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Effect of sprouted fenugreek seeds on various diseases: a review

Abstract

The reference use of fenugreek in diabetes mellitus, obesity, metabolic syndrome and other various diseases such as antibacterial, anti-inflammatory, hypo-lipidemic, antiaging and antioxidant etc. These disease treatment are available in indigenous system of literature i.e. AYUSH literature but there are little data being contemporary in modern parameters of outcome. Sprouted fenugreek seeds have amazing benefits on the metabolic diseases and hence we can use these seeds as a large number of nutraceuticals. These sprouted fenugreek seeds lower the absorption of glucose from the large intestine and improves beta cells generation in the pancreatic Islet's of Langerhans. Also imparts the antioxidant property on various systems to protect from free radical's generation. Some unlikely effects were also shown by fenugreek sprouts such as diuretic, maple-syrup odor and bitter smell. Besides that fenugreek sprouts have amazing effect on the body.

Keywords: type II diabetes mellitus, sprouted fenugreek seeds, metabolic syndrome, obesity, fasting blood glucose, serum lipid profile

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Introduction

For many past years of mankind, plants were using as a source to alleviate or cure chronic illness such as diabetes, hypolipidemic, anti-arthritic, cardio-vascular diseases, cancer, antibacterial etc. Herbal plants are rich in pharmacologically active compounds and hence these medications are used in worldwide in many years. Fenugreek is an annual crop plant and the biological name is Trigonella foenum graecumis family *'Fabaceae'*, its common name is *"methi"*. It is an herb cultivated for its seeds majorly in Mediterranean countries. In India, it is mainly cultivated in regions of Rajasthan (maximum production), Tamil Nadu, Gujarat, Madhya Pradesh, Punjab and Uttar Pradesh. Apart from the flavouring properties of its seeds, it has been able to mark its presence in Ayurvedic system of medicines since ages, owing to its nutritional and therapeutic benefits. It is a rich source of fibers, proteins, vitamin A and C, iron and calcium. It is a highly recommended medicinal plant for treatments of various dysfunctions and diseases, as recorded in history of Ayurveda. Being rich in photochemical like phenols, flavonoids, alkaloids and tannins, it has been tagged as antidiabetic, anticarcinogenic, hypocholesterolemic, antioxidant and immunological booster. Many studies have reported antioxidant properties of fenugreek seeds,[1] Fenugreek seed powder supplementation in diet has also been reported to reduce oxidative damage biomarkers in alloxan-diabetic rats,[2] Further polyphenols present in the seeds are known to prevent oxidative haemolysis and lipid peroxidation induced by hydrogen peroxide in vitro, in human erythrocytes.[3] Germination or sprouting is a processing intervention by which nutritional content of the crop can be enhanced significantly.[4] Sprouting has shown to improve the nutritional profile of fenugreek seeds and decrease the fiber content such that it gets digested and absorbed in the system more easily. Also, germinated fenugreek seeds have higher antioxidant content and enhanced antidiabetic effect than its boiled counterpart.[5] This effect was attributed to the release or higher bioavailability of bound antioxidants upon germination. Physical conditions such as light and temperature, genotype[6] and chemical composition of seeds have also been reported to be a cause of variation on antioxidant properties and germination of fenugreek seeds.[7] Few reports are available on the effect of germination on total phenol content and antioxidant properties of fenugreek seeds. These studies either employed use of natural elicitors like fish protein hydrolysates, lactoferrin and oregano extract for sprouting fenugreek seeds.[8] Different fractions of the germinated seeds were evaluated for the phytochemical analysis.[9] However, very few studies have been conducted on antioxidant properties of whole aqueous extract of germinated fenugreek seeds of varieties available locally in Delhi/NCR region of India. Thus, present study is aimed to investigate the effect of germination on total phenolic content and antioxidant properties of fenugreek seeds in Delhi/NCR region for the purpose of using it as a nutraceutical, showing maximum potential of antioxidant activity under given conditions.[10]

Soaking and germination of fenugreek seeds

Fenugreek seeds in eight portions of 50g each were soaked in 70% ethanol solution for 15minutes at room temperature for disinfection. Soaked seeds were then washed with tap water and distilled water. Washed seeds were then soaked in distilled water (1:10 w/v) for 12h at room temperature. The presoaked seeds were again washed in distilled water and kept for germination on flat trays lined with moist paper towel. The trays were covered with aluminum foil for dark germination. The germinating seeds were kept moist with distilled water and germinated for 7days. Sprouted seeds after each day starting from first day were frozen to stop further germination.[11]

Phytochemistry

Fenugreek contains a number of chemical constituents including steroidal sapogenins. Diosgenin component has been found in the oily embryo of fenugreek. There are two furastanol glycosides, F-ring opened precursors of diosgenin that have been reported in fenugreek also as hederagin glycosides. Alkaloids such as trigocoumarin, nicotinic acid, trimethyl coumarin and trigonelline are present in stem.

The mucilage is a standing out constituent of the seeds.[12]

There is about 28% mucilage; a volatile oil; 2 alkaloids such as trigonelline and Choline, 5% of a stronger-smelling, bitter fixed oil, 22% proteins and a yellow coloring substance are present in stem.[13] Fenugreek contains 23–26% protein, 6–7% fat and 58% carbohydrates of which about 25% is dietary fiber. Fenugreek is also a rich source of iron, containing 33mg/100g dry weight.[14]

Leaves

The leaves contain seven saponins, known as graecunins. These compounds are glycosides of diosgenin. Leaves contain about 86.1%moisture, 4.4%protein, 0.9% fat, 1.5%minerals, 1.1%fiber, and 6%carbohydrates. The mineral and vitamins present in leaves include calcium; zinc iron, phosphorous, riboflavin, carotene, thiamine, niacin and vitamin C.[15] Fresh leaves of fenugreek contain ascorbic acid of about 220.97mg per 100g of leaves and b-carotene is present about 19mg/100g. On the other side, it was reported that 84.94% and 83.79% ascorbic acid were reduced in sun and oven-dried fenugreek leaves respectively. Fresh leaves are used as vegetables in the diets. It was found that there was a better retention of nutrients in the leaves of fenugreek. The leaves of fenugreek should be stored in either in refrigeration conditions, or dried in oven, or blanched for sometime (about 5min) and should be cooked in pressure cooker.[16]

Seed

Fenugreek is known for its pleasantly bitter, slightly sweet seeds. The seeds are available in any form whether whole or ground form is used to flavor many foods mostly curry powders, teas and spice blend. Fenugreek seed has a central hard and yellow embryo which is surrounded by a corneous and comparatively large layer of white and semi-transparent endosperm. The chemical composition of fenugreek (such as seeds, husk and cotyledons) showed that endosperm had the highest (4.63g/100g) saponin and (43.8g/100g) protein content.[17]

As against this, husk contains higher total polyphenols. The extracts of endosperm husk, and fenugreek seed at about 200µg concentration exhibited antioxidant activity 72%, 64%, and 56% respectively by free-radical scavenging method. The seeds of fenugreek contain about 0.1–0.9% of diosgenin and are extracted commercially. The plant tissue cultures from seeds of fenugreek when grown under optimal conditions have been found to produce as much as 2% diosgenin with smaller amounts of trigogenin and gitongenin. Seeds also contain the saponin (fenugrin B). Fenugreek seeds have been found to contain several coumarin compounds as well as a number of alkaloids (e.g., trigonelline, gentianine, carpaine). The large amount of trigonelline is degraded to nicotinic acid and related pyridines during roasting. The major bioactive compounds in fenugreek seeds are believed to be polyphenol compounds, such as rhaponticin and isovitexin. Small amount of volatile oils and fixed oil has been found in fenugreek seeds. Fenugreek on the aroma detection with the help of Gas Chromatograph and these includes the olfactometry iacetyl, 1-Octene-3-one, sotolon, acetic acid; 3-Isobutyl-2-methoxypyrazine, butanoic acid, isovaleric acid, 3-isopropyl-2-methoxypyrazine, caproic acid, eugenol, 3-Amino-4,5-dimethyl-3, linalool, (Z)-1,5-Octadiene-3-one, 4-dihydro-2(5H)-Furanone with characteristic aroma of buttery like, roasty/earthy, metallic, pungent, paprika like, sweaty/rancid, flowery, musty, spicy respectively. A study was conducted on sweat of human after fenugreek ingestion and it has been concluded that compounds responsible for the strong maple-syrup odor present in sweat after fenugreek ingestion are due to the following components including the following: pinene;3-octen-2-one, 2,5-dimethylpyrazine, b-; camphor; terpinen-4-ol; 4-isopropylbenzaldehyde; neryl acetate and b-caryophyllene but it was observed that 2,5-dimethylpyrazine to be a major component responsible for sweat odor contributing compound.[18]

Traditional uses

The medicinal value of fenugreek seeds is mentioned in Ayurvedic texts as well as in Greek and Latin pharmacopoeia. The Ayurvedic texts praise this herb for its power as an aphrodisiac, but modern *vaidyas* seem to be using it more for digestive and respiratory problems stemming from an excess of *kaph* (phlegm) and *vat* (wind). In ancient Egypt, *methi* was used to ease childbirth and to increase milk flow, and modern Egyptian women are still using it today to relieve menstrual cramps, as well as making *hilba* tea out of it to ease other kinds of abdominal pain. The Chinese call it hu lu ba, and also use it for treating abdominal pain. Though this cool season crop is grown in most corners of the world, its uses and people's awareness of its value vary considerably. In India, fresh *methi ka saag* (the stems and leaves of the plant) is very commonly cooked as a winter vegetable, and the seeds are used year round as a flavoring agent for various dishes. The seeds are also eaten raw as sprouts and used medicinally. In Egypt and Ethiopia, *methi* is used in baking bread, and the Swiss use it for flavoring cheese. In the USA, it is mainly used to make spice blends for soups and stews. The herb of fenugreek has been used for centuries as a cooking spice in European countries and it remains a popular ingredient in curry powders, pickles and spice mixtures in India, Pakistan, Bangladesh and other Asian countries. Fenugreek has been used in the folk medicines for the treatment of cellulitis, boils, and tuberculosis. Fenugreek remained a key ingredient in a 19th century patent medicine for dysmenorrheal and postmenopausal symptoms. It also has been recommended for the promotion of lactation. The seeds of fenugreek have been used as an orally as insulin substitute for reduction in blood glucose, and the extracts from seed have been reported to lower blood glucose level. The maple aroma and flavor of fenugreek have led to its use in imitation maple syrup.[19]

Mechanism of action

The hypoglycemic effects of fenugreek have been attributed to several mechanisms. *In vitro* the amino acid 4-hydroxyisoleucine in fenugreek seeds increased glucose-induced insulin release in human and rat pancreatic islet cells. This amino acid appeared to act only on pancreatic beta cells, since the levels of somatostatin and glucagon were not altered. In human studies, fenugreek reduced the area under the plasma glucose curve and increased the number of insulin receptors, although the mechanism for this effect is unclear. In humans, fenugreek seeds exert hypoglycemic effects by stimulating glucose-dependent insulin secretion from pancreatic beta cells, as well as by inhibiting the activities of alpha-amylase and sucrase, two intestinal enzymes involved in carbohydrate metabolism. Fenugreek seeds also lower serum triglycerides, total cholesterol (TC), and low-density lipoprotein cholesterol (LDL-C). These effects may be due to sapogenins, which increase biliary cholesterol excretion, in turn leading to lowered serum cholesterol levels. The lipid-lowering effect of fenugreek might also be attributed to its estrogenic constituent, indirectly increasing thyroid hormone T4.[20]

Antidiabetic activity

One of the chronic metabolic diseases is diabetes mellitus which occurs as a result of disordered metabolism of carbohydrates, proteins,

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and lipids. Though several forms of treatments are available in terms of medications and injectable insulin, they are accompanied with side effects. Diabetes mellitus can be regulated by the food habits which not only offer an economical approach but also are rich in chemical constituents that will help in maintaining blood glucose level. One of the well-studied herbal plants is fenugreek which has been quite researched with respect to its effect on diabetes.[21] It is documented that seeds, leaves, and its extracts are a good agent in our fight against diabetes. Diabetes was induced by streptozotocin in rats and effect of fenugreek water seed extract was determined via three different dose levels by intragastric intubation. It was observed that there was a weight gain in fenugreek treated mice as compared to the group that received only streptozotocin. In addition, blood glucose level decreased to a greater extent as compared to the group that received streptozotocin only. Similar results were obtained in the study done by another group of researchers who found that there was an increase in the body weight of rabbits that were supplemented with fenugreek as compared to the alloxan monohydrate induced diabetic rabbits.[22] Plasma glucose level was reduced by the oral administration of fenugreek seed powder not only in the diabetic rabbits but also in nondiabetic rabbit. Histopathological analysis of pancreas of placebo controls was done in which normal acini and cytosol in the islets of Langerhans was observed. But there was an extensive damage to islets of Langerhans and reduced dimensions of islets in alloxan induced diabetes. Islets of Langerhans in diabetic rats that were treated with fenugreek extract were found to be restored.[23]

An active compound can also be isolated from the crude extract which can perform a beneficial role against the glucose level. In a study in which the GI was isolated from the aqueous extract of fenugreek seeds. Even in Egyptian folk medicine, fenugreek held an important place as a hypoglycemic agent. The extract of fenugreek in a dose dependent manner was able to inhibit α–amylase activity. A further in vivo study concluded and confirmed in vitro inhibition as it showed suppression of starch digestion and absorption in normal rats, suggesting that the hypoglycemic effect of the used plant extract was mediated through insulin mimetic effect.[24]

The effects of on the human patients who had reduced blood glucose concentration after the consumption of either the sprouted fenugreek seeds. Greater amount of reduction was observed using the whole seed followed by the gum isolated from cooked or uncooked seeds. In another study by the same group, it was observed that, on consecutive consumption of sprouted fenugreek seeds, serum total cholesterol, LDL and VLDL cholesterol, and triglycerides were significantly reduced but no effect on HDL cholesterol levels was found. The important constituents that are found to be responsible for generating the antidiabetic effects are galactomannan rich soluble fiber fraction, saponin, and an amino acid called 4–hydroxyleucine which helped in increasing insulin in hyperglycemic rats and humans.[25]

Antioxidant activity

Free radicals are being studied by the researchers for a long time as radicals are a source of ROS that hamper the structure of lipid membrane and thus initiate cascade of events leading to various diseases. To suppress generation of free radicals, natural products have been found as safe and effective remedy. One of the herbal extracts which are known to have antioxidant potential is fenugreek. Various studies have been done by the researchers to determine the antioxidant potential of fenugreek.[26] That methanolic seed extract was able to quench the free radicals. This group in another set of experiments investigated the protective effect of fenugreek seed polyphenol extract. Rat liver was damaged using ethanol but when treated with fenugreek seed polyphenol extract (200mg kg−1 day−1) there was a significant reduction in the levels of lipid peroxidation products and protein carbonyl content. Also there increase in the activities of antioxidant enzymes along with restoration of the levels of thiol groups. Similar study was conducted on rats by using sprouted fenugreek seeds. Ethanol was fed for 60 days to induce toxicity in rats which resulted in enhancement in the activities of serum aspartate transaminase, alanine transaminase, and alkaline phosphatase.[27] However, simultaneously administrating the seed of fenugreek resulted in an increase of antioxidant level and prevented further rise in lipid peroxidation. The administration of sprouted fenugreek seed could result in prevention of the enzymatic leakage and the rise in lipid peroxidation and enhancement of the antioxidant potential. Histopathological studies related to the rat liver and brain revealed the protective role of the seed extract against ethanol induced toxicity. The constituents that are understood to be responsible were flavonoids and phenolic compounds which generally marks their presence in the polar solvent system due to their self-polar nature. Thus, due to the ability of fenugreek extracts to quench the radicals, it can be a useful candidate to alleviate the harmful effects of various diseases and thus can be used for treatment purposes.[28]

Antitumor and Anticarcinogenic Activity

The chemical constituents of fenugreek possessing anticancer activity are phytoestrogens and saponins. Saponins selectively inhibit cell division in tumor cells and also can activate apoptotic programs which can lead to programmed cell death. In an in vivo study that was carried out on rats, azoxymethane was used to induce colon cancer.[29] The effect of fenugreek seed powder along with its bioactive compound diosgenin was checked and it was observed that both the crude extract and diosgenin were able to inhibit the formation of aberrant crypt foci (ACF) which can be observed as preneoplastic lesion. After the positive response of the extract in vivo experiment, anticancer potential of diosgenin was explored in vitro experiments. HT-29 human colon cancer cells were used and it was seen that diosgenin inhibited the proliferation of cells along with the induction of apoptosis. The effect on apoptosis can be validated by observing the effect on apoptotic proteins.[30] Diosgenin suppressed the expression of proapoptotic protein bcl-2 and there was an increase in the expression of caspase-3, an antiapoptotic protein. It has been reported that diosgenin have anticancer activity in bone cancer. It suppressed cell proliferation and development of bone cells through inhibition of tumor necrosis factor.[31] Protodioscin, a furostanol saponin isolated from fenugreek, also induces apoptotic changes leading to death in a leukemic cell line (HL–60). Several studies on anticancer properties of chemical constituents of fenugreek have been done and have shown positive results. Some constituent of alkaloids, called "trigonelline," has revealed potential for use in cancer therapy.[32] In vivo cytostatic and cytotoxic effect of fenugreek seed extract was studied. Breast cancer in the mammalian model, that is, female Wistar rats, was induced by DMBA, a polycyclic aromatic hydrocarbon. Inhibition of the mammary hyperplasia and decrease in its incidence were seen after aqueous seed extract of fenugreek was given daily to the rats at a dose of 200mg/kg body weight for 120 days.[33]

Hypocholesterolemic activity

Anticholesterol activity of fenugreek sprouts extract has been well studied by the researchers all over the world. Studies have been

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performed in vivo and were not limited to the rats and mice as they were also performed on different species of rabbits. The inclusion of fenugreek seeds as a diet component for the mice aided in reducing cholesterol level up to 42% and 58% both in control group and in hypocholesterolemic group, respectively.[34] Another study was done to test the effects of fenugreek sprouts on the cholesterol level. There was a reduction in total blood cholesterol, LDL, VLDL level, and triglycerides and there was an increase in HDL cholesterol level after the consumption of sprouted fenugreek seeds in Albino rabbits. Presence of cholesterol in plasma is an indicator of coronary heart disease. Researchers have studied the effect of fenugreek seed extract on the lipid profile of plasma. Fenugreek seed administration and its extracts significantly decreased plasma cholesterol, triglyceride, and LDL cholesterol. However, HDL cholesterol level was found to be constant; that is, no effect was registered on it.[35]

Antigenotoxic activity

Some researchers have used plant systems to examine the antigenotoxic effect of fenugreek. Chromosomal aberration assay in the Allium root is one of the most established assays to monitor the toxicity at the gene level. Root tip meristem cells of onion were treated with toxic chromium trioxide. Methanolic extract of the sprouts of fenugreek showed dose-dependent decrease in chromosomal aberration in Allium cepa roots. Studies have also been done in microbial systems to observe the antimutagenic effect of fenugreek. Aqueous extract of fenugreek seeds inhibited the mutagenic activity of the direct acting mutagens against Salmonella typhimurium.[36]

Anti-Inflammatory activity

Fenugreek for past many years has been in use as a traditional medicine in several countries like Iran, southern India, and African countries as a remedy for inflammation and its related effects. The main chemical constituents responsible for the anti-inflammatory activity are alkaloids, saponins, and flavonoids.[37] In vivo effect of methanolic extract using cream based system. Inflammation in terms of edema was induced in Wistar rats using careegenan and anti-inflammatory effect was observed both by intraperitoneal administration and by the topical application in form of the cream. The anti-inflammatory and antimelanogenic effect *in vitro* system using human monocytic cell line (THP-1). Production of inflammatory cytokines such as IL-1, IL-6, and TNF–α was initiated using phorbol myristate acetate. Inhibitory action of fenugreek extract with methanol as a solvent system was observed with suppression in TNF-*α* production. Not only seeds but also antipyretic and anti-inflammatory activity of the leaves of T. foenum-graecum has been reported. On similar lines, the comparison of anti-inflammatory activity of a bioactive compound isolated from fenugreek seed and leaves extracts and its aqueous extracts both *in vivo* and *in vitro* systems. It was observed that chloroform fraction of seeds and aqueous extract of leaves of fenugreek were effective against anti-inflammatory activity.[38]

Antibacterial activity of fenugreek

Screening of medicinal plants for antimicrobial activities is important for finding potential new compounds for therapeutic use. Fenugreek have activity antibacterial, according reports, this plants kill bacteria. The use of synthetic α–glucosidases inhibitors such as acarbose, cause adverse side effects such as abdominal distention due to the excessive inhibition of pancreatic enzymes, resulting in the abnormal bacterial fermentation undigested carbohydrates in the colon. Hence, research on the development and utilization of anti-diabetic plants with mild inhibition of pancreatic enzymes is beneficial.[39]

The mechanism of inhibition of the glycolytic activity of α-amylase may occur through the direct blockage of the active center at several sub-sites of the enzyme as also suggested for other inhibitors. The α-amylase inhibitory factors present in the fenugreek extract probably in-teract with the active sites of the enzyme in a substrate specific manner. Fenugreek is effective in inhibiting the growth of *Pseudomonas* spp., *E. coli, Shigella dysentiriae*, and *Salmonella typhi.*[40]

Anti-arthritic and vascular protective effects of fenugreek

Rheumatoid arthritis is a systemic inflammatory disease associated with generation of oxidative stress that produced vascular dysfunction. Is an autoimmune disorder characterized by synovial proliferation and inflammation, and subsequent destruction and deformity of joints. Not exist much findings related with this activity fenugreek, and not clear mechanism this fenugreek activity, only reported this activity.[41]

Effect of fenugreek on total body and organ weights

Obesity is one of the major risk factor for morbidity and mortality. Obesity may be defined as abnormal growth of adipose tissue. Some researchers indicated that fenugreek seed extract supplementation in reducing the body and adipose tissue weight. The probable mechanism of fenugreek decreasing the total body and adipose tissue weight) fenugreek flushes out the carbohydrates from the body before they enter the blood stream resulting in weight loss. Fenugreek seeds contain a high proportion (40%) of soluble fiber.[42] This fiber forms a gelatinous structure (similar to gaur gum) which may have effects on slowing the digestion and absorption of food from the intestine and create a sense of fullness in the abdomen, thus suppresses appetite and promotes weight loss. In conclusion this plant is effective on blood lipids and sugar and on some bacterial strains, antioxidant activity of fenugreek causing protective of organs and inhibition of entrance diseases to body, too decreases body fats and is effective on obesity.[43]

Anti-diarrheal activity

Fenugreek is important and useful to identify plants with anti-diarrheal activity. The study evaluate the effect of methanol and aqueous extracts of Trigonella foenum-graecum for its anti-diarrheal activity.[44] The anti-diarrheal activity of methanol and aqueous extracts of was evaluated using castor oil induced diarrhea The effect of methanol and aqueous extracts on gastrointestinal tracts motility after charcoal meal administration and PGE2 induced intestinal fluid accumulation (enter pooling) .The plant extracts showed significant ($P<0.01$) inhibitor activity against castor oil induced diarrhea and PEG2 induced enter pooling tested at 250mg/kg. The methanolic extract showed $P<0.01$ and aqueous extract ($P<0.05$) reduction in gastrointestinal motility. The observations suggest that methanolic extract of TEG seed has significant anti-diarrheal activity compared to aqueous extract.[45]

Anti-cataract activity

Cataract is the opacification in the eye lens and leads to 50% of blindness worldwide. Cataract remains the leading cause of visual disability, and it contributes 50% blindness worldwide. Several risk factors have been known in the pathogenesis of senile cataract. Despite aging, diabetes, smoking, gender, steroids, and nitric oxide

are liable for the growth of cataract.[46] Fenugreek supplemented group significantly restored the GSH level in a dose-dependent manner. It was observed that, in the presence of selenite stress, antioxidant enzymes were reduced as compared with the average group.[47]

Other medicinal uses

The fenugreek seeds are important in keeping a healthy digestive system; thus the continue, and daily use of this spice may increase the digestibility of eaten food, which may further promote good absorbing capacity of food constituents in blood for best metabolic use in the body cells. Fenugreek seeds have restorative and nutritive properties.[48] The daily use of fenugreek seeds as the dietary supplement is safe. It has good beneficial effects to increase blood Hg by natural means. This might extra help avoid and cure anemia and have good healthy life for longer duration in females of child bearing age.[49] Modulatory effect of fenugreek seeds on 1, 2-dimethylhydrazine-induced hepatic oxidative stress during colon carcinogenesis was studied in male Wistar rats. It was identified that in pulverized seed of fenugreek in the diet of DMH treated rats reduced the colon incidence up to 16.6%. Acetylcholinesterase inhibitors (AChEI) give a significant relief to some of the clinical signs of the disease. They studied to regulate the extract of fenugreek with trigonelline by HPTLC method and determine the in vitro AChE inhibitory activity of fenugreek and its components using galantamine as a reference. From this, they showed that the fractions and trigonelline fenugreek seed has a potential AChE inhibitory activity and could be used for the cure of Alzheimer's disease (Table 1).[50]

Table 1 Traditional uses of Pharmacological activities for side effect of Fenugreek

Traditional uses	Pharmacological activities	Side effect of Fenugreek
To treat arthritis, asthma, bronchitis, improve digestion, increase libido and male potency, to cure skin problems (wounds, rashes and boils), to treat sore throat, and cure acid reflux, treatment of reproductive disorders, to induce labor, to treat hormonal disorders, to help with breast enlargement, and to reduce menstrual pain, Blood Sugar Regulation.	Anti-diabetic Anti-inflammatory Anti-toxic Anti-cancer Hypoglycemic, hypercholesterolemia, gastroprotective, chemopreventive, antioxidant, laxative, appetite stimulation, Anti-cataract, Immunomodulatory activity, Anti-atherogenic	Minor side effects including Nausea, Gastrointestinal discomfort (diarrhea and/or gas).[51–62]

Conclusion

Fenugreek having antidiabetic, anti-inflammatory, hypocholesterolemic, anti-toxic, chemo protective, anti-cancer, antimicrobial, antiparasitic, lactation stimulant and antioxidant property has been shown in this review article. Fenugreek sprouts has been very useful bioactive compound used as nutraceutical. In this review it was observed that sprouts of fenugreek seeds have been used as food stabilizer, food adhesive, bakery products, food emulsifier and gum.

The seed extracts of fenugreek, leaf and sprouts exhibited antioxidant and antimicrobial activity in different type of solvents. But in case of water extract of germinated fenugreek seed it has been observed the highest antioxidant and antimicrobial activities compared to the other extracts. The presence of flavonoids and polyphenols in sprouted seeds of fenugreek it will make to strong antioxidant and shows potent antimicrobial activity. Germinated fenugreek seeds have greatly used as a natural antioxidant in various metabolic disease and immunomodulatory source. In future it will be explored in food industry as well as floor industry.

The present review provides additional beneficial information for using and supporting of germination process as inexpensive, easy and safe method to extract the bioactive compounds from medicinal plant seeds with significant levels of their activities. Trigonella foenum-graecum has been used as an agent for the treatment of skin diseases which is available in various research articles and literature. The biological studies of sprouted seeds of fenugreeek such as antibacterial, antidiabetic, anti-cataract, anti-atherogenic, antidiarrhoeal and hepato-protective activities were shown in the extracts.

The study of pharmacology (Pharmacokinetic and Pharmacodynamic) and phytochemicals may help to understand the effect of sprouted Fenugreek seeds in traditional as well as future use of medicinal plants. Based on various past reported scientific findings sprouted fenugreek seeds have several health usefulness as discussed in this review. Fenugreek can be recommended for the diet and must use in daily habit for its medicinal health benefits and its safe use. The present study on fenugreek, suggest that the functional, nutritional and therapeutic characteristics of fenugreek can be use further in the development of healthy life and nutritional value of medicinal plants.

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Conflict co interest

The author declares there is no conflict of interest.

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