

Therapeutic Uses of *Trigonella foenum - graecum* L.

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ABSTRACT

The health benefits and therapeutic uses of herbal products are known since ages. Developing and underdeveloped countries depend on plant – based medicines for treatment of diseases as they are cheaper and form the basis of their traditional medicinal systems. *Trigonella foenum-graecum* L., commonly known as fenugreek is a seed spice used to enhance flavor, color and texture of food. It has been used in traditional medicine for a wide range of ailments related to digestive, endocrine and reproductive systems. It is also used as a galactagogue- lactation inducer. This article summarizes published experimental studies and scientific literature from PubMed, Google Scholar and local library searches. Besides its known medicinal properties, newer research has identified antioxidant, anti-inflammatory and anticarcinogenic effects of fenugreek. In most of the studies seed powder or different plant part extracts have been used. Research on *Trigonella* reveals its health benefits and potential medicinal properties in various symptoms and has little or no side effects, suggesting its pharmaceutical, therapeutic and nutritional potential. In this article, the most important biological effects and reported compounds about fenugreek seed and its therapeutic applications are investigated. Findings based on its traditional uses and scientific evaluation indicates that phytochemical studies have shown the presence of various categories of secondary metabolites, such as, saponins, steroids, alkaloids, flavonoids, terpenes, phenolic acid derivatives, amino acids and fatty acids and their derivatives. Compiled data indicates its effectiveness on several pharmacological activities such as antimicrobial, antiviral, anti-inflammatory, antispasmodic, cardiovascular, anticancer, hepatoprotective, hypoglycemic and carminative. Fenugreek has emerged as a good source of traditional medicine and it provides a noteworthy basis in pharmaceutical biology for the development and generation of new drugs and future clinical uses.

Keywords: Health, Phytochemical, Traditional medicine, Therapeutic, *Trigonella foenum-graecum* L.

INTRODUCTION

According to World Health Organization, about 80% of world population from the developing and underdeveloped countries still bank on plant-derived medicines for their healthcare requirements¹⁴ Medicines derived from plants, have been well documented for

several millennia²⁶. Fenugreek (*Trigonella foenum-graecum* L.) is a short living annual plant, belonging to the family Fabaceae. It is native to the eastern Mediterranean but is cultivated worldwide in many parts of Asia, Africa, and Europe as food, condiment, spice, and ethnomedicine.

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The genus *Trigonella* is named by virtue of its triangular shaped flowers³⁶. The species *foenum-graecum* is derived from historical context of Romans, who referred to it as Greek-hay. Fenugreek plant attains the height of 1–2 feet and bears green trifoliate leaves consisting of 3 small obovate to oblong leaflets (Fig. 1). The flowers are white to yellow in color and the plant bears thin pods. The pods are about 15 cm in length and contain an average of 10–20 seeds^{36,30}. Fenugreek seeds are golden yellow in color and their average height, width, and thickness are 4.01–4.19, 2.35–2.60, and 2.40–2.66 mm, respectively. The dried fenugreek seeds are ground to obtain fenugreek seed powder which is used as condiment. Fenugreek gum is obtained from the endosperm of the seeds⁴. Fenugreek is used as a spice and herb in many culinary dishes and its green leaves and seeds are edible. In Indian cuisine, leaves are used to flavor dishes or eaten as greens, and seeds are used for seasonings, tempering or crushed to prepare curry powders and pastes⁵⁰. In addition to being used in various food preparations, fenugreek also has medicinal benefits. Fenugreek is one of the oldest plant whose medicinal properties are well documented in the ancient medical literature. In Ayurveda, the traditional Indian medical system, fenugreek was used as a digestive aid and ancient Egyptians and Chinese used it as incense, in

mummification and as lactation aid and in edema^{52,8}. In ethnomedicine, uses of fenugreek, are the treatment of lung congestion and sinus, indigestion, baldness in men, hair tonic, conditioner and as a galactagogue. At present, researches on fenugreek have shown properties such as antioxidant¹³, anti-inflammatory¹⁶, antidiabetic^{2,32,38}, antiobesity¹⁵, anticancer^{44,45,42}, hepatoprotective⁵⁴, antihyperlipidemic¹⁰ and female health modulating activities^{12,7}.

The health promoting and disease preventive properties of fenugreek are owed to the presence of a broad range of phytochemicals. Ethno-medicinal aspects of fenugreek have been presented in previous literature, while newer developments arose in fenugreek research lately^{56,35}. The objective of this study is to provide information on recent researches of the nutritive value and therapeutic properties of fenugreek in prevention and treatment of diseases.

MATERIALS AND METHODS

The scientific researches conducted on fenugreek and its medicinal uses were identified by rigorous browsing on PubMed and Google Scholar. Only English language publications or reports were considered. More relevant publications were procured from the bibliography of primary literature.



Fig 1: *Trigonella foenum-graecum*

RESULTS AND DISCUSSION

The phytochemical analysis of fenugreek has revealed the presence of various categories of secondary metabolites³⁵. This plant has medicinal alkaloids, steroid compounds, and saponin. It has been used to ease childbirth, to aid digestion, and as a general tonic to improve metabolism. Trigonelline is considered as the most important metabolite of fenugreek, which is very effective in treating diabetes and decreasing blood cholesterol⁸.

Dietary fibers

Fenugreek is good source for dietary fiber. Two types of dietary fibers present in fenugreek seeds -insoluble and soluble⁴⁰. Insoluble fibers soften the stools and decrease the appetite; whereas soluble fibers inhibit the absorption of glucose into the blood stream and enhance its glycemic control⁸. The cell wall of fenugreek seeds contain mostly polysaccharides made of galactomannan⁴⁹. The galactomannan in fenugreek is unique due to its 1:1 ratio of mannose to galactose.

Amino acids

Fenugreek is rich source for a number of nitrogen-containing amino acids, such as aspartic acid, glutamic acid, leucine, phenyl alanine and tyrosine. Sulfur containing amino acids cysteine and methionine are relatively low.

Lipids and fatty acids

Fenugreek leaves have a high content of mono and di-galactodiacylglycerols along with glyco and phospholipids³⁷. The seeds are rich in fatty acids, namely oleic, linoleic, and linolenic acids and several phospholipids^{37,21}.

Vitamins and minerals

Fenugreek leaves are rich in vitamin C and also a good source of calcium, β -carotene, and folic acid Fenugreek plant is rich in essential inorganic elements and the plant is a good source for major dietary elements, such as Fe, Ca, P, S, and Mg. Fenugreek seeds contain vitamins A, B₁, B₂, C, niacin, and nicotinic acid⁵⁰. The seeds contain adequate amounts of important trace dietary elements such as Co, Cu, Mn, Zn, and Br⁴⁸.

Saponins and steroidal compounds

Of all phytoconstituents found in fenugreek, saponins are present in the maximum quantity. Steroidal saponins are generally of two types, namely spirostanol and furostanol. The majority of saponins isolated from fenugreek belong to the furostanol class. The saponins mainly isolated from fenugreek seeds after acid hydrolysis are diosgenin and yamogenin. Diosgenin is the most extensively studied steroidal saponin due to its role as an advanced product intermediate for the synthesis of oral contraceptives and also its pharmacological activities as anti-inflammatory and anticancer agents. Fenugreek is one of very few natural sources of diosgenin, which is currently extracted from Mexican and Asian yams⁴¹.

Alkaloids

Trigonelline is a pyridine alkaloid and a phytoestrogen, due to its ability to activate estrogen receptor.

Flavonoids

Fenugreek contains a number of important, beneficial flavonoids and polyphenol compounds isolated from the individual parts of fenugreek plant and also from the extracts of leaves, flowers, and stems. The phytochemical analysis of fenugreek revealed that most flavonoids are quercitrin, afroside, and isovitexin^{39,20}.

Phenolic and acid derivatives

A number of important phenolic and styrylic acid derivatives, such as *p*-coumaric acid, caffeic acid, chlorogenic acid⁴⁸, coumarin derivatives, namely scopoletin were isolated from different parts of fenugreek plant. Al-Daghri et al.³ isolated polyphenol derivatives, such as zingerone, vanillin, gingerol, and eugenol, from fenugreek extract and reported anticancer activities of these compounds. Girardon et al.¹⁷ have reported more than 50 volatile chemicals from fenugreek seeds and have chemically characterized 39 of those phytochemicals. In 2002, Mazza et al.²⁹ analyzed micro extract of fenugreek seeds and identified 175 compounds and 66 of those were identified in fenugreek for the first time.

Bioavailability of active compounds

Kandhare et al.²³ studied the bioavailability of furastanol glycoside isolated from fenugreek seed extract (FSE) in rats. They studied the pharmacokinetics, tissue distribution, and excretion following oral administration of furastanol glycoside extract. Further, Kandhare et al.²⁴ reported the pharmacokinetics and tissue distribution of flavonol glycoside, vicenin-1 in various rat tissues. Buqui et al. studied the absorption and pharmacokinetic parameters of vicenin-2 and noted that approximately 40% of its original dose was rapidly absorbed in the small intestine⁹. Literature has reported the pharmacokinetic studies of fenugreek and its safety profile, either used alone or in combination with other natural products²². Fenugreek has been used for centuries around the world, especially in Asia and Africa. Fenugreek-based nutraceuticals are becoming increasingly popular worldwide.

Antioxidative effect

All aerobic living organisms require Oxygen as an essential and integral component of life. Oxygen is highly reactive and undergoes metabolism to generate the reactive oxygen species (ROS), which are free radicals containing oxygen atom¹¹. ROS induce membrane lipid peroxidation (LPO) impairing cellular functions, fragmentation of amino acid residues leading to loss of protein function, DNA damage which alters replication and transcription and results in mutations and genetic defects. ROS play an important beneficial role in homeostasis and cell signaling³⁴. Normally all living beings are equipped with endogenous defense mechanisms, such as superoxide dismutase (SOD), glutathione peroxidase (GPx), and catalase (CAT) to metabolize the toxic intermediates and protect against ROS-induced damage¹⁸. Imbalance of pro-oxidation and antioxidation leads to oxidative stress⁴⁶ which is implicated in more than 50 diseases, including inflammation, cancer, and diabetes¹⁹. Whenever there is oxidative stress, there is a critical need for antioxidants. The best source for antioxidants is foods rich in polyphenols,

such as fruits and vegetables²⁷. The phytochemical analysis of fenugreek revealed the presence of a number of polyphenols which were investigated by several groups worldwide to study the antioxidant properties of fenugreek⁵³. Sharma et al.⁴³ reported that administration of FSE reduced the in vitro LPO induced by ferrous sulfate (FeSO₄), hydrogen peroxide (H₂O₂), and carbon tetrachloride (CCl₄) in a concentration-dependent manner. Naidu et al.³³ have experimentally showed the direct correlation between the presence of polyphenols in fenugreek seeds and their concentration on antioxidant activity. The concentration of polyphenols follows the decreasing order: husk>seed >endosperm and observed their IC₅₀ values for scavenging. Polyphenols in fenugreek also help to protect the RBCs from oxidative change inflicted by the peroxide treatment²⁵. The role of fenugreek in ameliorating the hepato- and nephro-toxicity induced by cypermethrin in rats was reported by Sushma and Devasena⁵¹. They showed that fenugreek reduced the levels of LPO by-product, TBARS, and the levels of antioxidant enzymes, such as SOD, GPx, and GST, were found to be increased in the liver and kidneys. When fenugreek extract was used in tandem with swimming exercise there was a significant increase in SOD, CAT, and GPx activities in the heart tissue of diabetic rats⁶. Fenugreek significantly reduced the LPO of WBCs in the livers of alloxan-induced diabetic rats. The antioxidant activity is concentration dependent and its activity was comparable to known antidiabetic drug, glibenclamide³¹. Anuradha and Ravikumar⁵ reported the ability of fenugreek extract to reduce the LPO and oxidative stress in alloxan induced diabetic rats, which may be due to fenugreek's ability to protect the Ca²⁺-ATPase activity in the liver. Fenugreek acted as a diabetic neuropathic agent⁵⁵. In another study, Abdel-Daim et al.¹ evaluated the role of fenugreek oil as a protective agent against deltamethrin-induced toxicity in rats. They observed that fenugreek oil maintained the hematological parameters namely, RBC ranges, platelet

counts, hemoglobin, and hematocrit values. Fenugreek oil restored the biochemical changes such as cholesterol, triglycerides (TGs), urea, uric acid, creatinine, and enzyme alanine amino transferase to normal levels. Fenugreek oil also prevented the LPO and oxidative stress in a dose-dependent manner.

Anti-inflammatory effect

Maurya et al.²⁸ reported the anti-inflammatory activity of HIL present in fenugreek. They noted that HIL ameliorated the ROS-induced inflammation. In another study, anti-inflammatory activity of HIL on TNF- α -mediated insulin resistance was analyzed¹⁶. HIL activated adenosine monophosphate-activated protein kinase in a dose-dependent manner and increased the insulin-stimulated glucose transport. Fenugreek mucilage significantly reduced the activities of inflammatory enzymes COX, lipoxygenase, and myeloperoxidase in arthritic rats⁴⁷.

CONCLUSION AND FUTURE PERSPECTIVES

From the studies outlined in this article, it is clear that the ethnomedicinal plant, fenugreek (*Trigonella foenum-graecum*), has the potential for not only serving as herb, spice, condiment and additive, but also has the ability to prevent and treat a wide range of human diseases. The health-promoting and prophylactic therapeutic effects of fenugreek extracts and its compounds are explained by cellular and molecular mechanisms. The in vitro, in vivo, and clinical studies presented in this study show that fenugreek extracts and phytoconstituents are effective in preventing and treating many health conditions including diabetes, inflammation, cancer and obesity. There is scope for further study to specify the mechanism of action of fenugreek products and isolation of pure compounds at molecular level. Some novel phytochemicals from fenugreek plant have been isolated and characterized. Fenugreek has profusion of phytoconstituents which include alkaloids, flavonoids, glycosides, phenolic compounds, saponins, and dietary fibers along with proteinergetic and non proteinergetic amino acids.

Even though many chemicals of fenugreek plant have been acknowledged for their beneficial effects, the activity of only few compounds, namely 4-hydroxyisoleucine and diosgenin, has been studied and there is an urgent need to study other phytochemicals. Standardized fenugreek extract is becoming popular as a botanical drug, medical food, and nutraceutical in India and all over the world. In conclusion, while fenugreek shows significant promise for preventing and treating numerous diseases, additional studies are needed to ascertain the real potential of fenugreek products as over the counter drugs. The studies presented and analyzed in this paper highly suggest that fenugreek is a unique medicinal plant with versatile health benefits.

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