

# FENUGREEK: A DETAILED OVERVIEW

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- **Abstract:**

Fenugreek, an ancient medicinal plant, is rich in fibre, phospholipids, glycosides, vitamins, and other functional elements. It's used as a spice, anti-diabetic, anticarcinogenic, hypocholesterolemic, antioxidant, and immunological agent. Fenugreek also serves as a food stabilizer, adhesive, and emulsifying agent. The paper discusses the nutraceutical properties, health benefits, disease management, nanotechnology application, galactogogues, and medicinal uses of Fenugreek, a plant used in developing nutritious extruded foods.

- **Keywords:**

Trigonella foenum-graecum, galactomannan, postprandial, antioxidant activity

- **Introduction:**

The self-pollinating annual dicotyledonous aromatic leguminous plant known as fenugreek (*Trigonella foenum-graecum*) is a member of the Fabaceae family, specifically the Papilionaceae sub-family (1–4). One of the first known and recorded medicinal herbs is fenugreek, which is thought to have originated in the Mediterranean or regions of Asia. Properties traditionally, dried seeds have been utilized in Egypt, China, India, and parts of Europe for their antibacterial, anti-inflammatory, galactogogue, insulinotropic, and restorative(5). The intrinsic dietary fiber component of fenugreek, which has promise nutraceutical value, is primarily responsible for these positive physiological effects, which include the anti-diabetic and hypocholesterolemia effects. The whole and powdered fenugreek seeds, which have a pleasant bitterness and a hint of sweetness, are used to flavor teas, spice blends, and carry powder. During the Greek era, it was also utilized to encourage labor before delivery (6). Chinese traditional medicine says that fenugreek can help with lymphedema, which is swelling in the legs (7). The seed have horny and relatively large layer of white and semi-transparent endosperm encircling central hard yellow embryo (8). It is referred to by a variety of names throughout the world, including "Methi" in India, "fenugrec/trigonelle" in France, "Alholva/Fenogreco" in Spain, "koroha" in Japan, and "fieno greco" in Italy(9). The many forms of fenugreek and other relevant details are given in (table 1). The Latin term "foenum-graecum" literally means "Greek hay." This suggests that it was once used as a fodder crop, and the Greek term "trigonella" means "little triangle." illustrating the flower's triangular form (10, 11). The fenugreek plant can grow up to 1-2 feet tall, with green trifoliolate leaves, white to yellow flowers, and pods that are typically 15 cm long and contain 10–20 seeds. The average height, width, and thickness of the golden yellow seeds are 4.01-4.19 mm, 2.35-2.60 mm, and 2.40-2.66 mm, respectively

(12). Fenugreek seeds contain about 175 different chemicals. Many religious texts, works of ancient literature, and travelogues have mentioned fenugreek's medicinal qualities. It is widely used as a food, medicine, herb, and spice all throughout the world. Fenugreek seeds have long been utilized in Chinese, Ayurvedic, and Unani medicine. Isoleucine, galactomannans, and steroidal saponins are the three main chemical ingredients that give fenugreek its nutritional benefit. Together, these three contribute to further health advantages. Fiber, saponins, gum, alkaloids, flavonoids, iron, and vitamins A, B, and C are all abundant in fenugreek seeds. Research has been done on the nutritional makeup of fenugreek seeds. The moisture content has been noted in a number of works. 7.5%–10.6%, 0.78%–1.5% for protein, 0.5%–1.6% for fat, 0.5%–1.5% for ash, and 73.6% for galactomannan (13, 14). Because of its many chemical components, which provide it antibacterial, antioxidant, antidiabetic, antihyperlipidemic, antiobesity, anticancer, anti-inflammatory, carminative, aphrodisiac, and emollient qualities, fenugreek is used to treat a variety of illnesses. In India, it's also utilized as a lactation aid.

**table 1:** fenugreek worldwide identification (15)

<b>Preferred scientific name</b>	Trigonella foenum-graecum
<b>Preferred common name</b>	Fenugreek
<b>International common name</b>	
English	Common fenugreek, goat`s horn, greek hayseed
French	Fenugrec
Spanish	fenugreco
Hindi	methi
porttuguese	Fenacho, fenogregq
<b>Local common Name</b>	
Germany	Bockshornklee, griechischer schabzigerklee
Indonesia	Kelabet, kla Kelabat bet
Italy	Fieno Greco
Malaysia	Halba
Myannar	Penantazi, venthiam
Maldives	venthiam
Netherlands	Fenegriek
Sweden	Bockhornskloever
<b>EPPO code</b>	TRKFG (Trigonella foenum-graecum)

▪ **chemical constituents of fenugreek(17):**

Sr. no	Class	Chemical constituents of fenugreek
1	Alkaloids	Trim ethylamine, Neurin, Trigonelline, Choilne, Gentisnine, Caepainw and Betain
2	Amino acids	Isoleucine, 4-Hydroxyisoleucine, Histidine,
3	Saponins	Graecunins, fenugrin B, fenugreekine, trigofenosides A-G
4	Steroids	Yamogenin, digosgenin, smilagenin,
5	Sapinogens	Sarsasapogenin, tigogenin, neotigogenin, gitogenin, neogitigenin, yuccagenin, saponaretin
6	Flavonoids	Quercetin, rutin, vitexin, isovetexin
7	Fibers	Gum, neutral detergent fiber
8	Lipids	Triacylglycerols, diacylglycerol, monoacylglycerols, Phosphatidylcholine, phosphatidylethanolamine, phosphatidylinositol, free fatty acids. (16)
9	Others	Coumarin, lipids, vitamins, minerals. 28% mucilage; 22% proteins; 5% of a stronger-swelling, bitter fixed oil.

### 1. Protein:

It was discovered that there is 43.8 g of protein in 100 g of endosperm. Nonetheless, 25.4 g of protein were present in 100 g of fenugreek seed (18). The main proteins and amino acids found in fenugreek seeds are listed in Table 1. A significant proportion of protein, between 20 and 30 % , particularly the amino acid 4-hydroxyisoleucine in fenugreek, has a strong potential for insulin-stimulating activity (19). The lysine-rich fenugreek protein fraction is comparable to soybean protein (20). Reduce the tension at the oil-water interface. Removing the associated proteins increases the molecular weight of fenugreek gum, and the more gum is present or the less protein is left connected, the higher the viscosity (21). The concentration of salt (NaCl) and pH levels have a significant impact on the emulsion and foaming properties of fenugreek proteins. At pH 4.5, the proteins' isoelectric point, neither the emulsion nor the foam qualities were strong. Additionally, they stated that the fenugreek protein concentrate had a high bulk density (0.66 g per ml), a high oil absorption capacity (1.56 ml oil per g protein), and a high water absorption capacity (1.68 ml H<sub>2</sub>O per g protein). Fenugreek seed protein was shown to be more soluble in alkaline 12 and acidic 4.5 environments than at almost neutral pH (22). It showed that heating had no effect on the quality of the proteins in fenugreek seeds (23).

### 2. Vitamins and minerals:

Despite having a relatively low mineral content, fenugreek does include some minerals in good amounts, such as phosphorus and sulfur (11). It has also been noted that fenugreek curry contains significant levels of calcium, iron, and zinc (7). An overview of the vitamins and minerals included in fenugreek seeds is given in Table 1. On the other hand, pyridoxine, cyanocobalamin, calcium pantothenate, biotin, and vitamin C are present in growing seeds (24). Fenugreek leaves contain 52 mg of vitamin C, 2.3 mg of  $\beta$ -carotene, 40  $\mu$ g of thiamine, 310  $\mu$ g of riboflavin, 800  $\mu$ g of nicotinic acid, and 0.1 mg of folic acid per 100 g. In contrast, the

contents for seeds were 43 mg, 96 µg, 340 µg, 290 µg, 1.1 mg, and 84 µg, respectively, as vegetables are boiled in water, steamed, or fried, they lose around 10.8 and 7.4% of their vitamin content, respectively. Additionally, as seeds germinate, they are exposed to  $\beta$ - and  $\gamma$ -radiation, which lowers their vitamin C concentration (12).

### 3. Fibers and gums:

Soluble dietary fiber is abundant in fenugreek seeds (25). By reducing the re-absorption of bile salts in the colon, the saponins, hemicelluloses, mucilage, tannins, and pectin found in 100 g of seeds—which supply almost 65% of the dietary requirements—help lower blood levels of low density lipoprotein-cholesterol (LDL). Fenugreek fiber has also been shown to bind to food toxins, protect the colon mucous membrane from cancer-causing toxins, and slow down the pace at which glucose is absorbed in the intestines, so regulating blood sugar levels. Additionally, the fibers may have prebiotic effects by modulating the gut flora, which will benefit the host's health (26). Galactomannan, one of the main soluble fibers found in fenugreek seeds, inhibits the intestinal absorption of bile salts and also slows down the body's digestion and absorption of starch (27, 28). According to reports, fenugreek husk is an exceptional source of phenolic acids and dietary fiber, which may make it a useful source of natural antioxidants and ingredients for functional foods (29). Galactomannan (Figure 2), which is isolated from the seeds' endosperm, is the primary ingredient in seed albumen. Galactomannans are heterogeneous polysaccharides made up of a single D-galactose branch connected by  $\alpha$ -(1→6) and a  $\beta$ -(1→4)-D-mannan backbone. Their mannose/galactose (M/G) ratio distinguishes them from one another (30). One characteristic of galactomannan is that it increases viscosity. These qualities, when dissolved in water, make it a great addition to a variety of dishes. Use in comparison to other natural hydrocolloids (31). Galactomannan from fenugreek can be used to stabilize meals. Reduction of surface and interfacial tension Fenugreek gum's properties are similar to those of Arabic gum. Even at lower concentrations than guar gum (42 and 55 mN/m, respectively), galactomannan in fenugreek can reduce surface tension. Fenugreek gum has the ability to stabilize oil-in-water emulsions and provide crucial gum/oil coverage. It was implied that the ratio for stable non-coalesced emulsion was lower than that for guar or other gum. It has better emulsification qualities than other galactomannans. Fenugreek gum can form oil-in-water emulsions with small droplet sizes (2–3 µm) and long-term stability because it has better interfacial activity than other galactomannans. On the oil interface, fenugreek gum was observed to adsorb (or "precipitate"), creating a comparatively thick interfacial coating (32). Fenugreek galactomannans' uniform structure helps them retain more of their crystal nature after they dry, particularly when the ratio of galactose to mannose is 0.93. Due to its higher galactose concentration, fenugreek gum is more soluble in water than other gum varieties, such as guar gum (33). According to some reports, pure fenugreek with 0.8% protein left behind can lower surface tension and create stable emulsions with tiny oil droplets (2–3 µm). A remarkably stable oil/water emulsion was produced when crude fenugreek gum (13.9% protein) was compared to 14 different hydrocolloid gums in a model system (34).

### 4. Alkaloid, flavonoids and saponin:

There are many alkaloids, flavonoids, and saponins in fenugreek, with the latter having the largest concentration (35-37). The two main components of fenugreek seeds that contribute to their bitter taste and unpleasant odor are their volatile and alkaloid contents (38). More than 100 milligrams of flavonoids are present in one gram of fenugreek (5). Table 1, the primary alkaloids, flavonoids, and saponins are displayed (39-42). Using HPLC–DAD–ESI/MS, examined the phenolic components in Moroccan fenugreek crude seeds. Using apigenin, luteolin, and kaempferol as aglycons, the majority of the compounds found were acylated and non-acylated flavonoids. Apigenin was the primary aglycon in the phenolic content of the examined crude fenugreek seeds, which was primarily composed of acylated and non-acylated flavone derivatives, according to the quantitative analysis of the detected compounds (43). Pharmacological effects were demonstrated by fenugreek's alkaloids, flavonoids, and saponins. They contain cholagogic,

hypoglycemic, and antilipidemic qualities. Clinical evidence suggests that they can lower serum cholesterol levels, which may help control hypercholesterolemia and diabetic mellitus. In addition to its beneficial qualities, it should be used with caution to prevent allergic reactions and mild gastrointestinal complaints (44).

## 5. Volatile compounds:

There are trace amounts of volatile oils in fenugreek (45). Found that the volatile oil of fenugreek seeds included 39 distinct chemicals, including n-alkanes, sesquiterpenes, and several oxygenated compounds. N-hexanol, hexanoic acid, pentadecane,  $\alpha$ -muurolene, dihydroactinoliolide, dihydroben-Zofuran, and tetradecane are the principal constituents. The main component of the aroma is sotolon (3-hydroxy-4, 5-Dimethyl-2(5H)-furanone), a hemiterpenoid- $\gamma$ -lactone that can be found in concentrations as high as 25 ppm (46). Found a few odorous chemicals in fenugreek seeds, which are indicated in Table 1 (47).

- **Nutraceutical properties of fenugreek:**

### 1. Hypoglycemic effect:

After a meal, dietary fiber from fenugreek reduces blood glucose levels. It is yet unclear how these effects work. The gum in fenugreek seeds is made up of galactose and mannose, and the seeds themselves contain 45.4% dietary fiber (32% insoluble and 13.3% soluble). The latter substances have a lower glycemic impact. People and animals with type 1 and type 2 diabetes mellitus have particularly been shown to benefit from fenugreek's hypoglycemic effects (48). Alloxan-induced sub-diabetic and overtly diabetic rabbits of varying severity were used to study the mechanism of action of an oral active hypoglycemic component that was derived from fenugreek seed water extract. The subdiabetic and mildly diabetic rabbits (five in each group) were given the active ingredient orally for 15 days at a dose of 50 mg per kg body weight. The results demonstrated a considerable improvement in the glucose-induced insulin response and a significant reduction of the glucose tolerance curve. The findings showed that the hypoglycemic impact might be achieved by inducing beta pancreatic cells to produce and/or secrete more insulin. When the same dose of the active principle was given to the severely diabetic rabbits for 30 days, the fasting blood glucose level was significantly lowered, but the fasting serum insulin level was only slightly raised. This suggests that the active principle acts extra-pancreatically. It could also have the effect of making tissues more sensitive to the available insulin. There was no chance of experiencing severe hypoglycemia, and the hypoglycemic effect was noted to be gradual yet persistent (49). A study examined the effects of a therapeutic diet containing fenugreek on the blood sugar levels of 24 patients with non-insulin-dependent diabetes mellitus. Legumes such as bengal gram, green gram, horse gram, dry peas, and fenugreek seeds were used to create a particular kind of medicinal diet. After consuming 30 g of the product for almost a month, it was discovered that there was a considerable decrease in both fasting and postprandial blood sugar levels. Thus, the benefits of a high-fiber fenugreek diet for diabetes treatment were determined (50). In experimental rats with diabetes, the effects of fenugreek extract on blood glucose, hemorrhageological markers, and general characteristics have been studied. Oral intragastric intubation was used to administer fenugreek extract at low, intermediate, and high doses, as well as metformin HCl, to the streptozotocin-induced rats (with diabetics) individually for six weeks. When compared to the diabetic group, rats given fenugreek extract had a higher body weight and a lower kidney/body weight ratio. Rats given fenugreek extract showed dose-dependent reductions in glycated hemoglobin and blood glucose levels as compared to the diabetic group. After six weeks of repeated therapy, it can be determined that fenugreek extract can improve hemorheological characteristics and lower blood glucose and the kidney/body weight ratio in experimental diabetic rats (51). The antidiabetic effect of fenugreek seeds may be due to their soluble fiber fraction, which is high in galactomannan. The hypoglycemic effects of fenugreek seeds on dogs were assessed in an animal investigation. The defatted seeds decreased somatostatin, plasma glucagon, and blood glucose levels; they also decreased hyperglycemia brought on by

carbohydrates. In a short investigation of patients with mild type-2 diabetes mellitus, clinical analysis revealed improved glucose control. Fenugreek users showed improved insulin sensitivity and decreased levels of glycosylated haemoglobin (52). Because it contains saponins that are converted to saponinins in the gastrointestinal tract, fenugreek may have a lipid-lowering effect. 25% of fenugreek seeds are made of fiber, which can reduce the pace at which glucose is absorbed after meals. Its hypoglycemic impact could have this as a secondary mechanism (53).

## 2. Antioxidant activity:

Chronic degenerative diseases result from the overproduction of reactive oxygen species, which oxidatively damages proteins and lipids. Fenugreek has been proposed as a possible antioxidant in a number of research (54). By measuring the degree of lipid peroxidation and the presence of antioxidants in the mice's bladder, fenugreek's protective effects against lipid peroxidation and enzymatic antioxidants were demonstrated in cyclophosphamide-treated mice (55). Fenugreek is a strong antioxidant since it contains a lot of vital elements. Fenugreek seed supplementation raised glutathione and beta-carotene levels, lowered alpha-tocopherol levels, and reduced lipid peroxidation. This study demonstrates that dietary fenugreek seed supplementation can correct defective free radical metabolism (56). According to a study, fenugreek had the strongest superoxide and radical scavenging effect, and the high phenolic content of fenugreek was linked to its antioxidant activity (57). Fenugreek seed extract has the ability to scavenge radicals when combined with methanol, ethanol, dichloromethane, acetone, hexane, and ethyl acetate (58). Fenugreek has a protective effect on lipid peroxidation and enzymatic antioxidants (59). The highest levels of protein and saponin were found in the proximate composition of fenugreek seeds, husk, and cotyledons. Husk, on the other hand, contained more polyphenols overall. Fenugreek seed, husk, and endosperm extracts demonstrated 72%, 64%, and 56% antioxidant capabilities by free-radical scavenging activity at a 200 µg concentration, respectively (60). According to the study, the process viability of separating fenugreek seeds into husk and endosperm may be improved by first selectively fractionating the bioactive components for successful isolation. Investigated how fenugreek seeds prevented rats from developing kidney stones. Those with calcic urolithiasis may benefit from fenugreek therapy (61). Fenugreek has anti-inflammatory properties. The highest phenolic concentration was found in *Aegle marmelos*, followed by fenugreek and *Coriander sativum* (62). Similarly, fenugreek had the highest flavonoid content, followed by *Coriander sativum* and *A. marmelos*. Using H<sub>2</sub>O<sub>2</sub> scavenging, NBT test, and reducing power, antioxidant properties were examined. *A. marmelos* exhibited the strongest reducing power, followed by *C. sativum* and fenugreek. However, fenugreek demonstrated the most superoxide and free radical scavenging, followed by *C. sativum* and *A. marmelos*, respectively (63).

## 3. Anticancer effect:

After cardiovascular disease, cancer is the second biggest cause of death worldwide and is quickly rising to prominence as one of the major diseases. Traditional cancer treatments have serious side effects and only prolong a patient's life by a few months or years. The active ingredients in fruits and vegetables are recommended for the treatment of cancer, and they also function as an alternative therapy. There are numerous plant-based anti-cancer medications on the market, including vinca alkaloids (vinblastine and vincristine), taxanes (paclitaxel and docetaxel), and derivatives of camptothecin (camptothecin and camptothecins). According to reports, incorporating fenugreek seed powder into one's diet can lower the incidence of colon cancer (64). The development of MCF-7 cells was inhibited by fenugreek seed extract, according to a study. Cell lines from liver cancer have not shown these effects. These findings demonstrate that fenugreek seed extract's effects are directly correlated with the type of cancer cell (65). Distinct normal and cancer cell lines were subjected to varying doses of fenugreek extract (100 mg/ml, 200 µg/ml, and 300 µg/ml) at various time points (0, 24, 48, 72, and 96 hours) in a distinct investigation. Numerous cancer cell lines, including T-cell lymphoma, have been shown to be susceptible to the selective cytotoxic actions of fenugreek extract. Under circumstances that are in vitro (66). Consuming fenugreek seeds, which contain diosgenin, may help prevent

colon cancer caused by azoxymethane in both its beginning and acceleration stages, according to some research. These cancer cells in vitro showed that the diosgenin found in fenugreek seeds suppressed cell proliferation and caused apoptosis in the human colon cancer cell line HT-29 in a dose-dependent manner (67).

#### **4. Weight Loss:**

In healthy overweight people, repeated administration of fenugreek seed extract resulted in a slight but considerable reduction in dietary fat intake. The effectiveness of fenugreek seed aqueous extracts in preventing fat buildup and improving dyslipidemia in obese rats fed a high-fat diet (HFD) was supported by these botanical components. Increased insulin sensitivity, lipid and glucose metabolism, antioxidant defense, and the downregulation of lipogenic enzymes were the causes of this (68). Mice given a high quantity of fenugreek (1%) showed significant weight loss. In a dose-dependent manner, fenugreek seed extract efficiently lowers body and fat tissue weight (69). Another study found that polyphenols, galactomannans, and proteins from fenugreek seeds can modify dyslipidemia in obese and diabetic animals (70). To learn more about fenugreek and other anti-obesity processes, more research is required.

#### **5. Hypercholesterolemic effect:**

Hypocholesterolemia is the term for the condition marked by a normal drop in blood cholesterol levels. In a mouse investigation, hypoglycemic effects were shown when methanolic and aqueous seed extracts were administered orally at a dosage of 1 gm/per kg of body weight. With galactose and mannose serving as the main components of the gum that forms the seeds, fenugreek seeds are known to contain a considerable amount of dietary fiber. This substance is linked to a lower level of electrons in the body (71). Experimental rats with diabetes have been used to study the effects of fenugreek extract on blood lipid levels. For approximately one and a half months (6 months), the streptozotocin-introduced diabetic rights were given orally via intragastric intubation separately along with low and moderate doses of fenugreek extracts and metformin HCL (72). The heteropolysaccharide fenugreek galactomannan is well-known for its capacity to control small intestinal surface activity and reduce blood glucose levels. It has been shown to have major health benefits, especially when it comes to decreasing LDL cholesterol levels in people with hypercholesterolemia. Furthermore, it has been shown that galactomannan has a beneficial effect on fibrinolysis, blood pressure, and blood lipids (73).. Because seeds contain antioxidants, they can help control high blood cholesterol levels. Flavonoids obtained from ethyl acetate extracts of seeds have been shown to exhibit hypocholesterolemic qualities (74). Only the fiber and saponin components of fenugreek seeds showed cholesterol-lowering activity after defatting, according to an analysis of the hypocholesterolemic effect of different fractions of the seeds. Thus, it can be assumed that the fiber and saponin components present in fenugreek seeds are responsible for the cholesterol-lowering impact (75, 76).

#### **6. Immunological activity:**

Immunomodulatory activity of fenugreek on immune function includes humoral immunity, leucocytic count, phagocytic index, serum globulin, related genes, body weight, relative thymus weight, hemagglutination titer, late type of hypersensitivity response, and plaque forming cell assay. An immunomodulatory effect is an agent that increases or decreases the immune response (77). Mice given three different dosages of fenugreek aqueous extracts demonstrated delayed hypersensitivity and enhanced humoral immune activity of 100 mg. In the treated mouse model, macrophage phagocytic capability and phagocytic index were markedly increased (78). It was discovered that the dietary supplement fenugreek (*Trigonella foenum graecum*) with gilt-head seabream (*Sparus aurata*) improved the haematological parameters and regulated immune-related genes (79) and increase certain enzymatic activity to improve the skin mucosal immune response (80). Furthermore, fenugreek extract improved the production performance and immunological system of laying hens (81, 82). At a dose of 400 mg/kg body weight, the haematology parameters analysis showed that the extracted Hb, RBC,

and WBC count significantly ( $P < 0.05$ ) increased in the rat model (83). Thus, the immune system could be strengthened by utilizing fenugreek's effectiveness and haematological factors.

### 7. Antidiabetic effect:

Elevated blood glucose levels are a hallmark of diabetes mellitus, a chronic metabolic disease. This disorder is brought on by decreased insulin secretion or function, which happens during fasting times and after meals. Numerous compounds have been extracted from fenugreek, and numerous studies have demonstrated how they affect blood sugar. These bioactive components, which include galactomannan, saponins, trigonella, diosgenin, and 4-hydroxyisoleucine, have been shown to have beneficial effects on diabetes (84). Fenugreek regulates diabetes through a variety of physiological mechanisms, For instance, resuming the function of pancreatic  $\beta$ -cells and blocking activity of alpha-amylase and sucrase. 4. Hydroxyis-Pancreatic  $\beta$ -secretion of insulin is directly induced by oleucine Cells. There are anti-diabetic properties in fenugreek saponin extract actions that are hypolipidemic and hepatoprotective (85-88). Fenugreek has been reorganized for use as an anti-diabetic treatment for those who suffer from it. It has been used extensively in a variety of experimental settings as a source of antimicrobial constituents obtained from its seeds, leaves, and extract to treat both type 1 and type 2 diabetes, There are currently a lot of commercial synthetic medications on the market to treat metabolic, carbohydrate, and insulin metabolism diseases including diabetes, however these medications can be costly and frequently have unfavorable side effects. Consequently, investigating natural alternatives is crucial for the treatment of metabolic diseases like diabetes. Fenugreek seeds' high soluble fiber content slows down the absorption and digestion of carbohydrates (89), which may aid in lowering blood glucose levels. Fenugreek seed powder was administered to 57 patients in a diabetic trial for three months. The patients' fasting and postprandial blood levels showed that fenugreek could be a useful natural supplement for controlling blood sugar levels. Twenty patients with borderline diabetes were given fenugreek juice for a month. Their PPBS levels were measured before and after the month, and a significant rise in PPBS was noted. Fenugreek seeds have been shown to significantly improve the insulin response to glucose and reduce glucose tolerance in both humans and animals.

Sr no.	Non-communicable Diseases	Model	Conclusion	Reference
1	Effect of fenugreek seeds on blood glucose and serum lipids in type I diabetes.	Human	Fenugreek diet notably decreased fasting blood sugar and improve glucose tolerance test.	90
2	Effect of fenugreek seeds on non-insulin dependent diabetic subjects	Human	Fenugreek lowers fasting blood glucose levels and Enhance glucose tolerance test.	91

3	Effects of fenugreek seed powder on type 2 diabetic patients	Human	Fenugreek seeds powder notably reduce serum lipid profile in type 2 diabetic patients.	92
4	Effect of fenugreek on Type 2 diabetic Patients	Human	Fenugreek seeds notably control pathology of diabetic patients if used as an adjuvant in type 2 diabetes mellitus.	93

- **Conclusion:**

Fenugreek, an ancient medicinal plant, is rich in fibres, phospholipids, vitamins, and other functional elements. It is used as a spice and has medicinal properties like anti-diabetic, hypocholesterolemic, antioxidant, and immunological activities. Fenugreek is also used in food product development as a stabilizer, adhesive, and emulsifying agent.

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