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A Review on Ethnobotanical and Therapeutic Uses of Fenugreek (*Trigonella foenum-graceum* L)

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Abstract

Fenugreek with the scientific name of *Trigonella foenum-graceum* L and with leaves consisting of 3 small obovate to oblong leaflets is an annual herbaceous plant of the Fabaceae family. It is native to the eastern Mediterranean but is cultivated worldwide. This plant has medicinal alkaloids, steroid compounds, and sapogenins and many uses have been mentioned for this plant in traditional medicine. This plant 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 cholesterol. Diaszhenin is another important compound in seeds of this plant, which is used in producing medicinal steroids like contraceptive pills. Many studies have been performed on the therapeutic effects and identification of chemical compounds of this plant. In this article, the most important biological effects and reported compounds about fenugreek seed are reviewed and its therapeutic applications are investigated.

Keywords

fenugreek, *Trigonella foenum-graceum*, medicinal plants

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Recently, there is an increasing tendency toward traditional medicine due to occurrence of harmful effects of chemical drugs on human health and various deficits of the modern medicine in treating some diseases.[1]

Medicinal plants have a long history of usage[2] with low side effects.[3,4] Recent studies have shown promising results for these plants in prevention[5,6] and treatment[7,8] of a wide variety of diseases such as diabetes,[9,10] hypertension,[11,12] atherosclerosis,[13,14] cardiovascular disease,[15,16] and cancer.[17,18] Medicinal plants have also the capacities to diminish drug-induced adverse effects[19,20] and even heavy metals or other toxicities toxicities.[21,22] Therefore, they might be considered as reliable sources for development of new drugs.

One of the medicinal plants that has been used since antiquity in the traditional medicine of Iran and for which significant therapeutic properties have been mentioned is fenugreek. The seed and aerial parts of the plant have been used, for centuries, as a valuable source of protein in man and animal's nutrition, and also in the traditional medicine for various conditions. The interesting point about fenugreek is the broad range of its therapeutic effects, including pain relief, antidiabetes, antiatherosclerosis, anti-inflammation, carminative, laxative, antispasmodic, anticancer, sexual desire increasing, astringent, heart tonic, laxative, hypertension decreasing, triglyceride lowering, breast milk increasing, and oxytocic properties are reported for this plant.[23] Images of leaves and seeds of fenugreek are given in Figures 1 and 2, respectively.

This plant has medicinal alkaloids, steroid compounds, and sapogenins and many uses have been mentioned for this plant in traditional medicine.[23] This plant 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 effective in treating diabetes and decreasing blood cholesterol. Trigonelline as a plant hormone is also used for cancer (liver cancer and cervical cancer) and migraine. Studying the effect of trigonelline on mice shows that this substance acts as sedative. This metabolite results from niacin that is one of the food and medicinal supplement vitamins and is generally used to reduce blood lipid and sugar.[24]

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Figure 1. Trigonelline leaves.

Figure 2. Trigonelline seeds.

Diaszhenin is another important compound in seed of this plant that is used in producing medicinal steroids like contraceptive pills. Many studies have been performed on therapeutic effects and identification of chemical compounds of this plant. In this article, the most important biological effects and reported compounds about fenugreek seed are reviewed and its therapeutic applications are investigated.[23]

Name, Classification, and Plant Characteristics

Trigonella foenum-graecum is an angiosperm plant that belongs to Rosaceae order, Legouminosae family, subfamily of Papilonaceae and Trigonela L. genus of the Trifolia group.[25] The name of this plant comes from the Greek word *trigonou* meaning triangle, because of the triangular shape of its leaflets. The term *foenum-graecum* means "Greek hay" or Greek grass because of its extensive use in ancient Greece. Fenugreek is an herbaceous and annual plant and its height reaches to 50 cm.

Table 1. Distribution of Some Species of Trigonella Genus.

Species	Geographical Origin
T coerulecscens	Iran
T striata	Iran
T moresshina	Iran, India, Africa, Egypt
T foenum-graecum	Iran, Turkey
T coerulescens	Iran
T aphanoneora	Iran
T tehranica	Iran
T elliptica	Iran
T monantha	Iran
T astroites	Iran
T uncata	Iran
T anguina	Iran, Sudi Arabia
T stellate	Iran, Sudi Arabia
T fischeriana	Turkey
T velutina	Turkey
T cretica	Turkey
T hamosa	Sudi Arabia
T corniculata	India

This plant has a single stem that is frequently crooked, glabrous, or with distributed tomentums. Leaves are oval, serrated, consisting of 3 small obovate to oblong leaflets and leaflets distributed from one point. Flowers are pale yellow or whitey purple 0.8 to 1.8 cm in diameter and pollination is done by insects. Fruits are curved pods 3- to 11-cm long and containing 5 to 20 angled seeds 4- to 6-mm long. Seeds have bitter and aromatic taste and their color varies from fawn yellow to brown. Its names and scientific classifications are as follows.

Taxonomy

Kingdom: Plant[25]
Family: Fabaceae
Genus: *Trigonella*
Species: *foenum-graecum*
General name: Fenugreek
English name: Fenugreek
Arabic name: Hhulbah, Hhelbah
French name: Trigonelle, Senegrain, Foingrec
German name: Gemeiner, Hornklee, Bockshornklee
Indian name: Sagmethi, Methi, Kasurimethi
Italian name: Fienogreco, Erbamedica
Persian name: Shanbelileh

Origin and Distribution

This plant is indigenous to the eastern coasts of the Mediterranean and North Africa. According to some experts and scholars, this plant primarily was indigenous to Iran and then was transferred to other areas. Fenugreek is widely grown in India, China, Africa, Algeria, Saudi Arabia, Pakistan, Egypt, Turkey, Ukraine, Spain, and Italy. This plant is frequently exported from India, China, Turkey, and Morocco.[23]

More than a hundred of wild and cultivated species of Fenugreek have been identified in the world. According to Iranica Flora, distribution of more than 32 species of this plant has been reported

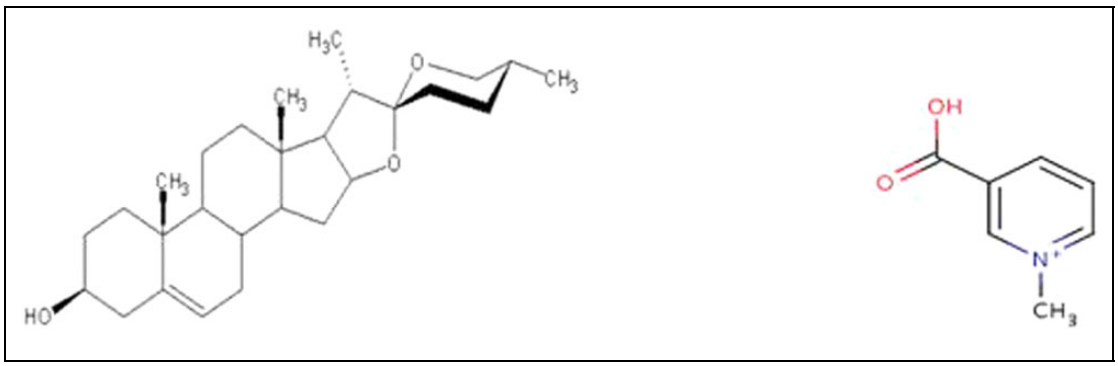

Figure 3. Molecular structure of trigonelline (right) and diosgenin (left).

in many areas of Iran, including Azerbaijan, Isfahan, Fars, Khorasan, Semnan, Damghan, and also central regions (Table 1).[25]

Plant Chemistry

The main ingredients of the seed contain steroidal saponins, alkaloids, mucilage, and fibers (50%).[23]

Steroidal Saponins. The most important steroidal saponins (0.1% to 2.2%) are diosgenin (Figure 3) and yamogenin. Other sapogenins include tigogenin, gitogenin, sarsapogenin, yuccagenin, and smilagenin. The seeds also contain a sapogenin peptide ester named fenugreekine.[26]

Alkaloids. Trigonelline is the alkaloid of this plant that up to 36% concentration of it has been extracted. Other alkaloids of the seed include gentanin and carpaine choline.[23]

Oils. Fenugreek seeds contain fixed oil containing golden yellow and odorless unsaturated fatty acids (6% to 10%). Oil is easily dissolved in ether, benzene, sulfur, and petroleum ether. Fenugreek oil has antimicrobial activity.[23]

Mucilage. Mucilage compounds exist in endosperm of the seed that produce mannose and galactose following hydrolysis. Fenugreek is neutral and contains galactomannan and a xylene. Fenugreek seeds have laxative property and this effect is because of mucilage presence. Mucilage of fenugreek has water-holding capacity against sodium alginate. Also its emulsifying and suspending effect is satisfactory.[26]

Protein Compounds. The amount of protein in this plant is high (22% to 25%), and its protein is rich in lysine, arginine, tryptophan, and to some extent, histidine. It contains low levels of sulfur-containing amino acids, threonine, valin, methionine and high levels of lysine, arginine, and gelicin.[27]

Carbohydrates. The amount of carbohydrates of this plant is about 8%. The seeds of fenugreek also contain proteinase-inhibiting compounds. They are also reported to contain minerals such as iron, phosphate, calcium, and vitamins such as nicotinic acid, B_1, C, A, and D.[23]

Flavonoids. The main flavonoids identified in this plant include glycoside, orientin, isoorientin, vitexin, epigenin, and quercetin.[27]

Aromatic Ingredients of Seeds. The aromatic ingredients of seeds, including *n*-alkenes, sesquiterpenes, and some oxygenized compounds like hexanol have been reported in this plant.[23]

Coumarins. Coumarins available in this plant are lactone *ortho*-dihydroxy cinnamic acid and the presence of a coumarin named scopoletin in fenugreek has also been reported. Other substances like tannins and carotenoid compounds have been reported in seeds.[28]

Traditional Uses of Fenugreek in Iran

According to opinion of traditional medicine experts, fenugreek has a dry and warm nature and its leaves have been used to alleviate cold cough, splenomegaly, hepatitis, backache, and bladder cooling reflex. Also, seeds of the plant have been used as local emollient, a poultice for local inflammation, and as a demulcent to alleviate pain of joints (arthralgia). Infusion of this plant mixed with honey is recommended to treat asthma and internal edemas.[24] Zakariya al-Razi has used fenugreek to treat diabetes and Sheikh Bu Ali Sina has presented some information about therapeutic properties and benefits of this plant in eliminating mouth odor, undesired odor of body and sweat in his book named *Medicine Law*. He has also mentioned some other properties and therapeutic benefits for this plant.[29]

The nature of this plant is dry and warm and has laxative properties. Its oil is useful for hair. Mucilage of fenugreek seeds, especially if mixed with oil of flower, treats striae created by cold. This plant is used to treat skin diseases like black spots and annoying odor of body, mouth, and sweat. It can treat dandruff if it is used as a shampoo. Boiled form of fenugreek helps treat the red spot of eye and helps soften throat and chest and provides relief from cough. Using this plant in the form of powder, infusion, decoction, and pomade has been very common in traditional medicine of Iran from ancient times.[29] The plant can be used for vaginal washing.[1,3] This plant is locally used as an emollient in treatment of pellagra, loss of appetite,

gastrointestinal disorders, and it is also used as a general tonic.[30]

Traditional Uses of Fenugreek in Other Countries

According to writings obtained from ancient civilizations, fenugreek is one of the oldest medicinal plants used in Roam and Egypt to ease childbirth and to increase milk flow. Even today, Egyptian women use this plant as Hilba tea to alleviate menstrual pains and sedating tummy problems.[31]

In the traditional medicine of China also this plant has been used to boost physique, to treat weakness of body, and gout. People with very slender physique in East used this plant to have strong and well-developed physique. This plant has been used in traditional medicine of India as a tonic and also as breast milk stimulant and as a spice. In nonmedicinal applications this plant has been burned and fumed with incense by Egyptians in religious rites and also used to mummify bodies.[32]

Recent Therapeutic and Pharmacologic Investigations

Regarding extensive use recorded for fenugreek and its significant therapeutic value, today many studies have been conducted on different effects of this plant to verify the use of effective compounds and their mechanisms in the treatment of diseases. Recent studies have shown that this plant has extensive effect in treatment of different diseases. The most important pharmacologic effects are presented below.

In Vitro Studies

The inhibitive effects of hydroalcoholic extract of fenugreek extract on growth of cancer cells have been studied and it has been suggested that the extract inhibits growth of these cells up to 70%. Also intraperitoneal administration of 200 mg/kg dosage of the mentioned extract produced 62.3% $\pm$ 12.9% inhibition of inflammation. Furthermore, in this study, 100 and 200 mg/kg doses have significantly increased number of macrophages of the peritoneal environment ($P < .01$).[33]

The saponin-rich dry ethanolic extract of fenugreek seed (extract:plant ratio) is 1:9. This extract with 1.25 minimum inhibitory concentration (MIC) prevents growth of Candida sp. fungi and *Escherichia coli*, Pseudomonas, *Staphylococcus aureus*, and *Enterococcus faecalis* bacteria.[34] One dry extract prepared from seeds of fenugreek with 100 mg/kg concentration has shown mild antibacterial effect on *Bordetella bronchiseptica*, *Bacillus cereus*, *Bacillus pumilis*, *Micrococcus flavus*, *Sarcina lutea*, *E coli*, and *Proteus vulgare* with 17- to 22-mm inhibitory zone compared with 1 mg/mL streptomycin that creates 19- to 32-mm inhibitory zone.[35] Furostanol saponins from fenugreek do have not antibacterial effect but when transformed into spirostanol-type, the produced substance exhibited strong dose-dependent fungicidal effect against *T harzianum*, Trichodermaviride, *Rosellinia necatrix* ($MIC_{50} = 50$ mg/mL) and *Candida albicans* ($MIC_{50} = 25$mg/mL).[19] An aqueous fluid extract of fenugreek (1:1 ratio) shows a mild relaxant effect on smooth muscles of isolated rabbit duodenum when applied at 0.5 mg/mL concentration.[36]

Animal Studies

Clinical and animal studies have suggested that use of seed of fenugreek reduces chronic and also acute blood sugar. In an animal study designed to compare dry extract of fenugreek with insulin in rat, it was shown that 15 mg/kg dose of dry extract of fenugreek decreased 1.5 unit/kg of blood sugar, the same as insulin, in rats made diabetic by aloxan. Cellular variables were studied and it was shown that fenugreek extract, by activating production of insulin in adibocytes and liver cells, was responsible this decrease in blood sugar and glucose tolerance.[37] When fenugreek was added to hypercholesterolemia-inducing diet for rats at levels of 15%, 30%, and 60%, the fecal exertion of bile acids and cholesterol increased dose dependently and increase of serum cholesterol was strongly inhabited at each of the 3 dosages ($P < .001$).[38] Addition of fenugreek at 30% to diet of rats fed on a hypercholestrolaemic diet for 4 weeks caused significant decrease in cholesterol to 201 mg/dL compared with 423 mg/dL in positive control rats ($P < .001$). Serum triglyceride levels were not affected by diet containing fenugreek.[39] In another study, in which dry ethanolic extract defatted from Fenugreek was added to the hypercholestrolaemic diet of rats at 30 g/kg, plasma cholesterol was significantly decreased ($P < .05$) and this effect was attributed to saponins in fenugreek.[40] Steroid saponins purified from fenugreek (12.5 mg/d, per 300 g body weight of animals for 2-4 weeks) significantly lowered plasma cholesterol level in healthy rats ($P < .001$) and streptozotocin-diabetic rats, but did not have any effect on triglyceride levels.[41] When a soluble gel of fenugreek (mainly containing galactomannan) was orally administered to rats, starch digestion and bile salt uptake were inhibited after 600 and 80 mg loading dose of this gel by 50%. Fenugreek administered to rats (50-200 g/kg) increased significantly the secretion of bile acids ($P < .05$), which possibly has been caused by its effect to increase conversion of cholesterol to bile salts.[42] Addition of 2 or 8 g/kg of powdered fenugreek to food of healthy and alloxan-diabetic rats for 2 weeks significantly and dose dependently decreased total serum cholesterol level, triglycerides, low- and very low–density lipoprotein, and cholesterol ($P < .05$ and $P < .001$). It also increased high-density lipoprotein cholesterol ($P < .05$) in inalloxan-diabetic rats.[43] When powdered fenugreek as 20%, 30%, and 60% of diet and 3 fractions prepared from fenugreek (defatted, saponin-free, and crude saponin added at levels equivalent to powder of fenugreek at 30% of diet) were given for 2 weeks to rabbits that had received high-fat diet for 9 weeks, plasma fat profile improved. Fenugreek powder and each fraction lowered cholesterol and triglyceride levels ($P < .01$) and none of mentioned diet had effect on high-density lipoprotein cholesterol but decreased ratio of plasma total cholesterol to high-density lipoprotein cholesterol ($P < .01$). Fraction of crude

saponin was more effective than fenugreek powder and other fractions.[44] In the glucose tolerance test, a suspension of fenugreek powder (0.25 g in 5 mL of water) was administered orally to streptozotocin-induced diabetic rats and decreased blood sugar level after a meal and defatted Fenugreek that was administered orally at 1.89 g/kg body weight for 8 days decreased blood sugar in alloxan-induced diabetic dogs ($P < .05$). This dose of the product decreased response to oral glucose ($P < .05$) and also decreased the basal glucagon ($P < .02$) in healthy dogs.[45] A fiber-rich fraction of fenugreek extract (79.4% fiber) reduced blood sugar ($P < .01$) and blood cholesterol in alloxan-induced diabetic dogs. Trigonelline purified from fenugreek at dose of 50 g/kg body weight administered orally decreased blood sugar significantly in alloxan-induced diabetic rats and this effect was constant for 24 hours.[46]

Aqueous decoction prepared from fenugreek could decrease blood sugar dose-dependently in healthy rats or alloxan-induced diabetic rats that increased to its maximum effect during 6 hours ($P < .05$). Blood sugar decreasing effect of dry ethanolic extract of fenugreek (1:21 ratio) in oral administration at 200 mg/kg body weight in alloxan-induced diabetic rats had effect similar as that of tolbutamide at the dose of 200 mg/kg.[47] Decoction prepared from fenugreek (40 g in 300 mL water) significantly decreased fasting blood sugar (17.7%) in glucose tolerance test when it was orally administered at dose of 4 mL/kg body weight of rabbits.[48] Addition of 20% fenugreek to diet of rats for 2 weeks reduced blood glucose 95% in the starch toleration test (1 g/kg body weight) without any observed change in the glucose tolerance test.[48] Addition of fenugreek powder at 2 or 8 g/kg body weight to diet for 2 weeks decreased blood glucose in healthy rats ($P < .05$) and alloxan-induced diabetic rats ($P < .01$) compared with the control group. Oral administration of 10 mg dose of dry hydroalcoholic extract of fenugreek (containing 12.5% steroid saponin and 4.8% free amino acids) in 300 g rats for 14 days significantly increased level of plasma insulin ($P < .01$) compared with the control group.[49]

Oral chronic administration of dry hydroalcoholic extract of fenugreek seed (12.5% saponin and 4.8% free amino acid) at dose of 10 mg to rats for 2 weeks caused 20% increase in food consumption ($P < .01$) and focus on eating ($P < .01$ on day 14) without any change in amount of drinking water. The same administered diet has decreased total cholesterol ($P < .05$) and low- and very low–density lipoprotein cholesterol ($P < .05$) and increased plasma insulin ($P < .01$).[38] Oral administration of aqueous extract (1:1) at 1 mL/100 g body weight for 5 days accelerated improvement of digestive wounds created by phenylbutazone and azepein in rats, compared with the control group ($P < .05$). This effect was related to surface structure of tissue by fenugreek extract and its mild cholinergic effect.[20] Daily administration of fenugreek seed at 500 mg/kg dose for 4 weeks significantly decreased ($P < .01$) amount of oxalate renal stones formation in rats. Renal stone was formed in these rats by adding 3% glycolic acid to their diet.[50]

4-Hydroxyisoleucine is an important amino acid that is present in the seeds of fenugreek. In one animal study conducted on diabetic rats resistant to insulin and streptozotocin-induced diabetic rats, insulin-resistant diabetic rats and streptozotocin-induced diabetic rats fed with fructose, the indicator of liver damage (aspartate transaminase) was increased significantly (84% and 93%, respectively; $P < .001$) compared with control group, which after 8 weeks of treatment with 4-hydroxyisoleucine (50 mg/kg) became normal in both groups ($P < .01$). In diabetic rats fed with fructose, 4-hydroxyisoleucine caused 36% decrease in blood glucose. Treatment with 4-hydroxyisoleucine in streptozotocin-induced diabetic rats did not change level of blood glucose and liver variables but high-density lipoprotein cholesterol was decreased by 31% ($P < .05$). Researchers of this study concluded that 4-hydroxyisoleucine could control variables related to liver damage in streptozotocin-induced and resistant to insulin diabetes and lead to blood glucose decrease in the first group and high-density lipoprotein cholesterol increased.[40] In a study conducted on rats, addition of extract of fenugreek seed to diet administered with glucose and performing biopsy from muscle tissue after the sport test showed that fenugreek extract increased biosynthesis of muscle tissue glycogen by 63% compared with the control group. In this study, which was performed on streptozotocin-induced diabetic rats, 0.5 and 0.1 g/kg body weight of fenugreek leaf was added daily to feed of rats and 600 mg/kg of antidiabetic drug, glibenclamide was given to the control group. After 45 days, blood sugar concentration, glycated hemoglobin, plasma insulin, and liver enzymes (hexokinase and glucose 6-phosphatase) were measured. Administration of fenugreek leaf (1 g/kg body weight) resulted in decrease of blood sugar concentration and also increase of plasma insulin and activity of hexokinase enzyme (key enzyme in increase of glucose metabolism).[51-53]

Clinical Studies

Effectiveness in Decreasing or Controlling Blood Glucose. In a double blind clinical study performed by Gupta et al,[54] effectiveness in controlling blood glucose was observed. Twenty-five patients with type 2 diabetes were divided into 2 groups and 1 group consumed daily 1 g of dry hydroalcoholic extract of fenugreek seeds and the second group consumed diet followed by exercise to control blood sugar. After 2 months, blood sugar was decreased in both groups (from 148.3 to 119.9 mg/dL in the fenugreek group and from 137.5 to 113 mg/dl in the diet group and sport) but no significant difference was observed between the 2 groups. Researchers concluded that fenugreek as well as diet and exercise both could be effective in controlling and decreasing blood sugar of patients with type 2 diabetes. Sharma et al[55] conducted a randomized, controlled, crossover study in patients with type 2 diabetes. In the study, blood glucose was decreased significantly from 179 ± 24 to 137 ± 20.2 mg/dL as a result of consuming diet containing fenugreek. Glucose tolerance improved in both groups and signs of hyperphagia and polyuria were also improved. Other performed case studies have shown that seed of Fenugreek controls and improves blood sugar in persons with type 2 diabetes.[55]

Treating Body Weakness and Anorexia. This plant is effective in treatment of osteomyelitis and skeletal tuberculosis in children. Some diseases resulted by anorexia and myasthenia can be treated due to the presence of iron, phosphorous, carbohydrates, diastases, and other nitrogenous substances in this plant. This plant can also be used for different cases where prescription of iron and phosphorous supplements is necessary.[25]

Toxicology Studies. Changes related to weight, clinical signs, and serum variables of toxicity like serum glutamic oxaloacetic transaminase and serum glutamic pyruvic transaminase, alkaline phosphatase, creatinine, bilirubin, and blood urea resulting from consumption of fenugreek seed were studied in one study performed on 60 type 2 diabetic patients for 24 weeks. At the beginning of the study both control and treatment groups received daily 300 g of carbohydrates for 7 days and after this period their blood samples were taken to determine base size of variables. A total of 25 g of powdered fenugreek seed was added to the usual diet of patients with diabetes in the day 7. Patients receiving fenugreek seed showed a nonsignificant weight change of 1 ± 1.6 kg. Some individuals who received fenugreek leaf showed digestive problems like diarrhea and cramp that were eliminated after 3 to 4 days. No considerable change occurred in blood variables and no renal or liver side effects were observed.[56]

Side Effects. No special side effects have been reported for fenugreek. One case of decrease in the awareness level of a 5-week old infant who was given fenugreek-containing herbal tea was reported. The problem was related to a metabolism disorder and presence of sotolon in fenugreek seed used in herbal tea.[57]

Sotolon is a lactone derivative and a powerful aromatic compound, with a typical smell of curry or fenugreek and is the major aroma component of fenugreek seed. It is also present in roast tobacco, aged sake and white wine, and dried fruiting bodies of the mushroom.[57] Sotolon can pass through the body relatively unchanged, and consumption of foods high in sotolon, such as fenugreek, can impart a maple syrup aroma to one's sweat and urine. In some individuals with genetic disorder, it is spontaneously produced in their bodies and excreted in their urine, leading to the characteristic smell caused by the disease.[57]

Use in the Lactation Period. Fenugreek can enhance breast milk production. However, with regard to studies performed, breast-feeding women are recommended to consider the following when consuming fenugreek seeds[58]:

1. Fenugreek should be consumed carefully by women who have signs of asthma or digestive disorders.
2. Minimum amount of consumption that provides effect should be considered.
3. It should be avoided in women with blood pressure and patients with cardiovascular diseases.
4. Women who have sensitive skin should check sensitivity to fenugreek.
5. Women who use warfarin plus aspirin should use fenugreek with caution.
6. Women who use fenugreek for their milk supply increase should avoid long-term use of it. It is recommended to check coagulation time and blood glucose test during the consumption period.

Dose and method of use. Use 5 to 10 g thrice as powder per day at mealtimes.[58]

Drug interaction. No considerable drug interaction has been reported.

Discussion

Fenugreek has played an extensive role since ancient times in treating and preventing diseases. The conducted studies also have confirmed many of these traditional applications and have shown clearly therapeutic value of this plant and abilities of the traditional medicine. However, the scientific evidence to determine the mechanism of action of this plant is not enough. Fenugreek has a considerable antidiabetic effect. It can slow down the absorption of sugar in the gastrointestinal tract and stimulate insulin release, resulting in lowering the blood sugar in diabetic patients.[59] Fenugreek is used for seveeral other conditions such as inflammation, loss of appetite, upset stomach, gastritis, atherosclerosis, and hypertension. Breast-feeding women sometimes use fenugreek to promote milk flow. However, the mechanisms of action in these conditions have not been established. Fenugreek has high level of iron and can be used for iron-deficient patients.[25]

It is used for kidney complications and some other toxicities. It has antioxidant activity and it seems that antioxidant property of this plant is one of the main effective factors in creating effects of fenugreek.[59] The antioxidant property of the plant has been attributed to the presence of many active phytochemicals, including flavonoids, plant sterols, vitamins, cumarins, terpenoids, carotenoids, curcumins, lignin, and saponin. However, the phenolic compounds have had the highest contribution in this effect. So, there has been a significant correlation between the polyphenolic components present in the extract and its antioxidant activity.[60]

Free radicals have been shown to induce oxidative stress and are implicated in a wide variety of diseases, including diabetes,[61,62] athrosclerosis,[63,64] cardiovascular diseases,[65,66] neurological disorders,[67,68] and learning disabilities.[69,70] These conditions involve many changes, including alterations redox state.[71,72] Various experimental and clinical trials have shown that plants that have antioxidant activity can combat pathologic conditions especially for the treatment and prevention of life-threatening diseases such as diabetes,[73,74] cancer,[75,76] infections,[77,78] and gastrointestinal disorders.[79,80] Medicinal plants—because they contain antioxidant compounds, bioactive compounds, phenols, flavonoids, and anthocyanin—have been shown to counteract these conditions and are capable of providing drug supply in complementary medicine.[81-109] A lot

of these plants have previously been used for preparation of new drugs or have shown promising results.[110-121] Therefore, fenugreek, which possesses phenolic compounds and antioxidant activity should have the ability to counteract these situations and might be a good candidate for a herbal drug.

Author Contributions

All the authors wrote the first draft of the manuscript equally. MRK revised and edited the last version.

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Ethical Approval

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