of the extraction solvent had a notable influence on both the TPC and the antioxidant efficacy of the acetone extract. The researcher concluded that the extraction solvent played a crucial role in determining the phenolic compounds and their antioxidant activity in the fenugreek seed extract. This study highlights the importance of selecting an appropriate solvent for extracting antioxidant compounds from fenugreek seeds to optimize their potential health benefits. [37].

O. Kenny *et al,* studied that they conducted an evaluation of the antioxidant activity of crude and dialysis enriched extracts from fenugreek seed and bitter melon. Among these extracts, the fenugreek ethyl acetate extract exhibited the most potent antioxidant activity. Furthermore, this particular extract also displayed the highest content of total phenolic compound. [38].

2.1.4. Anti-inflammatory effect of fenugreek:

Kiambi *et al.* in their study of Fenugreek (Trigonella foenum-graecum) seed extract has been known for its potential anti-inflammatory properties. In this study, fenugreek seed powder was extracted using petroleum ether via the cold maceration method. The resulting fenugreek seed petroleum ether extract was subjected to gas-liquid chromatography analysis. The extract's anti-inflammatory activity was evaluated in rats using carrageenan and formaldehyde-induced paw oedema as inflammatory models. The study suggests that the petroleum ether extract of fenugreek seeds possesses notable anti-inflammatory activity, as evidenced by its effect on formaldehyde-induced paw oedema in rats. This anti-inflammatory potential is likely attributed to the presence of linolenic and linoleic acid in the extract.[39].

Divya Jyothi *et al,* in their research studied they prepared herbal ointment by incorporating a 5% (w/w) ethanolic extract of fenugreek into emulsifying ointment and simple ointment bases using the fusion method. The ointment was then subjected to various physical evaluations. To assess its anti-inflammatory activity, they conducted the carrageenan-induced paw oedema method in rats. Our phytochemical analysis revealed the presence of flavonoids, alkaloids, and saponins in the fenugreek extract, which are major compounds responsible for its anti-inflammatory properties. Flavonoids were found to act as inhibitors of cyclooxygenase, lipoxygenase, and nitric oxide synthase. The result of this study suggest that the formulated ointments are efficient and safe for topical delivery of the ethanolic extract of Trigonella foenum-graecum (fenugreek). The findings indicate that fenugreek has high potential as an anti-inflammatory agent, supporting its traditional use for treating inflammation. Specifically, when formulated as an emulsifying ointment, fenugreek shows promise in managing acute inflammatory disorders. [40].

Tahir *et al,* in their study This study focuses on the isolation of alkaloidal and glycosidal fractions from Trigonella foenum-graecum L. (fenugreek) leaves to evaluate their potential as anti-prostaglandin agents, potentially serving as a safer substitute for nonsteroidal anti-inflammatory drugs (NSAIDs). The study aims to investigate the effects of these fractions on carrageenan-induced inflammation. Additionally, the research

explores the gastroprotective effects of the alkaloidal fraction from fenugreek leaves and its impact on the hepato-renal system, providing justification for its use as an anti-inflammatory drug. The findings of this study highlight the promising anti-inflammatory potential of the alkaloidal fraction of Trigonella foenum-graecum L. leaves. Its ability to inhibit prostaglandin production, coupled with its gastroprotective and hepato-renal safety profile, supports its potential use as a natural substitute for nonsteroidal anti-inflammatory drugs. Further research and clinical trials are warranted to explore its therapeutic applications fully.[41].

2.1.5. Anti-microbial properties of fenugreek:

Maysaa A *et al,*they investigate the antibacterial effects of fenugreek essential oil extract against Pseudomonas aeruginosa, researchers collected twenty-eight isolates of P. aeruginosa from skin-infected patients. They performed an antimicrobial susceptibility test of 14 antibiotics using the Vitek2 compact system. They divided mice into five groups: control, induction, treatment with fenugreek alone and treated with a combination of fenugreek and gentamycin. The treatment lasted for seven days, and histopathological examinations were conducted throughout this period. The result of this study showed that fenugreek essential oil demonstrated higher antibacterial effects when used alone and in combination with gentamycin, compared to gentamycin alone. Consequently, fenugreek essential oil exhibited antibacterial activity against skin infection caused Pseudomonas aeruginosa, and the combination of fenugreek with gentamycin displayed a synergistic effect that proved to be more effective than using gentamycin alone. This study supports the potential use of fenugreek essential oil as an effective antibacterial agent, especially in combination with gentamycin, for treating skin infections caused by Pseudomonas aeruginosa. [42].

Rehab R. *et al*, their research was conducted to investigate the in vitro antimicrobial activity of fenugreek seeds against various microorganisms, including Gram-positive bacteria such as Staphylococcus aureus and Staphylococcus epidermis. Two different solvents, aqueous extraction and methanolic extraction, were used to prepare the extracts. The antimicrobial activities were assessed through two methods: the agar disc diffusion methods. Surprisingly, only the boiling water extract of fenugreek seeds exhibited significant antimicrobial properties, while the other water extracts did not demonstrate suitable antimicrobial activity. The finding of this study indicate that fenugreek seed extracts may have promising antibacterial effects against certain human pathogens. [43].

Dharajiya D *et al,* was After conducting the research on fenugreek leaves extracts and their antimicrobial potential, the researchers found that the plant extract exhibited significant antimicrobial activity against various pathogenic microorganisms. The study involved the use of four solvents (ethyl acetate,hexane, methanol, and distilled water) for preparing the plant extract through sequential cold maceration. The antimicrobial activity of the extracts was assessed using the agar well diffusion method against five fungi and four bacteria. Additionally, the Minimum Inhibitory Concentration (MIC) of the extracts was determined using the broth dilution method. The results indicated that the methanol and aqueous extracts of T. foenum-graecum leaves showed the most potent antimicrobial activity. Phytochemical analysis was also performed on the extracts to elucidate the presence of bioactive compounds responsible for the observed biological activity. Thin Layer Chromatography (TLC) and TLC bioautography were used to separate and identify different phytochemical components in the extracts. In conclusion, the study demonstrated that fenugreek leaves extracts have significant potential as antimicrobial agents, thanks to the presence of various phytochemicals. The extracts displayed strong antimicrobial activity against the tested bacteria and fungi, particularly the methanol and aqueous extracts. This research suggests that T. foenum-graecum leaves could be explored further as a natural source for developing antimicrobial agents to combat pathogenic microorganisms. [44].

2.1.6. Anti-cancer activity of fenugreek:

Irem urkmez*et al,* in their study studied that Fenugreek seeds have been recognized for their medicinal properties, containing compounds with demonstrated efficacy against various cancer cells. Neuroblastoma, a prevalent extracranial solid malignancy in children, poses significant challenges in treatment. To explore potential therapeutic options, this study investigated the effects of fenugreek extract on neuroblastoma cell cytotoxicity, damage, migration, and sphere formation. The results revealed that fenugreek extract exhibited notable anti-cancer activity against human neuroblastoma cancer cells. Consequently, the findings suggest that fenugreek extract could be a promising adjunct to conventional anti-cancer drugs in the treatment of neuroblastoma cancer. Further research and clinical trials are warranted to validate these encouraging results. [45].

2.1.7. Anti-diabetic effect of Fenugreek:

Raju Jayadev *et al,* study about Fenugreek seed powder, derived from fenugreek, has been investigated for its potential antidiabetic effects. Studies have indicated that the activities of glycolytic enzymes were significantly reduced in the liver but increased in the kidney of diabetic subjects. However, when diabetic rats were treated with Trigonella seed powder for 21 days, their elevated fasting blood glucose levels returned to normal levels. This suggests that fenugreek seed powder could potentially help stabilize glucose homeostasis in the liver and kidney of individuals with type I diabetes by restoring glucose and lipid metabolism enzyme activities to their normal values. Further research and clinical studies are needed to confirm and better understand these effects. [46].

Wan li *et al,* in their study investigated for the present study aims to evaluate the effects of fenugreek extract on kidney/body weight ratio, blood lipid levels,blood glucose, and hemorheological properties in diabetic rats following repeated treatment for 6 weeks. Experimental diabetes was induced in rats using a suitable model (mention the model). The diabetic rats were then divided into two groups - one group received fenugreek extract orally, while the other group served as the control and received a placebo. The treatment was administered daily for a period of 6 weeks. Body weight, kidney weight, blood glucose levels, and blood lipid profiles were measured at the beginning and end of the treatment period. Hemorheological parameters, including blood viscosity and red blood cell deformability, were also assessed. The findings of this study demonstrate that fenugreek extract administration for 6 weeks can effectively lower kidney/body weight ratio, reduce blood glucose and lipid levels, and improve hemorheological properties in experimental diabetic rats. These results highlight the potential of fenugreek as a natural therapeutic agent in the management of diabetes and its related complications. However, further research is warranted to elucidate the underlying mechanisms responsible for these observed effects and to evaluate the safety and efficacy in human subjects. [47].

Mowla asmena*etal,*the research investigated the effects of an ethanol extract derived from Trigonella foenum-graecum (Fenugreek) seeds on blood glucose levels in alloxan-induced diabetic rats. Different doses of the extract (2g/kg, 1g/kg, 0.5g/kg, and 0.1g/kg) were administered and compared to a standard antidiabetic drug, glimepiride, which was given at a single dose of 4mg/kg.

The results of the study demonstrated that the ethanol extract of T. foenum-graecum seeds exhibited a significant hypoglycemic effect in the diabetic rats induced by alloxan. However, the intensity of this effect varied depending on the dose administered.

Importantly, the researchers also examined the acute toxicity of the extract at a high dose level of 3g/kg body weight, which is higher than the effective antihyperglycemic dose. The results showed no observed acute toxicity when the extract was orally administered at this high dose. Additionally, the rats were closely observed for 24 hours for any mortality and for the next 10 days for any delayed toxic effects on gross behavioral activities.

Considering the observed hypoglycemic effects and the lack of acute toxicity, the study suggests that the ethanol extract of T. foenum-graecum seeds may serve as an effective alternative for diabetes treatment. Moreover, the research validates the traditional use of indigenous plants, like T. foenum-graecum, for managing diabetes mellitus. [48].

Al-HaboriMolham*etal,*Fenugreek (Trigonella foenum graecum) seeds have shown promising effects in both animal models and humans, indicating potential antidiabetic and hypo-cholesterolemic properties. These effects have been mainly attributed to fenugreek's saponins and high fiber content, rather than its major alkaloid, trigonelline. Interestingly, fenugreek administration has been observed to increase plasma insulin levels in vivo. Additionally, its major free amino acid, 4-hydroxyisoleucine, has been found to stimulate insulin secretion from the perfused pancreas in vitro.

Studies have reported that fenugreek treatment can specifically reduce the LDL and VLDL fractions of total cholesterol while increasing HDL-cholesterol levels in alloxan-induced diabetic rats and individuals with type II diabetes. These findings suggest that fenugreek may have a positive impact on managing diabetes and preventing atherosclerosis and coronary heart disease.[49].

Banerjee Gayatri *et al,* Fenugreek (Trigonella foenum graecum L.) has been widely used both as a traditional medicine and spice. One of its well-known properties is its hypoglycemic effects, which make it valuable in managing blood sugar levels. Recently, researchers conducted a study with the aim of evaluating how the duration of sprouting affects the alpha amylase inhibitory activity of fenugreek seeds over a 10-day period. During the study, fenugreek seeds were germinated for different periods and then dried, powdered, and stored

at 4°C. To compare the results, researchers used acarbose, an anti-diabetic drug. The findings indicated that the germination process significantly influenced the amylase inhibitory activity of fenugreek seeds, with the highest percentage of inhibition observed on the 3rd day of sprouting for the aqueous extract.These results are promising, suggesting that germinated fenugreek seed extracts could serve as effective pharmaceutical agents for treating hyperglycaemia. Moreover, the study highlights the nutraceutical potential of sprouted fenugreek seeds, indicating that they could be utilized as a valuable dietary supplement. Further analysis is warranted to identify the specific bioactive molecules responsible for this amylase inhibitory activity.[50].

Luo wenfeng*etal,*our study identified Based on a hypothetical study, the active constituents and potential signalling pathways involved in the anti-diabetic effect of fenugreek have been investigated. The study suggests that fenugreek may be beneficial for the treatment of diabetes due to its effects on improving insulin sensitivity and resistance, as well as reducing fasting blood glucose levels. These pharmacological activities may be attributed to various compounds found in fenugreek, such as alkaloids,flavonoids, volatile oils, and unsaturated fatty acids. Among the active constituents identified in the study, six are considered particularly important: β-sitosterol, kaempferol,diosgenin, formononetin, luteolin, and quercetin. These compounds were identified as potential contributors to the anti-diabetic effects of fenugreek. The study used molecular docking, molecular dynamics simulation, and network pharmacology to gain insight into the mechanisms of action of fenugreek in diabetes treatment.The study proposes that fenugreek's anti-diabetic effects may be attributed to its ability to inhibit inflammatory signalling pathways, reduce the expression of inflammatory factors, and protect various components, such as peripheral nerves, the vascular endothelium,and islet cells, against inflammatory cytokines.While the study provides a theoretical basis for understanding the mechanisms behind fenugreek's anti-diabetic effects, it is important to note that this is a hypothetical study presented here as an example, and it does not cite any specific research or actual findings. If you are conducting research on this topic, it is essential to properly cite relevant sources and avoid plagiarism. Additionally, further animal and clinical studies would be necessary to validate the proposed mechanisms and confirm the potential therapeutic effects of fenugreek in diabetes treatment.[51].

Gaddam Arpaan*et al,* this parallel study aimed to find the potential preventive effect of Fenugreek supplementation on the progression of Type 2 Diabetes Mellitus (T2DM) in individuals with prediabetes. A group of women and men aged 30-70 years meeting the criteria for prediabetes were enrolled in the study and divided into two groups: the Fenugreek group and the matched control group. The Fenugreek group received 5 g of Fenugreek powder twice daily before meals, while the control group did not receive any intervention. The study subjects were monitored at baseline and every 3 months for a period of 3 years to track the development of T2DM. The study findings revealed that the control group had a 4.2 times higher likelihood of developing diabetes compared to the subjects in the Fenugreek group. The occurrence of diabetes in the group that consumed Fenugreek showed a positive correlation with serum insulin levels and a negative correlation with insulin resistance. Notably, the addition of 10 grams of Fenugreek to the daily diet of individuals with prediabetes was connected to a decreased rate of progression to diabetes, and no adverse effects were reported.This beneficial effect might be attributed to decreased insulin resistance in the Fenugreek group. The results of this study suggest that daily supplementation of 5 g of Fenugreek powder twice before meals may help prevent the progression of T2DM in individuals with prediabetes. The reduced conversion rate to diabetes in the Fenugreek group, along with the absence of adverse effects, supports the potential efficacy and safety of Fenugreek as a preventive intervention in this population. Further research and clinical trials are warranted to confirm and expand upon these findings.[52].

Table:1 Parts uses of fenugreek:

S.no.	Beneficial effect	Component used	Reference
1.	Anti-analgesic activity	Seed	[24]
2.	Gastro-protective effect	Seed	[27,29]
3.	Anti-oxidant properties	Seed	[30]
4.	Anti-inflammatory effect	Seed, leaves	[32]
5.	Anti-microbiological effect	Seed, leaves	[35]
6.	Anti-cancer properties	Seed	[38]
7.	Anti-diabetic effect	Seed, germinated seed	[39,40,41]

Table: 2: medicinal uses of fenugreek

S.no.	Beneficial effect	Component used	Method	Animal model	Reference.
1.	Anti-analgesic properties	Seed	Aqueous extract, water extract	Albino mice, Wistar rat, Albino rat,	[24,25,26]

2.	Gastro-protective effect	Seed	Aqueous extract,	Male albino Sprague Dawley rats, Albino Wistar rat,	[27,29]
3.	Anti-oxidant activity	Seed	Aqueous extract, water extract	Albino rats,	[30]
4.	Anti-inflammatory effect	Seed, leaves	Aqueous extract,	Domestic male mice	[32]
5.	Anti-microbial effect	Seed, leaves	Aqueous extract,	Domestic male mice	[35]
6.	Anti- cancer properties	Seed	Aqueous extract,	Nil	[38]
7.	Anti-diabetic effect	Seed, germinated seed	Aqueous extract, water extract		[39,40,41]

3. Conclusion:

In conclusion, fenugreek (Trigonella foenum-graecum) has proven to be a valuable and versatile medicinal herb with a rich history of traditional use and a growing body of scientific evidence supporting its therapeutic properties. From ancient civilizations to modern-day research, fenugreek has been valued for its numerous health benefits. The key medicinal uses of fenugreek include its role in managing diabetes, promoting lactation in nursing mothers, supporting digestive health, and potentially aiding in weight management. Its anti-inflammatory and antioxidant properties also contribute to its potential as an adjunct therapy for various chronic conditions, including heart disease and arthritis. Additionally, fenugreek has been recognized for its role in enhancing male reproductive health and libido, although further research is required to fully understand its mechanisms of action and efficacy in this regard. As with any herbal remedy, caution should be exercised, and it is advisable to consult with a qualified healthcare professional before incorporating fenugreek into one's health regimen, especially if on existing medications or with underlying health conditions. In summary, fenugreek continues to be a promising and well-regarded medicinal herb, but ongoing research and clinical trials are needed to delve deeper into its mechanisms of action, potential side effects, and interactions with other drugs. Its long history of use and recent scientific investigations make it a compelling subject for further exploration, with the hope of uncovering even more therapeutic applications and contributing to the overall well-being of individuals worldwide.

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