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Fenugreek: A Review on Nutritional Composition of Fenugreek seed and its health benefits

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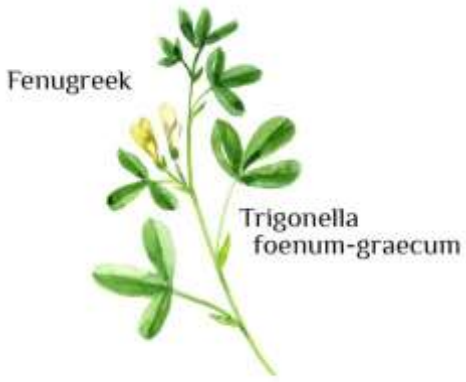
ABSTRACT
One of the oldest herbs used for medicine, fenugreek has a remarkable nutritional and therapeutic profile. Significant amounts of fiber, phospholipids, glycolipids, choline, oleic acid, linolenic acid, nicotinic acid, niacin, and vitamins A, B1, B2, and C are present in fenugreek seeds. The disease that causes the most damage to fenugreek crops is powdery mildew, which significantly affects all parts of the plant and reduces its production. Besides its medicinal applications, it could be a great off-season fodder and animal food supplement. But first, strategies for increasing its biomass production should be developed; genetic diversity among various accessions could be mapped and breeding and crop improvement programs could be started to enhance the biomass and nutritional and functional elements. The morphology, adaptability, nutritional components, related functioning, and therapeutic relevance of fenugreek are highlighted in this review; its ethno-historical usage and pharmacological presumptions have also been covered. It may thrive in a variety of environments; it can even be profitably produced on marginal soils. It is relatively tolerant to salinity and drought. These qualities and fenugreek's ability to remove heavy metals make it a good fit for a variety of cropping schemes. Biotechnological techniques like as ovule culture, micro propagation, in vitro selection, and soma clonal variants, for instance, can be employed in fenugreek breeding programs to produce cultivars resistant to powdery mildew disease.

Keywords: Fenugreek Seeds, Health Benefits, Peroxidase, Flavanoids

I. INTRODUCTION

Fenugreek, or Trigonella foenum-graecum L., is a significant spice crop that is eaten by humans. Because it is rich in phytochemicals, alkaloids, carbohydrates, steroidal saponins, amino acids, and minerals, it can be used for nutritional, nutraceutical, medicinal, and therapeutic purposes **[1**]. Nowadays, fenugreek is grown extensively over much of the world, and there are more than 260 species of Trigonella **[2]**. However the majority of farming is done in India **[3]**. Fenugreek is mostly grown in the Indian states of Uttar Pradesh, Madhya Pradesh, Gujarat, and Rajasthan. Rajasthan is the state with the largest fenugreek production hub, with over 80% of its area devoted to this crop. Carotene and acerbate are also present in fenugreek's green leaves, and its seed is widely utilized in pharmaceutical, nutraceutical, and medicinal applications [4]. Fenugreek is a member of the Fabaceae family. Because of its yellowish-white, triangular blossoms, it was given the Latin name Trigonella, which translates to "little triangle" [5]. There is a significant quantity of fiber in fenugreek seeds [6]. zinc, calcium, iron, and fiber even more than typical food products [7] Lips that are chapped, severe skin inflammation, and aging skin are typically treated with fenugreek seed extract[8]. In this investigation, paraffin oil—which is primarily a combination of hydrocarbons from the methane series—has been used. It exists as a translucent, tasteless, greasy, colorless, and non-fluorescent liquid that, when heated, has a slight petroleum smell [9].Water-in-oil emulsions are used increasingly frequently for emollient applications and the treatment of dry skin [10].



(Fig 1-Fenugreek plant)

This study set out to quantify the impact of a W/O fenugreek seed extract cream on skin

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mechanical parameters, including R0, R1, R2, R3, R4, R5, R6, R7, R8, and R9. A mother's stress and anxiety, nursing difficulties, early dietary diversification in the newborn, or an endocrine disorder or breast abnormality that prevents the mother from lactating (which affects 5% of women) are some of the many factors that can lead to true inadequate milk supply. Even while psychological assistance or information about nursing mothers can frequently boost their milk production [11][12]. It has been observed that 56.8% of Iranian babies are breastfed at four months and 27.7% at six months. At four months, this ratio is 58% in rural areas and 29% in urban areas; at six months, it is 56% in rural areas and 27% in urban areas [13].

Morphology

DOMAIN: EUKARYA
Kingdom: Plantae
Division: Magnoliphyta
Class: Magnoliopsida
Order: Fabales or Leguminales
Family: Fabaceae
Sub-family: Trifoliae
Genus: Trigonella
Sub-genus: Foenumgraecum
Species: Trigonella foenum-graecum [14]

Nutritional Composition of Fenugreek seeds

High levels of protein, fiber, fat, calcium, magnesium, zinc, and iron can be found in fenugreek. By supplying necessary nutrients, assisting in the prevention of disease, and improving food quality, these ingredients support health [15][16]. Fenugreek is rich in proteins, polysaccharides, dietary fibers, vitamins, minerals (particularly calcium and iron), and low fat content. These nutrients support healthy digestion, immunity, the production of milk, and general well-being [17].Because of its nutritional and therapeutic qualities, fenugreek seeds are good for your health because they are high in protein, dietary fiber, and bioactive substances like phenolic that contribute to antioxidant capabilities [18].

Table 1: Nutritional composition of fenugreek

Fenugreek	Composition
Iron	3.9mg
Copper	0.2mg
Manganese	0.1mg
Magnesium	22mg
Vitamin B6	0.3mg
Vitamin A	0.6mg
Vitamin C	0.3mg
Sodium	0.67mg
Calcium	0.17mg
Potassium	0.77mg
Phosphorus	0.29mg
Zinc	0.2mg
Niacin	0.1mg
Thiamin	0.3mg
Riboflavin	0.3 mg

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Chemical Constituents:

Classes of chemical constituents	Chemical constituents
Proteins	Globulin, Albumin and Lecithin
Lipid fatty acids	Linoleic acid, A-Linolenic, Oleic, Stearic acids, Palmitic and Sterols: BSitosterol, Campesterol, Cycloartenol, Triacyl glycerides.
Carbohydrates	Mucilage or gum: Galactomannan
Saponins	Fenugrin B, Fenugreekine, Trigofoenosides A-G, graecunins
Steroidal Saponins	Diosgenin, Yamogenin, Gitogenin, Tigogenin, Neogitogenin, Smilagenin, Sarsasapogenin.
Flavanoids	Apeginin, Luteolin, Vitexin, Isovitexin, Irilone, Tricine, Calycosin, Daidezin,Orientin.
Alkaloids	Trigonelline, Choline, Carpaine, Gentianine.
Fibers	Gum, neutral detergent fiber lipids triacylglycerols, phosphatidylcholine.
Amino acids	Isoleucine, Leucine, lysine, Arginine, Histidine.

Health benefits:

Fenugreek in asthma treatment

Further research is needed to fully understand its efficacy. Fenugreek seed extract raised the 10% heights of FEV1 and FEV1/FVC while lowering blood IL-4 levels. The cationic proteins Charcot-Leyden and eosinophil, which are also capable of acting as antioxidants, were inhibited by flavonoids. Fenugreek and honey syrups enhanced the outcomes for asthma patients; the latter was better when paired with the former [21].

Effect of Fenugreek on Milk Composition

However, fenugreek mostly affected lactose, particularly in our model, and its content was often elevated [22][23]. It is not possible to gather the milk released at the start and finish of each nursing session separately. At L18, the end of the rat's lactation period, the composition of the milk was evaluated. Rat milk composition varies as it goes through lactation [24]. the concentration of macronutrients in milk was unaffected by the increase in litter size. Milk lactose was raised by 27% by fenugreek, while proteins and lipids stayed the same. The literature has documented inconsistent outcomes of fenugreek supplementation on the macronutrient composition of milk in a number of animal species, including goats, sheep, rabbits, and ewes [25] [26]. The beneficial effect of fenugreek on total milk production may be explained by the important osmotic regulatory role lactose plays on milk secretion. This is because lactose increases the flow of water from mammary epithelial cells into mammary secretory vesicles, which in turn enter the alveolar lumen [27].

Anticancer perspectives

The growth of tumor cells was 70% reduced by fenugreek seed extract. Lipid peroxidation and tumor incidence are reduced by fenugreek seed extract [28]. One of the main causes of death worldwide is cancer, which is prevented by active compounds derived from plants. Studies have shown that fenugreek seeds can reduce the growth of HL60 cells and prevent rats from developing mammary hyperplasia [29]. Illustrates

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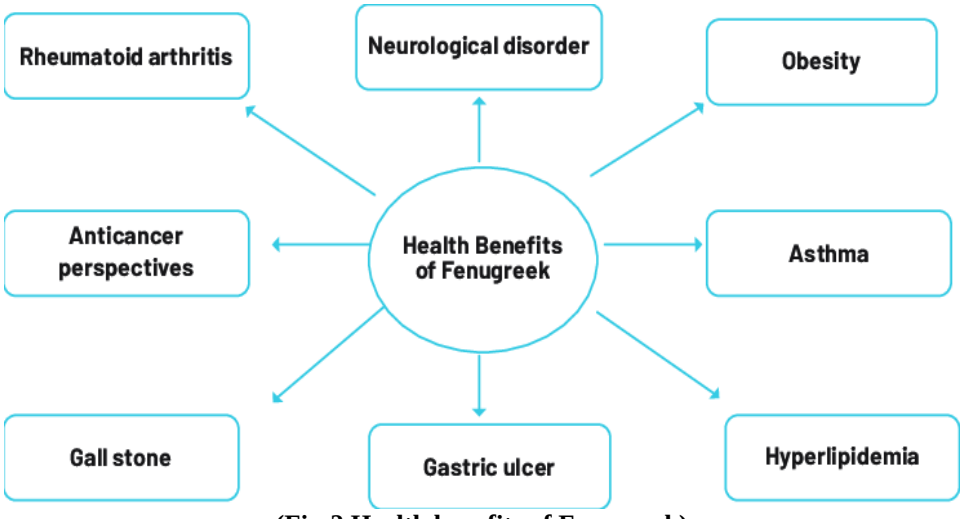
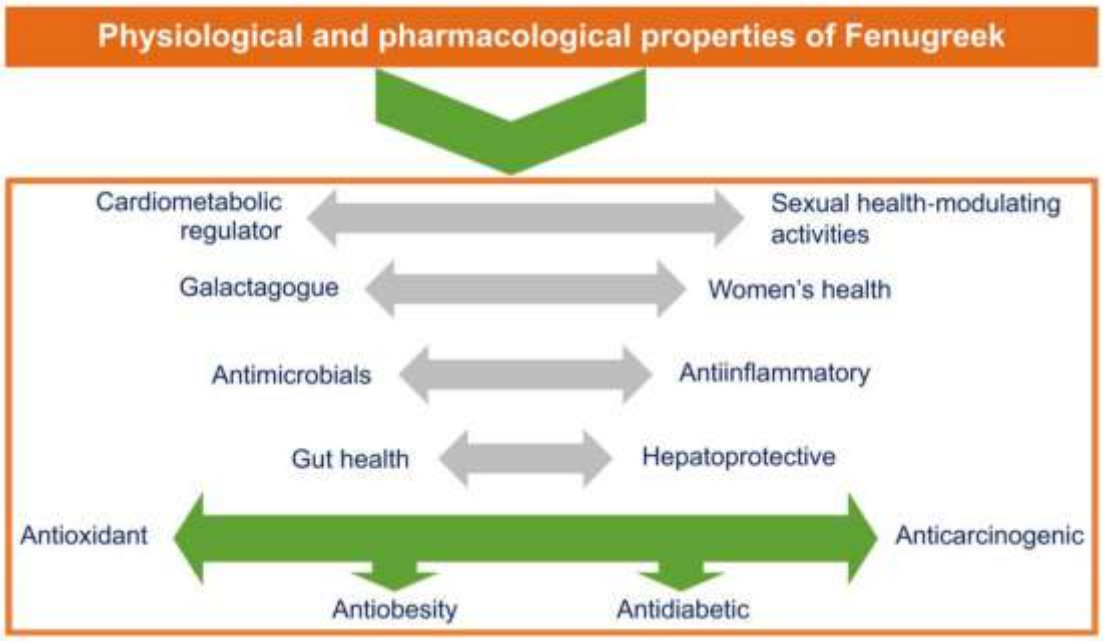
the cytotoxic effects of fenugreek (Trigonella foenum-graecum) extract obtained from the whole plant against a variety of human cancer cell lines. Fenugreek extract has been found to have anti-cancer properties, including the capacity to delay the growth of cancer cell lines from breast and pancreatic malignancies, although having no effect on primary or immortalized prostate cells [30][31].



(Fig-2 Health benefits of Fenugreek)

Effects on testosterone levels in men

Furthermore, fenugreek may limit the metabolism of serum testosterone and block enzymes like 5-alpha-reductase and aromatase, which could explain a rise in serum testosterone levels [32]. Furthermore, fenugreek may limit the metabolism of serum testosterone and block enzymes like 5-alpha-reductase and aromatase, which could explain a rise in serum testosterone levels [33].



(Fig-3 Physiological and Pharmacological effects on men)

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Antidiabetic potential

It is discovered that fenugreek seeds have a significant quantity of fiber (51.7%). Two categories of fiber are identified within this content: 19.2% mucilaginous fiber and 32.5% neutral fiber. Reportedly, using a decoction of fenugreek seeds has shown promise in improving diabetes, lowering glycosuria in mild cases, and lessening the severity of diabetes [34][35]. The application of fenugreek as an Antidiabetic strategy for patients suffering from type I and type II diabetes has garnered considerable attention. It has been extensively utilized in numerous experimental configurations as a source of Antidiabetic components extracted from its seeds, leaves, and extracts [36]. OS plays a significant part in the etiology of cancer, diabetes, and the disorders that are linked to these diseases. Supplementing with fenugreek seeds has been shown to have antioxidant potential by up regulating vitamin C, phenolic characteristics, and superoxide dismutase in the liver while down regulating glutathione reductase and glutathione peroxidase [37]. It has been demonstrated that feeding rats with fenugreek seed powder lowers the risk of colon cancer development and inhibits lipid peroxidation in rats receiving DMH treatment. Additionally, this meal boosted the activities of glutathione transferase (GST), catalase (CAT), and glutathione peroxidase (GPx) in the rats' livers [38]. Dietary fenugreek, which was further boosted by the inclusion of onion, significantly improved the diabetic hyperglycemia and related metabolic abnormalities in the experimental rats. It has been suggested that one of the Antidiabetic benefits is the modulation of OS. Furthermore, it was discovered that fenugreek's nutraceutical effect on OS brought on by diabetes was stronger when combined with onion ingestion [46][47].

Fenugreek against gall-stone and gastric ulcer

It aids in the treatment and prevention of cholesterol gallstones and raises the levels of biliary phospholipids and total bile acid. Active ingredients such avonoids, which are present in fenugreek seeds, gel, and aqueous extract, have a positive effect on several conditions [39]. They found that mucosal glycoproteins and ant secretory activity are affected by the aqueous and gel components of fenugreek seeds. They also found that when onion was supplemented with fenugreek, the combination of the two had the best anti-lactogenic benefits, lowering cholesterol gallstones by 76%, 27%, and 75%, respectively [40].In a rat model, the antiulcer properties of Trigonella forename seed [41].

Antioxidant potential

Significant amounts of phenolic and flavonoid chemicals found in fenugreek seeds contribute to the spice's natural antioxidant potential [42]. The term "oxidative stress" refers to a state in which the body's levels of oxidants and antioxidants are out of balance, which can result in a number of illnesses [43]. A theory exists indicating that fenugreek seeds have a strong antioxidant characteristic that benefits the pancreas and liver. Studies on the antioxidant characteristics of germinated fenugreek seeds have been spurred by the correlation between antioxidant qualities and the health benefits of natural products. These studies have demonstrated that the benefits of germinated seeds are larger than those of dried seeds, mainly because of the increased bioavailability of different fenugreek components. The results of the study show that germination-processed fenugreek seeds contain a significant level of antioxidant activity. It is hypothesized that the presence of flavonoids and polyphenols in the seeds is responsible for this effect [44]. Rats have been used in studies to test fenugreek's ability to lower LDL oxidation because arteriosclerosis is known to be significantly influenced by LDL oxidation. The results show that fenugreek seed ingestion guards against LDL cholesterol oxidation [45]. Bentham Science It has been demonstrated that feeding rats with fenugreek seed powder lowers the risk of colon cancer development and inhibits lipid peroxidation in rats receiving DMH treatment. Additionally, this meal boosted the activities of glutathione transferase (GST), catalase (CAT), and glutathione peroxidase (GPx) in the rats' livers [48].

Fenugreek against neurological disorders

The mechanisms underlying the antidepressant effects of fenugreek avonoids have been studied using animal models. These studies contribute to the increasing amount of data demonstrating the potent neuroprotective benefits of fenugreek components [49]. Fenugreek has been researched as a powerful medicinal herb for the treatment of neurological conditions such as depression, Parkinson's disease, and Alzheimer's [50]. Research has indicated that fenugreek saponins, 5% fenugreek seed powder, and fenugreek ethologic extract were useful in improving neurotransmission, reducing the

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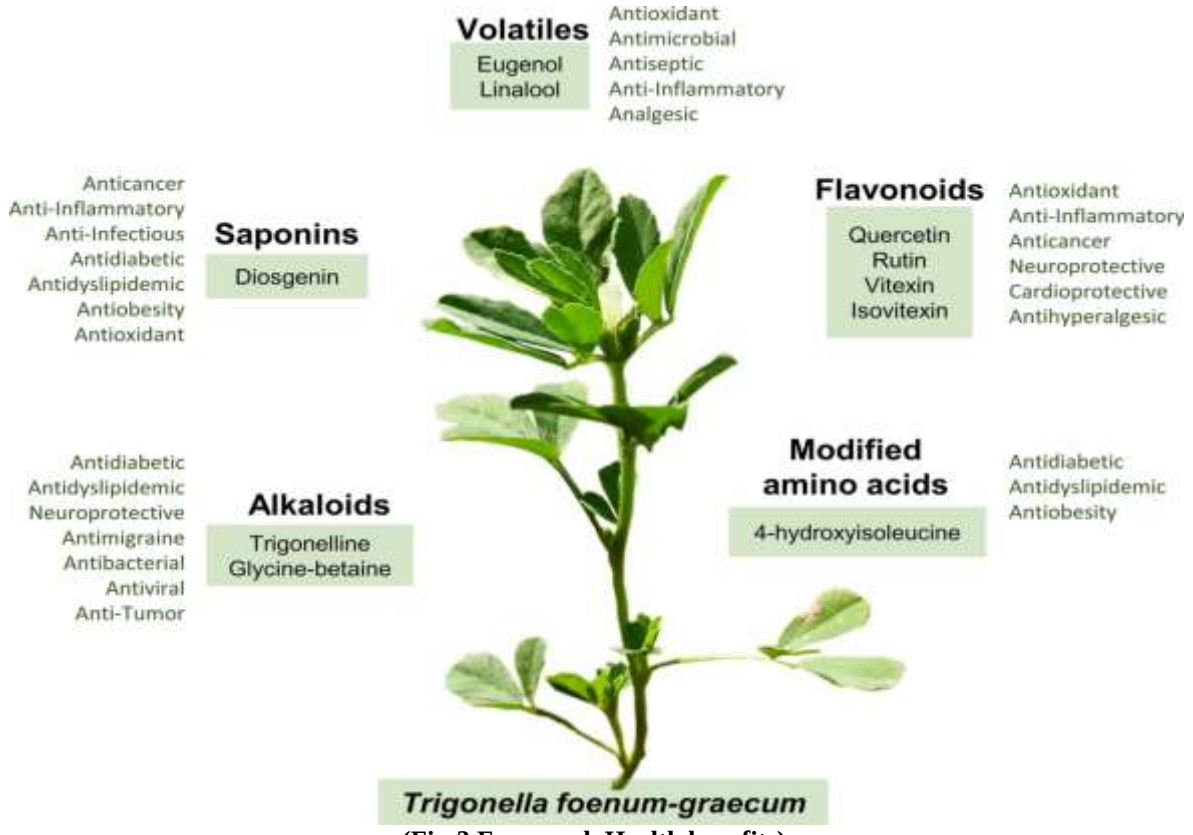
incidence of Parkinson's disease, and attenuating depression [51].

Anticancer potential

Several studies have been conducted to investigate the potential anticancer effects of chemical constituents present in fenugreek, with encouraging results. For example, research has demonstrated that compounds from the "Trigonelline" class of alkaloids have potential medicinal uses in the treatment of cancer [52]. Anticancer action of Diosgenin, a steroidal saponins contained in fenugreek seeds. Fenugreek seed-derived protodioscin efficiently prevents HL60 cell proliferation by triggering apoptotic modifications [53]. The results of the study show that protodioscin, a substance obtained from fenugreek seeds, can stop HL60 cells from growing by causing apoptotic changes. A claim has been made that eating these seeds causes apoptosis to occur more frequently, and this could have an effect on breast cancer. Fenugreek seed extract has been shown to be effective in vitro at inducing cytotoxicity against a variety of human cancer cell lines, including neuroblastoma, IMR-32, and HT-29 cancer cell lines [54].

Effect of Trigonella against obesity

Furthermore, the bar content of fenugreek lowers appetite, which is increased in experimental units that are obese. Oral fenugreek tablets have been shown to significantly speed up weight loss in a short amount of time. It has been demonstrated that fenfuroTM, a furanostolic saponins produced from fenugreek, enhances insulin sensitivity, lowers the phosphorylation of insulin-activated protein kinase B, and improves glucose tolerance [55]. Oxygen-induced insulin resistance is lessened by hydroxyl isoleucine, as numerous investigations have shown. It decreased the activity of a catalyst that converts mTNF to sTNF, the tumor necrotic factor [56].



(Fig-3 Fenugreek Health benefits)

Cardio protective potential

A number of studies have indicated that fenugreek seeds have the ability to lower cholesterol, which suggests that they may be effective as a cardio protective agent. The constituents of fenugreek, which include saponins, Diosgenin, Galactomannan, coumarin, nicotinic acid, saponins, scopolamine, and Trigonelline, have

been found to have pharmacological effects. In a different study, rats were given isoproterenol to induce myocardial infarction, and then the effects of fenugreek were assessed. The results showed that fenugreek had a cardio protective effect on rats, as evidenced by an increase in the levels of superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx), and reduced glutathione (GSH) [57]. Fenugreek seeds are rich in dietary fiber. Their possible cardioprotective effects were evaluated in rats that had experimentally induced myocardial infarction. Fenugreek was added to the diet prior to treatment, and this had a significant positive effect on tissue lipid composition, especially when hypercholesterolemia was present. The study's conclusions showed that when myocardial infarction was induced, the degree of cardiac damage was increased when hypercholesterolemia was present. The degenerative changes in heart tissue and the lipid abnormalities in both blood and cardiac samples improved when fenugreek was added to the diet [58].

II. CONCLUSION

The high-sugar diet's effects on increased food intake and blood glucose levels were mitigated by fenugreek seed extract. Additionally, it is crucial for improving the levels of blood total cholesterol, triglycerides, and low density lipoprotein that are brought on by a high-sugar diet. In conclusion, by keeping mice on a high-sugar diet and maintaining a normoglycemic state, body weight, and food intake, fenugreek seed extract avoided the development of diabetes and obesity. According to the study, the optimal germination time for fenugreek flour (GFF72) to achieve the highest nutritional content was 72 hours. After germination, functional characteristics like oil absorption and dispensability also increase, and it is discovered that these characteristics are in charge of the production of protein-enriched products.

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