

FENUGREEK WITH ITS MEDICINAL APPLICATIONS

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Abstract: *Trigonella foenum-graecum* plant is also known as methi and used in Ayurvedic medicines for the treatment of bronchitis, rheumatoid arthritis, abscesses or wounds and digestive abnormalities. The review article has been made for the standardization and phytochemical evaluation of Fenugreek seeds and this one is comprises of powder microscopy, fluorescence analysis and some other physio-chemical constants such as foaming index and swelling index.

In modern food technology Fenugreek is used as food stabilizer, adhesive and emulsifying factor because of its gum, protein and fiber content. It is a rich source of calcium, iron and other vitamins.

In this study after a general discussion of physio-chemical constituents, the biological & pharmacological reactions of Fenugreek such as anti-diabeti activity, antihypercholesterolaemic properties, anti-toxic activity, anti-cataract activity, immunomodulatory activity and anti-oxidant activities were briefly investigated. The results of these studies provide a complete understanding of the biological action of *T. foenum-graecum*.

Keywords: *Trigonella foenum-graecum*, Fenugreek add pharmacological properties, Methi leaves

INTRODUCTION:

Now these days, the herbal products represent security had viewed in contrast to the synthetics as harmful to human and environment. People are turning to the naturals with the promise of protection, security & improvement of human health status. Herbs have been valued for their flavoring, remedial and fragrant qualities for ages. Latest researches proved that the fenugreek is beneficial for hypertension, diabetes, hyperlipidaemia, hypertriglyceridemia and much health disorders.

History

Fenugreek is as one of the oldest cultivated medicinal plants identified in written history, and further studies evaluated that the seeds and leaves of fenugreek having antioxidant properties. India is one of the major producers of the *Trigonella foenum-graecum* L. all over the world and the production is approximately 45,000-55,000 tonnes per annum. According to historical facts, the classical texts of Ayurveda, Charak Samhita and Sushruta Samhita were written around 1000 B.C. and these include 600 medicinal plants along with therapeutics. Fenugreek have originated in the Mediterranean region of the parts of Asia and recently it was suggested so as to fenugreek originated in Turkey.

About 260 species are currently available in *Trigonella* genus. Most of the species include *Trigonella foenum-graecum* L. are diploids with $2n=16$ chromosomes but some other species may include 18, 30, 32 or 44, 99 chromosomes.

Introduction Of fenugreek:

Fenugreek is one of the major species of human food. It provides natural food fiber and other much important nutrient products in human body. Its leaves and seeds are used in food and also in Ayurvedic medicinal system. The aromatic and flavorful fenugreek is a popular spice and is broadly used for culinary and medicinal properties. Fenugreek contains strong spicy and seasoning type sweet flavor. "Kasuri methi" is very famous for its amazing fragrance and also used for culinary preparations.

Botanical Classification of *T. foenum graecum*

Domain : Eukarya

Kingdom : Plantae

Division : Magnoliophyta

Class Magnoliopsida

Order : Fabales

Family : Fabaceae

Sub-family Trifoliae

Genus : *Trigonella*

Sub-genus *Foenumgraecum*

Species : *Trigonella foenum graecum*

Various Names of *Trigonella foenum graecum***Table 1:** Common Names of Fenugreek

Language	Common Names
Kannada	Menthya,
Tamil	Meti
Telugu	Menthulu
Malayalam	Uluva
Sinhalese	Uluhaal
Persian	Shanbalileh
Oriya	Hulba
Hindu,Urdu,Punjabi	Methi
Burmese	Penantazi
English	Fenugreek
Hindi	Methi ,Saag methi,Kasuri methi
French	Fenugreec,Trigonelle
Galician	Alforfa
German	Bockshornklee,Griechisch Heu
Georgian	Solinji, Chaman
Japanese	Koruha, Fenu-guriku
Dutch	Fenugriek
Romanian	Molotru, Molotru comun, Schinduf
Assamese	Methi, Mithi
Sanskrit	Methika

Morphology:

Appearance: Solid-rhomboidal seeds, 3 to 5 mm long, 2mm thick. Hard, pebble like.

Colour: Yellowish brown-light brown

Odour: characteristic spicy

Taste: Bitter and mucilaginous

The Fenugreek Plant

The fenugreek seeds sown in well prepared soil sprouts in three days. Seedling grows erect, semi-erect or branched and attains a height of 30 to 60 cm.

It contains pinnate compound, trifoliate leaves, auxiliary white to yellow flowers, and 3-15 cm long thin pointed beaked pods and every pod contains 10-20 oblong greenish-brown seeds with unique hooplike grooves⁹.

Fenugreek is the only single plant of Fabaceae family which is pollinating annual leguminous bean¹⁰.

Stem

Fenugreek having a number of steroidal saponins. Only the oily embryo contains diosgenin, the trimethylcoumarin, alkaloid trigonelline, trigocoumarin and nicotinic acid are been found in stem. Mucilage is a dominant ingredient of the seeds¹¹.

Further researches proved that approximately 28% mucilage, 5% of a stronger smelling, bitter fixed oil, 22% proteins, a volatile oil, two alkaloids and a yellow colouring substance are present in stem.



Figure 1: Stem of *T. foenum graecum*

Leaves

Fenugreek leaves are trifoliate, triangular stipules, 10-30mm long, 5-15 mm wide, truncate at apex, narrowed towards the base, margins shallowly serrate to dentate glabrous. The leaves contain 7 saponin compounds, known as graecunins and these are glycosides of diosgenin. Leaves having rich sources of mineral and vitamin contents like phosphorus, iron, carotene, calcium, riboflavin, thiamine and vitamin-c¹³.



Figure 2: Leaves of *T. foenum graecum*
Seeds

Seeds are rhomboidal, pebble like shape, 3-5 cm. long, 2mm thick, plain surface, yellow in colour. Bulk of the fenugreek seed is dietary fiber and protein both of which have no taste or flavor¹⁴. Plant tissue cultures from seeds grown under optimal conditions have been found to produce as much as 2% diosgenin with fewer quantities of gitongenin and trigogenin. The major components of fenugreek seeds are highly carbohydrates, proteins, flavonoids, alkaloids, saponin, free amino acids, glycosides, mucilage, minerals and much more¹⁵. Further investigations have shown its effectiveness in diminishing blood glucose levels, treating gastric abnormalities on lowering cholesterol¹⁶.



Figure 3: Seeds of *T. foenum graecum*

Physico-chemical constituents of Fenugreek seeds

The major physicochemical constituents can be classified as

Table 2: Physico-chemical constituents of *T. foenum graecum* seeds

Sr.No.	Parameters	Results/W
1.	Foreign matter	1.16
2.	Loss on drying	12.62
3.	Foaming index	259.95
4.	Swelling index	10.5
5.	Ash value	
	Total ash	3.3
	Acid insoluble ash	0.4
	Water soluble ash	1.6
6.	Extractive values	
	Alcohol soluble extractive value	14.40
	Water soluble extractive value	35.00

Alkaloids, Saponin and Flavonoids in Fenugreek

The different alkaloids, saponin and flavonoids are to be found in fenugreek, but saponin are to be found to be high level concentration in the fenugreek¹⁷. Alkaloid is one of the natural bases having at least one nitrogen atom in its heterocyclic ring structure¹⁸. Alkaloids and volatiles are the two major constituents of fenugreek seed which causes bitter taste and bad odour¹⁹. One hundred gram of fenugreek endosperm is investigated to be containing 4.63 gm saponin. These photochemical constituents act as antilipidemic, hypoglycemic and cholagogic factor and their use should be promoted to manage diabetes mellitus and hypercholesterolemia. At the time of these clinical hazardous conditions, care should be taken to avoid minor gastrointestinal symptoms and allergic reactions on its consumption²⁰. This research investigated alkaloid and saponin as anti-nutritional factors in human food through the extract of fenugreek containing saponin is found to be enhancing hunger and reducing hypercholesterolemia in rats²¹.

Vitamins in fenugreek

Fenugreek seed especially rich in vitamins-A, B1, B2, C, niacin and nicotinic acid where as germinating seeds contains pyridoxine, calcium pantothenate, biotin & Ascorbic acid²². Srinivasan investigated that 43 mg of B-carotene, 96µg of β-carotene, 340µg of thiamine, 290µg of riboflavin, 1.1mg of nicotinic acid and 84µg of folic acid in fenugreek seeds²³

Proteins in fenugreek

Fenugreek endosperm is highly rich in protein such as globulin, albumin, histidine and lecithin²⁴. Isikli studied that seed of fenugreek has a high proportion of protein ranging from 20 to 30% as well as amino acid, 4-hydroxyisoleucine, which contains high

potential for insulin-stimulating activity²⁵. The molecular weight of fenugreek gum is elevated by removing the attached proteins. It is concluded in the animal study that the replacement of casein diet up to 10% by fenugreek seeds did not create any harmful effect in protein quality of casein and also for protein efficiency ratio & protein digestibility²⁶.

Minerals in fenugreek

Fenugreek does not have so much minerals but it has good amount of phosphorus and sulphur²⁷. It is also known for its higher occurrence of calcium, iron and zinc²⁸.

Volatile content

In 1997, this study investigated the following compounds based on the fenugreek aroma detection by the help of gas chromatography: acetic acid, linalool, isovaleric acid, butanoic acid, 3-isopropyl-2-methoxypyrazine, olfactometry diacetyl, eugenol, caproic acid, 3-Amino-4,5-dimethyl-3, 3-isobutyl-2-methoxypyrazine²⁹.

Fenugreek gum

The fenugreek gum can be utilized for thickening, stabilizing and emulsifying food agents³⁰. Fenugreek gum is less exploited in the food industry as compared to other gums. Fenugreek gum is originated from the endosperm of the seeds and it consists of mannose & galactose³¹. Whenever making bread with wheat flour with combination of fenugreek, the prepared dough showed more water absorption in spite of the dough made without fenugreek gum. In 1997, this scientific study concluded that purified fenugreek gum, containing 0.8% residual protein, could reduce the surface tension and form stable emulsions with small oil droplets approximately 2-3 μm ²⁶.

Fenugreek Fiber

The fiber content of fenugreek seed extract plays a role in its ability to moderate metabolism of glucose in the digestive tract³². The 100g of seeds gives more than 65% of dietary fibers. Fiber binds to toxins in the food and helps to prevention of the colon mucus membrane from cancer causing toxins. The higher concentration of fiber in fenugreek influences its strength for glucose level tolerance. Galactomannan is an important soluble fiber of the fenugreek seeds; it diminishes the bile salts uptake in intestine and also decreases the digestion and absorption of starch in body³³.

Traditional uses of Fenugreek

As a functional food

Fenugreek is well known for the principal source of soluble fiber in the plant. Dietary fiber is highly capable to reduce risk of cardiovascular abnormalities and some specific type of cancer due to the reduction of LDL level and total cholesterol³⁴. Researches investigated the physicochemical & nutritional properties of bread made from fenugreek flour supplemented with wheat flour³⁵. Trigonelline, alkaloid of fenugreek can be used in the manufacture of imitation maple syrup and artificial flavoring for vanilla, butterscotch and rum³⁶.

As a traditional medicine

Fenugreek is highly rich in phytochemicals such as flavonoids, steroids and alkaloids, which have been identified and isolated by the pharmaceutical companies or industries for the manufacture of hormonal and therapeutic drugs³⁷. The use of fenugreek seeds in eczema or other inflammatory situations is one of the more historical medicinal uses and the practice is still in use today in many countries. The extracted oil from fenugreek represents about 6-8% of the seed weight. It was also used as a tonic and treatment for weakness and edema of the legs³⁸.

As a forage crop

Fenugreek was cultivated as a forage crop, from the ancient Greek period. In another study, fenugreek seed was added as a supplementary into a dairy cattle diet and was concluded to significantly improve the fatty acid profile in the milk produced. The study also confirmed that the fenugreek fed cattle had a 4% reduction in blood cholesterol concentration as well as 19% decrease in milk cholesterol level³⁹.

Pharmacological Activities

Urotoxicity Activity

An anti-cancer drug Cyclophosphamide causes toxicity by its reactive metabolites acrolein and phosphoramidate mustard. Fenugreek showed protective effect on lipid peroxidation activity and enzymatic anti-oxidants. Animals that are treated by Cyclophosphamide drug showed a significant decrease in the activities of glutathione S-transferase, glutathione reductase, glutathione peroxidase and catalase when compared to the control groups. L-buthionine-SR-Sulfoximine treatment depicted an additive toxic effect in CP-treated animals. The pretreatment of herbal extract showed an overall protective effect on additive effect of CP and BSO⁴⁰

Antioxidant Activity

Flavonoids of Fenugreek extract have been investigated to possess anti-oxidant activity⁴¹. In a latest study fenugreek seed extract has been reported to prevent lipid peroxidation and hemolysis in RBC. Fenugreek seeds have also been proved to raise the anti-oxidant levels and reduce the liver peroxidation in liver of diabetic rats⁴². The seed extract exhibited scavenging of hydroxyl radicals and inhibition of hydrogen peroxide-induced LPO in mitochondria of rat liver cells. The OH scavenging activity of the extract was demonstrated by pulse radiolysis and the deoxyribose system. The fenugreek seeds extract contains antioxidants and protects cellular structures from oxidative damage. An aqueous methanolic extract of fenugreek was investigated for its antiradical and invitro antioxidant activity in various model systems. The results gained by different methods provide some important factors responsible for the antioxidant activity of fenugreek seeds⁴³.

Effect of Enzymatic Activities

Various researches have shown that fenugreek has the ability to some extent to restore the actions of key enzymes in particular lipids and carbohydrates in human and animal models. The administration of Trigonella in rats restored the changed enzyme activities and decreased hyperglycemia. The altered levels of superoxide dismutase, glutathione peroxidase and antioxidant enzymes catalase in liver and kidney of experimental diabetic rats were treated by the combined dose of insulin, vanadate and fenugreek

respectively. This study concluded that the activities of glucose 6-phosphatase and fructose-1, 6-biphosphatase in the liver and kidneys of diabetic rats are diminished by administration of fenugreek seed extract⁴⁴.

Immunomodulatory Activity

An agent that increases or reduces the immune responses is known as immunomodulator and such effect is immunomodulatory effect. Fenugreek in the diet showed a mark reduction in signs & symptoms of diabetes like polyuria, urine sugar, renal hypertrophy, excessive thirst and glomerular filtration rate⁴⁵. Aqueous extract of fenugreek was investigated to ameliorate additive urotoxicity of buthionine, sulfoximine and cyclophosphamide by restoring the anti-oxidant status and reversing the cyclophosphamide-induced cell death in free radical-mediated lipid peroxidation in the urinary bladder⁴⁶. To assess the immunomodulatory activity male albino mice were treated with three doses of aqueous extract of fenugreek 50, 100, 250 mg/kg of body weight respectively for 10 days. The increase in thymus weight was due to by an increase in cell counts. This may be due to the stimulatory effect of plant extract on the lymphocytes and bone marrow hematopoietic cells⁴⁷.

Anti-cataract Activity

Cataract is the opacification in the eye lens and it remains the leading cause of visual abnormality, also contributes 50% of blindness worldwide⁴⁸. The anti-cataract potential of *Trigonella foenum graecum* was evaluated in selenite induced in vitro medium. The medium was supplemented with selenite and aqueous extract of *T. foenum graecum* to the test group. An increasing level of malondialdehyde and diminishing level of GSH were seen in control as compared to standard lenses. *T. foenum graecum* amazingly restored glutathione & decreased malondialdehyde levels. It also plays an important part in restoration in the anti-oxidant enzymes such as superoxide dismutase, glutathione, peroxidase, catalase and glutathione-s-transferase. Fenugreek protects against the experimental cataract due to its anti-oxidant properties and also significantly restored the GSH level in a dose-dependent manner⁴⁹.

Anticarcinogenic Activity

Trigonella foenum graecum seeds showed potential protective activity against 7, 12-dimethylbenz (a) anthracene-induced breast cancer in rats at 200mg/kg of body weight and the extract significantly inhibited the DMBA-induced mammary-hyperplasia and decreased its incidence. The ethanolic extract of fenugreek seeds with an ED₅₀ less than 10µg/ml in the brine shrimp cytotoxicity assay, was also observed to possess anti-tumour activity in A-549 male lung carcinoma, MCF-7 female breast cancer. Further studies concluded that fenugreek is a safe medicinal herb for complementary therapy in cancer patients because fenugreek extract shows a protective effect by modifying the cyclophosphamide induced apoptosis and lipid peroxidation in the urinary bladder of experimental mice⁵⁰. Fenugreek contains a crystalline steroid saponin, Diosgenin as a starting material for the synthesis of steroid hormones such as cortisone and progesterone. It has the potential to prevent invasion, suppress proliferation and osteoclastogenesis through inhibition of necrosis factor and enhances apoptosis induced by cytokines and chemotherapeutic agents⁵¹.

Anti-diabetic Activity

The harmful side effects of synthetic drugs, the enormous cost and in the capacity of existing modern techniques to control all pathological aspects and the poor advance therapies for many rural populations in developing countries. Galactomannan, a soluble fiber is isolated from Canadian grown fenugreek seeds, responsible for reduction of postprandial blood glucose level. Because of its viscous property, galactomannan has ability to reduce intestinal absorption of high or low concentration of glucose, so that there is the benefit of blood glucose control⁵².

When the fenugreek seed powder treatment for 21 days to diabetic rats brought down the high fasting blood glucose levels to control levels. The enzyme activities were restored to control values in both the kidney and liver. The anti-diabetic actions of fenugreek seeds have been considered as to the presence of steroid saponins and fiber content in the seeds⁵³. The effect of oral administration [5% in the diet] of powder of fenugreek seeds in alloxan-induced diabetic rats for 21 days were investigated, the glycolytic, NADP linked lipogenic and gluconeogenic enzymes were determined in the kidney and liver tissues of rats.

The *T. foenum graecum* saponin fraction significantly modulated the glycogen enzyme and disaccharidase activities in the intestine, it suppressed the increase of blood sugar level, increased the hepatic glycogen content and improved results in the oral glucose tolerance test. The fenugreek saponin also protected the liver function, which occurred due to the significant increases of superoxide dismutase, catalase, glutathione peroxidase, aspartate transaminase, lactate dehydrogenase, alanine transaminase enzyme activities. Fenugreek saponins reveal attractive qualities and can be considered as capable for potential purpose, mainly those related to the improvement of anti-diabetic, hepatoprotective and hypolipidemic drugs⁵⁵.

Antifertility Activity

The antifertility effect was evaluated due to the addition of 30% fenugreek seeds to feeding diet of male and female rabbits and reported the following results: a) the circulation of plasma progesterone concentrations at 10 and 20 days of gestation significantly increased with no any side effect on the prebreeding estrogen concentrations. b) significant reduction of developing foetuses in the female rabbits. c) in the experimental animals the plasma concentration of the androgen hormone and sperm concentration were halved. d) toxicity effect in male rabbit. e) an antifertility effect of fenugreek seed in female rabbit. f) testis weight in male diminished with damage to the seminiferous tubules and interstitial tissues⁵⁶.

Hyperlipidemic Activities

Atherosclerosis and its related abnormalities compose the mainly common cause of death in western or urban societies. A diet rich in fiber and vegetables has to reduce the atherogenesis. Inhibition of low density lipoprotein oxidation can diminished the risk of atherosclerosis independent of reducing plasma cholesterol levels.

The effect of fenugreek were evaluated related to blood lipid level, fibrinogen, platelet aggregation, blood sugar and fibrinolytic activity. Healthy individuals and patients who are suffering with coronary artery disease and non insulin dependent diabetes mellitus, who either had CAD or were without CAD. The dose of fenugreek 2.5g two times a day for 3 month to healthy individuals, no any changes were seen in the blood lipids and blood sugar level both fasting and postprandial. Then the same daily dose for same duration administered to CAD patients also with NIDDM, fenugreek significantly reduce the lipid level without affecting the high density lipoprotein cholesterol. After that the same daily dose administered to those patients who are suffering from NIDDM mild

cases only, fenugreek reduced the blood sugar but in the condition of severe NIDDM cases, the blood sugar was only slightly decreased fenugreek did not affect platelet aggregation, fibrinogen and fibrinolytic activity⁵⁷.

The hypocholesterolemic properties of ethanol extract of fenugreek seeds were investigated. The experimental rats were administered 30 or 50g ethanol extract/kg of fenugreek seeds for one month. Approximately 18 to 26% reduction were seen in plasma cholesterol as well as liver cholesterol. The ethanol extract from fenugreek seeds contained hypocholesterolemic component, saponin that interact with bile salts in the digestive tract. The focus on the contribution of an ethanol extracts of fenugreek seeds in reducing cholesterol levels in hypocholesterolemic rats⁵⁸.

Conclusion

Fenugreek is one of the supplements used to support non-insulin dependent diabetes mellitus. Fenugreek seed helps by not only reducing blood sugar levels due to its high concentrations of phytochemicals, but it has also helped reduce low density cholesterol. Fenugreek has an extensive variety of actions which are likely to protect human body against a number of abnormalities. In spite of various actions of *Trigonella foenum-graecum* on chronic disorders, the relevant clinical applications and mechanism of action is still to be the area of research.

In this review article, various activities like antidiabetic, antioxidant, anticarcinogenic, antiulcer, antifertility, immunomodulatory and many more discussed last three decades. High fiber, protein content and other bioactive compounds make it a naturally several health promoting herb. Anti-cataract effect of this plant is a significant pharmacological activity, which should be focused more in the future.

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