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Fenugreek

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Fenugreek Cultivation in the Middle East and Other Parts of the World with Emphasis on Historical Aspects and Its Uses in Traditional Medicine and Modern Pharmaceutical Science

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Abstract

Fenugreek (*Trigonella foenum-graecum* L.) belongs to the botanical family Papilionaceae, and its native geographic range is the area extending from Iran to Northern India, but it is presently cultivated also in other regions of the world. Historically, fenugreek has been used as an important traditional, multipurpose medicinal herb in Iranian, Indian, Chinese, and Tibetan Medicinal Practices for several centuries. The most important compositions of fenugreek seeds are neutral detergent fiber, protein, gum, moisture, lipids, starch, and ash. Fenugreek seeds and leaves are anti-cholesterolemic, anti-inflammatory, anti-tumor, carminative, demulcent, deobstruent, emollient, expectorant, febrifuge, galactagogue, hypoglycemic, laxative, parasiticide, restorative, and uterine tonic and useful in burning sensation. Traditional uses of fenugreek seeds around the world are in bone and muscles, respiratory system, gastrointestinal system, female reproductive system, cardiovascular system, endocrinology, and hepatic. The most important modern health benefits of fenugreek are in appetite suppressant and weight loss, reduce cholesterol, reduce cardiovascular risk, control diabetes, a good relief

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for sore throats, it cures acid reflux or heartburn, relieves constipation, prevents colon cancer, good for kidney trouble, good for skin infection, increases milk production, reduces menstrual discomfort, and it minimizes symptoms of menopause. Integrative use of modern science and traditional medicine with novel technologies and discoveries will secure production of medicinal herbs and promote sustainability in a long-term and a wide-range. Treatment with natural medicine especially barberry as non-synthetic drug is recommended.

Keywords

Trigonella · Fenugreek · Traditional medicine · Modern pharmaceutical science

2.1 Introduction

2.1.1 Fenugreek—History, Occurrence, and Cultivation

Herbal medicines have played a major role in the health care system of many countries throughout the world (Ogbaji et al. 2013, 2018; Shahrajabian et al. 2019a, b, c, d; Sun et al. 2019a, b; Shahrajabian et al. 2020a, b, c, d, e, f, g, h, i, j; Sun et al. 2020a, b). Fenugreek (*Trigonella foenum-graecum* L.) is an annual crop belonging to the legume family (Alaghemand et al. 2017). This crop is native to an area extending from Iran to northern India, but is now widely cultivated in China, north and east Africa, Ukraine, and Greece (Petropoulos 2002). It was called as *Trigonella* from Latin language that means little triangle due to its yellowish-white triangular flower (Shashikumar et al. 2018). Hippocrates considered it a soothing herb. Fenugreek is a Greek hayseed originating in the Mediterranean, Southern Europe, and Western Asia (Altuntas et al. 2005). The Near East region, extending from Israel through Syria and southern Turkey into Iran and Iraq, and the Mediterranean center including Spain, Morocco, and Turkey are the centers of origin of *Trigonella*, *Trifolium*, and *Medicago* species. It is also part of Traditional Persian Medicine (TPM), and more than 32 species of this plant have been found in central regions of Iran. Fenugreek is one of the oldest cultivated medicinal plants identified in written history. According to historical facts, the classical texts of Ayurveda, Charaka Samhita, and Sushruta Samhita were written around 1000 BC and these include 600 medicinal plants along with therapeutics (Jhahhria and Kumar 2016). Fenugreek was introduced into Chinese medicine in the Sung dynasty, 1057 AD. Dioscorides, a Greek physician of Anazarbus in Cilicia and who considered father of pharmacology (65 AD), write that fenugreek is an active compound of ointments and mentions fenugreek as a spice crop in his texts. Both the foliage and seeds of fenugreek are edible and are especially integral to Indian cuisine, found in curries and chutney. The seeds are also sometimes roasted and used in India as a substitute for coffee. The leaves are used to make an herbal tea, and the seeds are sprouted and used as a vegetable in many African nations. Fenugreek is also used in the Jewish version of halvah, a sweet confection. Fenugreek was also used to embalm the dead

Table 2.1 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	Foenum graecum
Species	<i>Trigonella foenum-graecum</i>

of the ancient Egyptians. The herb was used by the Jewish defenders of Jerusalem during the first Jewish-Roman war to repel the invaders from the city wall. Fenugreek was combined with boiling oil and then poured down upon the city walls, making them too slick for the Romans to climb. In Moroccan cuisine, it is the whole fenugreek seeds which are primarily used as a spice. These fragrant, golden seeds most famously show up as a key ingredient in the Moroccan chicken and lentil dish of Rfissa. Due to fenugreek's ability to promote lactation, this particular dish is traditionally prepared for new mothers several days after giving birth. Helba is an ingredient in a number of other cuisines, including Indian, Pakistani, Egyptian, Chinese, Greek, Turkish, and Middle Eastern. Ghormeh sabzi is the quintessential Iranian recipe. It is a stew prepared with fresh herbs that is considered to be the national dish of Iran, and fenugreek leaves are the most important ingredients of it. Fenugreek is resistant to a wide variety of crop diseases; but is susceptible to the fungal pathogen powdery mildew (*Erysiphe polygoni* D. C.) and does not grow well in moist and humid areas that facilitate the fungal infection. This plant is recommended for the semi-arid regions of Asia, Sub-Saharan Africa, and Latin America as a low input, dryland, annual forage legume. The genetics, physiology, and highly specialized arid and semi-arid climate adaptations allow fenugreek to work as an active nitrogen-fixer with low water requirement and allow the crop to grow in arid or semi-arid climatic regimes under low input agriculture system practices in several poor developing and under-developed nations. India is the largest global producer of fenugreek in the world. Since fenugreek is a low input crop marginal lands in Iran could be used for commercial fenugreek production and can contribute towards income generation for farmers with lower capacity for agricultural investments. Also, the rising popularity for fenugreek products in the international markets could be an important opportunity for Iranian farmers for earning extra profit for a low input industrial crop. Basu and Zandi (2017) stated that fenugreek has the potential to become a chemurgic crop suitable for supply of raw materials rich in phytochemicals for the emergent global food and nutraceutical industries. They have concluded that fenugreek foods and fenugreek products show significant promise for sales into global niche markets; if the target consumers are made aware of the important health benefits of fenugreek comprehensively. Botanical classification of fenugreek is shown in Table 2.1. The diversity and current

Table 2.2 The diversity and current distribution of the crop across major continents

Continent	Countries
Asia and the Middle East	Turkey, Israel, Lebanon, Jordan, Syria, Saudi Arabia, Bahrain, Qatar, the UAE, Kuwait, Oman, Yemen, Iraq, Iran, Afghanistan, Turkmenistan, Azerbaijan, China, Taiwan, India, Pakistan, Nepal
Africa	Egypt, Morocco, Tunisia, Algeria, Sudan, Libya, Ethiopia, Eritrea, Kenya, South Africa
Europe	Russia, the UK, France, Spain, Portugal, Greece, Italy, Sweden, Germany, Switzerland, Austria, Hungary, Poland, Ukraine, Romania, Croatia, Slovenia
North America	Canada, the USA
South America	Argentina
Oceania	Australia

Table 2.3 Major *Trigonella* species and their distribution

<i>Trigonella</i> species	Distribution
<i>T. Arabica</i> Delile (Syn. <i>T. pecten</i> Schenk)	N. African, especially in Arabia; Syria to NE Egypt
<i>T. caerulea</i> (L.) Ser. (syn. <i>Melilotus caeruleus</i> Desr. <i>Trifolium caeruleum</i> Moench., <i>Trigonella melilotus caerulea</i> L. Aschers. Et Graebn)	E. Mediterranean region; SE Europe, origin in Mediterranean region
<i>T. caerulea</i> (L.) Ser. ssp. <i>Caerulea</i>	C., W., and S. Europe; N. Africa, widely cultivated in gardens
<i>T. corniculata</i> (L.) L. (syn. <i>Medicago corniculata</i> L. Trautv., <i>Trifolium corniculata</i> L., <i>Trigonella esculenta</i> L.)	Mediterranean region; Near East countries
<i>T. stellata</i> Forsk	N. Africa, Arabia, Egypt, Tunisia, Algeria, Morocco, Canary Islands, W. Asia, Iran, Iraq, Middle East, Israel, Lebanon, Kuwait
<i>T. foenum-graecum</i> L. (syn. <i>Foenum graecum officinale</i> Moench, <i>T. graeca</i> St. Lag.)	Caucasus, ex Soviet Union, C. Asia, E. Europe

distribution of the crop across major continents is shown in Table 2.2. Major *Trigonella* species and their distribution are shown in Table 2.3.

Ogbaji et al. (2018) reported that soaking and germination of fenugreek seeds resulted in significant changes in bioactive components and antioxidant activity. They have found from their results that germinated fenugreek possess more health potential compared to non-germinated fenugreek seeds. Kaur (2016) showed that fenugreek accumulated Pb and translocated it in the harvestable parts of the plants. Metal accumulation increased consistently with increasing concentration of Pb in the treatments. Dry matter yield of plant increased with decreasing Pb concentration in the treatment, and fenugreek can be used for remediation of Pb contaminated soil. Singh et al. (2018) observed that increased green leaf and seed yields occurred when nitrogen level increased and cutting was delayed, and the maximum harvest index (0.44) was when nitrogen was applied at 60 kg/ha and plants were cut at 60 DAS.

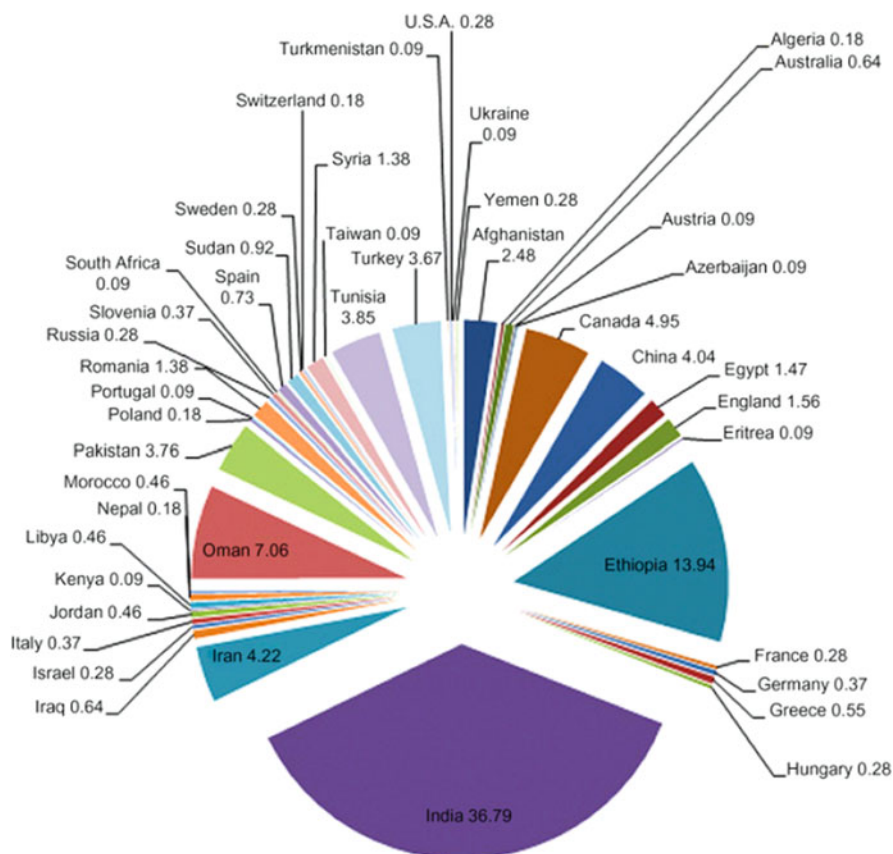


Fig. 2.1 Pie chart indicating relative frequency of fenugreek diversification distributed across different countries

They concluded that delaying cutting increases nitrogen requirement in fenugreek if supplied in proper amount and it results to increased yield. Pie chart indicating relative frequency of fenugreek diversification distributed across different countries is presented in Fig. 2.1.

2.2 Chemical Constituents and Nutritional Composition

Fenugreek is a natural source of iron, silicon, sodium, and thiamine and it contains mucilagins which are known for soothing and relaxing inflamed tissues. Fenugreek seeds contain alkaloids, including trigonelline, gentianine, and carpine compounds; the seeds also contain fiber, 4-hydroxyisoleucine, and fenugreekine, a component that many have hypoglycemic activity (Moradi kor et al. 2013). Seed of fenugreek contains lysine, and L-tryptophan, proteins, mucilaginous fiber and saponins,

Table 2.4 Important phytochemicals reported from fenugreek as a medicinal herb

Trigonelline
Tigogenin
Diosgenin
Apigenin
Kaempferol
Luteolin
Atroside
Yamogenin (Steroidal sapogenins)
Graecunin B, C, D, E, and G (Spirostanol Saponins)
Gitogenin (dihydroxy-sapogenins)
Triterpenoids
Galactomannan (complex carbohydrate)
4-hydroxy isoleucine (essential amino acid)
Fenugreekine (alkaloids)
Saponins
Quercetin (flavonoids)

coumarins, fenugreekine, nicotinic acid, sapogenins, phytic acid, scopoletin, and trigonelline (Bukhari et al. 2008). Important phytochemicals reported from fenugreek as a medicinal herb are shown in Table 2.4.

Fenugreek seeds are a natural source of vitamins such as thiamine, biogenic elements such as Fe, Si, and Na, and a rich source of P and S (El-Nasir and El-Tinay 2007). In the research conducted by Kochhar et al. (2006), fenugreek seeds contained 25.8% crude protein and 6.53% oil. Seed dry matter had the following chemical composition: 3% ash, 6.28% crude fiber, and 58.13% total carbohydrates. El-Nasir and El-Tinay (2007) estimated the protein content of fenugreek seeds at 28.4%, crude fiber at 9.3%, and crude fat at 7.1%. The fatty acid profile was dominated by unsaturated acids: oleic, linoleic, and alpha-linolenic acids which account for 16.3%, 50.0%, and 24.4% of total fatty acids, respectively. The unique mineral and organic properties of fenugreek are exploited in the production of functional and nutritional foods as well as nutraceuticals and cosmetics (Hooda and Jood 2005; Lubbe and Verpoorte 2011). Bienkowski et al. (2017) investigated that fenugreek seeds grown in north-eastern Poland contained 26.0% protein and 4.8% oil. They have observed that total unsaturated fatty acids accounted for 80% of the fatty acid profile, with a predominance of essential fatty acids in oil: linoleic acid (37.9%) and α -linolenic (28.2%) acid. Sowing date and weed control were responsible for up to 3.1%–4.5% of differences in concentrations of essential fatty acids between treatments in their experiment. Composition of fresh fenugreek leaves and mature fenugreek seeds is shown in Table 2.5.

Chandra et al. (2018) revealed that consumption of fenugreek fiber flakes (5 and 10 g) with a standard breakfast increased satiety satisfaction and fullness. Fenugreek fiber flakes reduced hunger and desire to consume food and prospective food consumption in 10 g significantly compared to 5 g. There were no significant

Table 2.5 Composition of fresh fenugreek leaves and mature fenugreek seeds

Component	Leaves	Seeds
Moisture	86.0 g	–
Protein	4.4 g	30 g
Fat	1.0 g	7.5 g
Fiber	1.0 g	50 g
Sapogenins	–	2 g
Trigonelline	–	380 mg
Ca	395 mg	160 mg
Mg	67 mg	160 mg
P	51 mg	370 mg
Fe	16.5 mg	14 mg
Na	76 mg	19 mg
K	31 mg	530 mg
Cu	0.26 mg	33 mg
S	167 mg	16 mg
Cl	165 mg	165 mg
Mn	–	1.5 g
Cr	–	0.1 mg
Choline	1.35 g	50 mg
Vitamin C	52 mg	43 mg
Beta carotene	2.3 mg	96 µg
Thiamine	40 µg	340 µg
Riboflavin	310 µg	290 µg
Nicotinic acid	800 µg	1.1 µg
Folic acid	–	84

Values expressed per 100 g

changes observed in glucose homeostasis with fenugreek fiber flakes. Fenugreek fiber flakes 5 g and 10 g showed an acceptable safety profile. In their study fenugreek fiber flakes have a role in the control of food intake in normal individuals who want to use diet as a method to control energy intake through their effects on appetite suppression and food intake.

2.3 Traditional and Modern Pharmaceutical Sciences

Fenugreek seeds are used in remedies for diabetes and hyper-cholesterolemia in Indian, Arabic, and Chinese medicine. Traditional Persian medicine (TPM) is one of the ancient traditional medicines, recommended prescriptions that are still in use in Iran and different countries in west and center of Asia for many diseases like asthma (Emtiazy et al. 2018). Zakariya al-Razi has used fenugreek to treat diabetes and Sheikh Bu Ali Sin 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*, and he has also mentioned some other properties and

therapeutic benefits for this plant (Bahmani et al. 2016). The nature of this plant is dry and warm and has laxative properties; its oil is useful for hair. Its mucilage in 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 (Bahmani et al. 2016). Using this plant in the form of powder, infusion, decoction, and pomade has been very common in traditional medicine of Iran from ancient times (Bu Ali Sina 1988). 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 (Sweetman 2009). The plant has been used for centuries in Indian Ayurvedic Treatment (IAT) as well as traditional Chinese medicine (TCM), and Unani System of Medicine (USM) as important medicinal herb (Thomas et al. 2006; Khan et al. 2017). Traditional Chinese herbalists used this plant for kidney problems and conditions affecting the male reproductive tract. The seeds also function as a preservative and are added to pickles, chutneys, and other similar products (Vortex health, Fenugreek). In modern food practice, the seeds or the extract are used in bakery products, frozen dairy products, meat products, relish, condiments, candy, gravy sauces, gelatin puddings, and in alcoholic and non-alcoholic beverages. The nourishing seeds are given during convalescence and to encourage weight gain, especially in anorexia. The seeds freshen bad breath and help restore a dulled sense of taste. The oil in the seeds is used as a skin softener and emollient. In China, the fenugreek seeds are used to treat cervical cancer. In the Middle East and the Balkans, the aerial parts of plants are a folk remedy for abdominal cramps associated with both menstrual pain and diarrhea or gastroenteritis. They are also used to ease labor pains (Indian food, Fenugreek) (Moradi kor et al. 2013). In addition to its medicinal properties, fenugreek is also recognized for its culinary value, and the plant is widely used as a spice that not only improves the taste of food, but also contributes to metabolic functions and overall health (Zuk et al. 2017). Wijaya et al. (2013) found that in traditional medicine, fenugreek is used to prepare infusions, water and alcohol extracts, tinctures, meads, tonics with antidepressant and psychotonic properties, and muscle growth supplements. Fenugreek is used in the treatment of seborrhea, acne, and dermatitis, and it is widely used in cosmetology (Wijaya et al. 2013). In traditional Persian medicine is used as an appetite stimulant, lung tonic and chest wall analgesic, also enhances breathing and lung secretion, clears the voice, and induces menstruation (Emtiazy et al. 2018). Yao et al. (2019) reported that fenugreek extract and its bioactive compounds showed excellent anti-diabetic activity and anti-obesity activity in studies; they have concluded that, although the fenugreek seed has been used as TCM raw materials for a long time of period in China, China is lacking the research of fenugreek in both depth and width. The rich medicinal properties of fenugreek is attributed to the presence of a wide diversity of important phytochemicals in the seeds and leaves of the plant like trigonelline, fenugreekine (alkaloids), atroside, quercetin (flavonoids), diosgenin, tigogenin, yamogenin (steroidal sapogenins), gitogenin (dihydroxy-sapogenins) triterpenoids, galactomannan (complex carbohydrate), and 4-hydroxy isoleucine (essential amino acid). Both

leaves and seed have important medicinal properties and are known to reduce blood glucose (anti-diabetic), and blood cholesterol (anti-hypercholesterolemic) levels in both human subjects and in experimental animals. Acharya et al. (2006) reported that leaves and seeds of fenugreek have been used extensively for medicinal purposes. Its seeds are known to exhibit anti-diabetic and anti-nociceptive properties and effects such as hypocholesterolemic, anti-cancer, and thyroxine-induced hyperglycemia. Fenugreek leaves and seeds have been used extensively to prepare extracts and powders for medicinal uses (Basch et al. 2003). Its utility has been proved experimentally in diabetic humans (Sharma and Raghuram 1990). Fenugreek is reported to have anti-diabetic, anti-fertility, anti-cancer, antimicrobial, anti-parasitic, and hypocholesterolemic effect (Al-Habori and Raman 2002). In India, fenugreek is used as a lactation stimulant (Tiran 2003). Fenugreek seed in powder or germinated form exhibits anti-diabetic properties (Broca et al. 2004; Devi et al. 2003), hypocholesterolemic (Suboh et al. 2004; Devaraj and Devraj 2003), anti-cancer (Devasena and Menon 2003), effect on thyroxine-induced hyperglycemia, and protective effect on ethanol toxicity (Thirunavukkarasu et al. 2003). Kaviarasan et al. (2006) suggested that the polyphenolic compounds of fenugreek seeds can be considered cytoprotective during ethanol (EtOH)-induced liver damage. Badale et al. (2019) concluded that diosgenin alone did not cause any particular body weight or fat gain, but is likely to interact in a complex manner with the other ingredients of the fenugreek seeds. Fenugreek seeds are healthy but very bitter legumes, making these seeds difficult to be consumed as it is or to formulate fenugreek-enriched food products. When incorporated into food products, including breads, cookies, pastas, and tortillas, fenugreek seeds can improve insulin sensitivity.

Walli et al. (2015) suggested that extracts of fenugreek may have antibacterial activity against some human pathogens. They have shown that only the boiling water extract contains the antimicrobial active ingredients of fenugreek seeds, while both cold water extract and methanol extract are not suitable for such purposes. Hassani et al. (2019) noticed that fenugreek is effective for fasting blood sugar (FBS) and HgA1C control, lowering body mass index (BMI), waist circumference, blood pressure and improving quality of life in type 2 diabetes mellitus (T2DM) patients. They have found that it can be ingested simply without adverse effects for blood glucose control in such patients. Avni et al. (2019) considered fenugreek as a useful medicinal plant for treatment of various dysfunctions and diseases in recorded history and in Ayurveda. They have mentioned that fresh leaves are also used as vegetables in the diets and the leaves is known for its medicinal qualities such as anti-diabetic, anticarcinogenic, hypocholesterolemic, and antioxidant. Lamfon (2012) discovered that fenugreek treatment leads to a significant decrease in the level of malondialdehyde (MDA) and increase in the activity of superoxide dismutase (SOD) and catalase (CAT). It is concluded that fenugreek extract can improve the testicular toxicity of carbendazim and this effect may be attributed to its antioxidant properties. Helal et al. (2019) observed that the high levels of fenugreek and soymilk intake can cause hormonal disturbance and decrease sperm count. They have suggested that the fenugreek oil and soy milk have high potential of negatively altering the lipid profile and increasing the health risks associated with a poor lipid

profile. Furthermore, both the fenugreek oil and soymilk possess potentials that can impair hormonal functions and fertility as demonstrated in their experiment. Badr (2017) concluded that 2.5% fenugreek is safe to be used as a hypocholesterolemic agent without any side effect for better kidney structure and function. El-Hak and Elrayess (2018) noticed that fenugreek seeds are rich with different benefits and medical compounds that have antioxidant and anti-inflammatory activity. Fenugreek seeds not recommended to be used to increase the male fertility, and if will be used should be used in low doses for a short time as using low doses of phytoestrogen neither affects the semen quality nor the reproductive function.

Kaya et al. (2019) observed that fenugreek prevented the proliferation of the parasite at certain times, and they thought that the dose can be increased when a rapid effect fenugreek extract on the parasite is desired ($LD_{90} = 36.92$ mg/mL), and the dose can be decreased if a long-term effect is expected ($LD_{90} = 16.42$ mg/mL). Sundaram et al. (2018) showed that fenugreek powder can be used adjunctive to scaling and root planning (SRP) to control the glycemic status and serum lipid levels in uncontrolled noninsulin-dependent diabetes mellitus (NIDDM) patients. Sharma et al. (2017) discovered that from bacteriological point of view fenugreek leaves and stem appear to play a great role in clinical as well as antibacterial agents. Poole et al. (2010) concluded that 500 mg of proprietary fenugreek extraction had a significant impact on both upper- and lower-body strength and body composition in comparison to placebo in a double blind controlled trial. Chourasiya et al. (2019) presented that not only substantiates the folklore use of the seed of fenugreek, but also suggests its inclusion in the treatment of anemia as it exhibited significantly anti-anemic activity. Kiss et al. (2019) did do a research and their study shed light to that chronic consumption of fenugreek seed is able to influence the complex interplay of anabolic hormones, their results also indicate that apart from its proven insulin sensitizing effect fenugreek might have a therapeutic potential in the adjuvant treatment of thyroid diseases. Singaravelu et al. (2018) announced that fenugreek seed extract is rich in polyphenol which protects the erythrocyte from oxidative damage and maintains the hemoglobin and PCV values. They have concluded that fenugreek seed extract has both gastro-protective and antioxidant property. Devi et al. (2013) in their study proved that a regular intake of fenugreek could reduce the oxidative stress by reducing the lipid per oxidation.

Bae et al. (2015) emphasized that fenugreek tea might be helpful on appetite control by reducing further food intake in overweight women. Abeysekera et al. (2018) concluded that seed extract of fenugreek had both anti-glycation and glycation reversing activities in BSA-glucose model. They have concluded that glycation reversing activity of fenugreek seed is a novel finding for anti-diabetic properties of fenugreek and indicates potential use in managing advanced glycation end products associated pathologies in diabetic patients. The most important health benefits of fenugreek are listed in Table 2.6.

Ajaya and Paramahand (2009) revealed that fenugreek in the diet showed a marked decrease in diabetes induced polydipsia, polyuria, urine sugar, hyperglycemia, renal hypertrophy, and glomerular filtration rate. The results of their experiment showed the beneficial effects of fenugreek in reducing kidney damage during

Table 2.6 The most important health benefits of fenugreek

It is used as appetite suppressant, and it facilitates weight loss
It reduces cholesterol
It reduces cardiovascular risk
It helps to control diabetes
It is a good relief for sore throats
It cures acid reflux or heartburn
It relieves constipation
It prevents colon cancer
It is good for kidney trouble
It is good for skin infection
It increases the milk production
It reduces menstrual discomfort
It minimizes symptoms of menopause

diabetes. Walli et al. (2015) indicated that only the boiling water extract contains the antimicrobial active ingredients of fenugreek seed, while both cold water extract and methanol extract are not suitable for these purposes. Sadak (2019) demonstrated the effect of silver nanoparticles on fenugreek plant. In his experiment, different concentrations increased plant growth, photosynthetic pigments, IAA contents, and yield quantity and quality. Among various concentrations used in the study, 40 mg/l AgNPs was the most effective treatment for the improvement in growth, biochemical parameters studied, and yield of fenugreek.

Zhou et al. (2019) successfully overcame the limitation of hydrophilicity of fenugreek gum by conjugating stearic acid as a hydrophobic chain through a simple esterification reaction. The obtained FG-C₁₈ could self-assemble into spherical nanomicelles with narrow size distribution. And FG-C₁₈ showed low hemolysis with the hemolytic ratio less than 5%. In vitro cytotoxicity studies showed high cell viability either on HepG₂ cells or on MCF-7 cells. Cellular uptake showed that C6-FG-C₁₈ NMs with galactose residues could specifically recognize ASGP-R receptor on HepG2 cell surface compared to C6 solution. Finally, they reported that FG-C₁₈ NMs showed enormous potential applicability as nanocarriers for intravenous administration of poorly soluble drugs due to biocompatibility, low toxicity, and liver-targeting potential. Figer et al. (2019) reported that in the human gastric carcinoma epithelial cells, fenugreek protected against the damage induced by ethanol at 5 µg/mL; whereas a protection of 67% at the dose of 1000 mg/kg was observed in the animal studies. The flavonoid derivatives, namely vitexin-7-O-glucoside, vicenin-2, orientin, and luteolin showed good interactions on H⁺/K⁺ ATPase while the saponins lacked good interaction in *in silico* analysis. Fenugreek seed extract showed gastroprotection in both: *in vitro* and *in vivo* studied and the possible mechanism of action for the extract was elucidated by *in silico* studies. Singh et al. (2013) stated that fenugreek leaves and seeds have been used extensively for medicinal purposes. Fenugreek seed is known to exhibit anti-diabetic properties and effects such as hypcholesterolemic, anti-cancerous, and thyroxine-induced hyperglycemia. They differ in morphology, growth habit, biomass and seed

production capability, and chemical constituents of the seed, for example, polyphenol, phytic acid, saponin, carbohydrate, protein, and proximate analysis contents also differed markedly.

Khan et al. (2018) confirmed that the study of pharmacology and phytochemicals may help to understand the effect of sprouted fenugreek seeds in traditional as well as future use of medicinal plants. Fenugreek can be recommended for the diet and must use in daily habit for its medicinal health benefits and its safe use. The side effects of fenugreek are nausea, gastrointestinal discomfort which includes diarrhea and gas. Wani and Kumar (2018) recommended fenugreek as daily diet as its liberal use is safe and various health benefits can be drawn from this valuable natural herb, on the basis of several health usefulness and various scientific findings reported in the past. 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 (Shahrajabian et al. 2020a): (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 (Turkyilmaz et al. 2011).

2.4 Conclusion

Fenugreek (*Trigonella foenum-graecum* L.) is an aromatic, medicinal plant rich in several important phytochemicals. Historically, fenugreek has been used as an important traditional, multipurpose medicinal herb in Iranian, Indian, Chinese, and Tibetan Medicinal Practices for several centuries. It is named as Methi (Hindi, Urdu, Punjabi, and Marathi), Hulba (Arabic), Moshoseitaro (Greek), Uluva (Malayalam), Shoot (Hebrew), Dari (Persian), and heyseed in English. Fenugreek plant history dates back at least to around 4000 BC. Its name is derived from its Latin name, *Trigonella foenum-graecum*, meaning Greek hay, in reference to the Greek tradition of amending inferior hay for livestock with fenugreek. Historical uses for fenugreek were predominantly medicinal and were thought to cure a gamut of disorders from fever, colic, flatulence, dysentery, coughs, tuberculosis, oedema, rickets, ulcers, gout, diabetes, and even baldness. The seeds also have been used to promote lactation and as an aphrodisiac. The plant is traditionally grown in major parts of South Asia, Middle East, North Africa, and Mediterranean Europe as a spice crop, and as an ingredient of the famous East Indian curries or as a part of the traditional curry mix powder of the Indian subcontinent. It is a very well-known traditional spice which is famous to South Asians and South Asian diaspora spread across the globe. The highest number of fenugreek cultivars is reported from India, Pakistan, and China; followed by North African countries (Egypt, Tunisia, Morocco, Algeria,

Libya, Sudan), Horn of Africa (Ethiopia, Eritrea), sub-Saharan African nations (Kenya, South Africa), the Middle East nations (Turkey, Israel, Oman, Jordan, Syria, Yemen, Iran, Iraq), and European countries (United Kingdom, France, Italy, Spain, Portugal, Germany, Greece, Romania, Slovenia, Poland, Austria, Switzerland, Hungary, Azerbaijan). Chemical constituents of fenugreek are proteins (Globulin, Albumin, and Lecithin), lipids fatty acids (Linoleic acid, A-Linolenic, Oleic, Stearic acids, Palmitic and Sterols, B-Sitosterol, Campesterol, Triunsaturated, Cycloartenol, and Diunsaturated Triacyl Glycerides), carbohydrates (Mucilage or Gum: galactomannan), saponins (Graecunins, Fenugrin B, Fenugreekine, Trigofenosides A-G), Steroidal saponins (Diosgenin, Yamogenin, Gitogenin, Tigogenin, Neogitogenin, Smilagenin, Sarsapogenin, Yuccagenin), flavonoids (Apigenin, Luteolin, Vitexin, Isovitexin, Quercetin, Kaempferol-Dirhamnoside, Kaempferol Rhamnoside, Orientin, Biochanin A, Formononetin, Irlone, Tricine, Daidzein, Calycosin), alkaloids (Trigonelline, Gentianine, Carpaine, Choline), fibers (Gum, Neutral Detergent Fiber Lipids Triacylglycerols, Diacylglycerols, Monoacylglycerols, Phosphatidylcholine, Phosphatidylethanolamine, Phosphatidylinositol, Free Fatty Acid), and amino acids (Isoleucine, 4-Hydroxyisoleucine, Histidine, Leucine, Lysine, L-Tryptophan, Arginine). The general uses of fenugreek are for bread, biscuits, extruded product, culinary use (color, flavor, aroma), spice and seasoning, organoleptic character improver, maple syrup and artificial flavoring, dietary fiber, galactomannan, curries, condiments, pickles, chutneys as a flavoring, food stabilizer, adhesive, and emulsifying agent. Traditional herb and medicine are making inroads into diets with their promises to improve health and nutrition. Consumers should choose nutritional and healthy food to maintain general health and reduce the risk of health problems. Traditional medicines and super-food and fruits play important role in sustainable agriculture and food system, it also offers a holistic approach to prevent diseases while making appropriate use of organic and herbal products especially growth by consumers.

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