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Fenugreek seeds based functional foods: A review

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Abstract

Several illnesses affecting humans are progressing much more quickly due to modern lifestyle choices, eating habits, stress, environmental variables, and extensive use of synthetic chemicals in food processing and agriculture. Worldwide, researchers have been searching for natural therapeutics that can be utilized to either treat or postpone the onset of various lifestyle-related illnesses. Due to the presence of various bioactive chemicals, several different kinds of medicinal plants have demonstrated the potential to be commonly used in therapies. One of these, fenugreek, is a significant herb that has gained international recognition from numerous scientists as an essential therapeutic plant. Numerous studies have shown this herb to be effective in treating conditions like cancer, high cholesterol, diabetes, and inflammation. Due to their therapeutic properties, the extracts/powders from various fenugreek sections have been successfully used in the food and pharmaceutical industries. In light of this, the current review aims to emphasize the significant nutritional advantages and therapeutic uses of fenugreek as a potent therapeutic agent against many disorders.

Keywords: Fenugreek seeds, functional food, therapeutic properties

Introduction

The food industry has been interested in creating food products that promote health in response to increasing consumer demands for healthier foods (Nematollahi *et al.*, 2016) [24]. Nutritional foods, which provide health benefits to consumers, prevent disease, and/or promote health, are widely accepted as marketing tools. Consequently, functional foods, which contain probiotics, prebiotics, vitamins, minerals, and dietary fiber, have become more popular (Nematollahi *et al.*, 2016) [24]. In spite of the astounding advances in medicine and combinatorial drug development, herbal plants continue to be widely used for treating or preventing a variety of disorders due to their extensive nutraceutical characteristics (Olaiya and Soetan, 2014) [25]. There are many crop plants that have nutritive, therapeutic, or nutraceutical benefits. Fenugreek is known to have all of these characteristics and is used extensively as a spice in human diets (Olaiya and Soetan, 2014) [25].

Fenugreek, also known as *Trigonella foenum-Graecum* L., comes from the Fabaceae family and has long been used as a spice (Aasim *et al.*, 2018). There have been studies of the beneficial health properties of dried seeds throughout India, China, Egypt, and some parts of Europe. These properties include galactagogues, antibacterials, anti-inflammatory agents, insulinotropic, and rejuvenates (IM and Maliakel, 2008) [14]. In the fenugreek seed, the yellow embryo is surrounded by a thick coating of semitransparent, white endosperm (Betty, 2008) [2]. While it has long been used as a condiment on human food, literature also explains how it can treat a variety of lifestyle-related diseases, such as cardiovascular disease, high cholesterol, high blood sugar, cancer, liver disease, and sexual disorders (Thorat and Gaikwad, 2019; Park *et al.*, 2019) [39, 26].

Fenugreek has been used extensively to flavor a variety of traditional foods. The medical qualities of fenugreek make it a valuable ingredient for food and pharmaceutical industries because of its anticarcinogenic, anti-diabetic, antioxidant, hypocholesterolemic, anti-lithogenic, antibacterial and immunological effects (Reddy *et al.*, 2019) [30]. Along with its health benefits, fenugreek has been used as an emulsifier and stabilizer in various foods (Wani and Kumar, 2018) [41]. Additionally, fenugreek extracts or powders have been noted as being used to make bread and other extruded products (Wani and Kumar, 2018) [41].

The study aims to explore how fenugreek seeds can be used to develop different functional foods as well as their potential health benefits.

Chemical constituents of fenugreek seeds

Protein: Fenugreek seeds contain 25.4 g of protein per 100 g, while endosperm contains 43.8 g per 100 g (Madhava *et al.*, 2011; Mathur and Choudhry, 2009; Jani *et al.*, 2009) ^[21, 22, 17]. In a study by Işikli and Karababa (2005) ^[15], it was found that fenugreek contains 20-30% protein, especially 4-hydroxy isoleucine, which increases insulin sensitivity (Işikli and Karababa, 2005) ^[15]. Salt (NaCl) concentration and pH levels affect the emulsion and foaming properties of fenugreek proteins (El Nasri and Tinay, 2007) ^[5]. There were no significant differences in emulsion or foam qualities at pH 4.5, the isoelectric point of proteins. In addition, they noted that the fenugreek protein concentrate had high water and oil absorption rates (1.6 ml per g of protein, 1.56 ml per g of oil, and 0.66 g per ml, respectively) and bulk density. It has been discovered that fenugreek seed protein is more soluble in acidic (pH 4.5) conditions. Srinivasan (2006) ^[38] found that cooking fenugreek seeds did not degrade their protein quality. (Srinivasan, 2006) ^[38].

Vitamin and Minerals

The mineral content of fenugreek is low, although some minerals are well-preserved, such as phosphorus and sulfur (El Nasri and Tinay, 2007) ^[5]. It is reported that curry made from fenugreek contains significant amounts of calcium, iron, and zinc (Jani *et al.*, 2009) ^[17]. Seeds that are sprouting are enriched with pyridoxine, cyanocobalamin, calcium pantothenate, biotin, and vitamin C (Parthasarathy *et al.*, 2008) ^[27].

Alkaloids, flavonoids, and saponins

A variety of alkaloids, flavonoids, and saponins are present in fenugreek (Kumar *et al.*, 2012; Uemura *et al.*, 2011) ^[19, 40], with saponins having the highest concentration (Singh and Garg, 2006) ^[37]. Fenugreek seeds contain alkaloid and volatile compounds that create a bitter taste and foul odor (Faeste *et al.*, 2009) ^[6]. Alkaloids, flavonoids, and saponins in fenugreek have pharmacological effects. In clinical trials, fenugreek seeds appear to reduce serum cholesterol levels, which may contribute to the treatment of diabetes mellitus and hypercholesterolemia (Izzo *et al.*, 2005) ^[16]. In addition, they act as both antilipidemic and hypoglycemic agents, as well as cholagogues. Apart from its beneficial effects, it should be used cautiously to prevent allergic reactions and mild gastrointestinal issues (Izzo *et al.*, 2005) ^[16].

Fibers and Gums

Fenugreek seeds are a good source of soluble dietary fiber (Sharma *et al.*, 1990) ^[33]. A 100 g serving of flax seeds contains 65% of the daily recommended intake of saponins, hemicelluloses, mucilage, tannins, and pectin that reduce bile salt absorption in the colon and lower blood levels of low-density lipoprotein cholesterol (LDL) (Mohammadi and Mortazavian, 2011) ^[23]. Fenugreek fiber also binds to dietary toxins, protects the colon mucosa from cancer-causing agents, and slows glucose absorption in the gut, regulating blood sugar levels (Mohammadi and Mortazavian, 2011) ^[23]. Moreover, fiber may have prebiotic properties since it influences the intestinal flora and promotes good health (Mohammadi and Mortazavian, 2011)

^[23]. Fenugreek seeds contain galactomannan, which inhibits bile salts and starch digestion in the intestine as well as absorption of bile salts (Uemura *et al.*, 2011; Singh and Garg, 2006) ^[40, 37]. Studies report that fenugreek husk is an excellent source of dietary fiber and phenolic acids, which are natural antioxidants and food additives (Madhava *et al.*, 2011) ^[21].

Volatile Compound

The volatile oil of fenugreek seeds contained 39 distinct chemicals, including n-alkanes, sesquiterpenes, and some oxygenated compounds (Girardon *et al.*, 1985) ^[9]. N-hexanol, heptanoic acid, dihydroactinoliolide, dihydro benzofuran, tetradecane, α -muurolene, β -elemene, and pentadecane are the primary constituents (Girardon *et al.*, 1985) ^[9]. Hemiterpenoid-lactone sotolon (3-hydroxy-4, 5 dimethyl-2(5H)-furanone), which is present in concentrations up to 25 ppm, is the predominant fragrance component (Girardon *et al.*, 1985) ^[9].

Health and therapeutic benefits of fenugreek seed

Diabetes management

In recent years, a lot of research has been conducted to determine the effects of fiber, particularly the soluble part of fenugreek dietary fiber, on blood sugar and insulin levels. Type II diabetics treated with fenugreek powder containing 50 percent dietary fiber for 20 days experienced a 25 percent reduction in blood glucose levels. Studies have shown that soluble fiber fractions can reduce postprandial hyperglycemia in Type 2 diabetic rats by inhibiting sucrose digestion (Hammerness *et al.*, 2003) ^[12].

The fructosamine level is reduced by taking 0.5 g/kg of fenugreek soluble fiber twice daily for 28 days. Therefore, soluble fiber had an adverse effect on dyslipidemia. A type 2 diabetic rat model has been shown to benefit from the drug by inhibiting platelet aggregation (Hannan *et al.*, 2003) ^[10]. In addition, soluble fiber from fenugreek promotes glucose homeostasis by delaying digestion and absorption of carbohydrates (Hannan *et al.*, 2007) ^[11]. It might be explained by ensuing gel production in the intestine and its low viscosity, which delays gastric emptying and shortens the intestinal transit of food mass (Hannan *et al.*, 2007) ^[11]. It is possible that the level of blood glucose may not rise suddenly because the glucose may be contained inside the gel and can instead leak out gently (Hannan *et al.*, 2007) ^[11]. The viscous and gel-forming properties of soluble fiber inhibit macronutrient absorption, reduce postprandial glucose responses, and have some beneficial effects on blood lipids (Hannan *et al.*, 2007) ^[11].

In both type 2 diabetics and non-diabetics, the SDF (Soluble Dietary Fibre) fraction prevented blood glucose spikes following oral sucrose administration (Hannan *et al.*, 2007) ^[11]. Sharma *et al.* (1996) ^[34] investigated the effects of fenugreek seed powder on glycemia and insulinemia in 60 T2 diabetics. As a result of taking fenugreek seed powder (25 g) for 24 weeks, both blood glucose levels at rest and after a glucose tolerance test decreased (Sharma *et al.*, 1996) ^[34]. An evaluation of 40 individuals found that, after 8 weeks of fenugreek seed ingestion, both urine sugar and glycosylated hemoglobin showed significant decreases of 13% and 12.2%, respectively (Sharma *et al.*, 1996) ^[34].

According to researchers, fenugreek (5.5 g) significantly decreases the area under the plasma glucose response curve when added to white bread and jam and fried rice containing

50 g of carbohydrates. A significant difference has been observed between obese individuals in postprandial plasma glucose and satiety (PPG) (Robert *et al.*, 2014) [14].

Impact on body weight and obesity

Fiber and protein-rich foods secrete higher amounts of the anorexigenic and insulinotropic hormone glucagon-like peptide-1 (GLP-1), which improves glucose tolerance and inhibits weight gain (Reimer and Russell, 2008) [32]. According to several studies, fenugreek seed extract supplements are effective at reducing body fat and body weight (Geetha *et al.*, 2011) [8]. In addition, fenugreek contains a high amount of soluble fiber, which forms a gelatinous structure that may slow the digestion and absorption of food and create a sense of satiety in the intestines (Geetha *et al.*, 2011) [8]. Possibly, the mechanism is related to flushing out carbohydrates before they enter the bloodstream, which results in weight loss (Geetha *et al.*, 2011) [8].

Effect on decreasing cholesterol level

Studies have been conducted on the efficacy of dietary fiber as a therapy for hypercholesterolemia, especially soluble forms like beta-glucans or galactomannans (Boban *et al.*, 2006) [3]. Researchers have found that fenugreek-derived galactomannans can lower plasma cholesterol levels most effectively because they contain a 1:1 ratio of galactose to mannose. Moreover, soluble fiber fractions reduce harmful low-density lipoproteins and triglycerides while maintaining desirable high-density cholesterol levels (Boban *et al.*, 2006) [3].

An experiment on 60 diabetics with high cholesterol and triglyceride levels showed a significant reduction in blood sugar, LDL cholesterol, and triglycerides when 25 grams of fenugreek fiber powder, which contains nearly 50% fiber, were given on a regular basis. HDL levels did not change (Favier *et al.*, 1995) [7]. A molecular mechanism for the hypolipidemic action of soluble fiber can be explained by its ability to bind bile acids, which are eliminated from the blood instead of regenerated (Peran *et al.*, 2007) [28].

Antioxidant activity and anti-carcinogenic effect

In recent years, cancer has become more prevalent, a deadly and complex disease characterized by uncontrolled and irregular cell proliferation (Khorshidian *et al.*, 2016) [20].

A healthy lifestyle, increased physical activity, quitting smoking, and a nutritionally balanced diet combined with toxin-free foods can reduce 90% to 95% of cancer cases, except for genetic abnormalities, which account for 5 to 10% of cancer incidence (Khorshidian *et al.*, 2016) [20].

The lack of fiber can cause irritable bowel syndrome and colon cancer. The fermentation of dietary fiber creates short-chain fatty acids like butyrate that can prevent colon cancer in anaerobic bacteria (Schatzkin *et al.*, 2007) [35].

The addition of fenugreek seeds in our diet regulates the function of mucinase and β -glucuronidase and protects against colon cancer. β -Glucuronidase significantly reduced free carcinogens without damaging colonocytes. Mucinase hydrolyzes protective mucin, and fiber, flavonoids, and saponins assist in this process (Devasena and Menon, 2003) [4].

The active phytochemicals in a plant determine its antioxidant activity. Fenugreek has phenolic and flavonoid

constituents that have a positive effect on the liver and pancreas (Kaviarasan *et al.*, 2004) [18].

Effect on neurological disorder

Neurodegenerative disorders are also treated with fenugreek as a potent herbal remedy. Several neurological conditions have also been shown to be reduced by the bioactive ingredients found in fenugreek extracts several. Studies have shown that the components of fenugreek are useful in treating neurological disorders, such as Parkinson's, Alzheimer's, and depression (Zameer *et al.*, 2018) [42].

Neurotoxicity was significantly reduced by dietary supplementation of 5% fenugreek seed powder for 4 weeks in mice (Hammerness *et al.*, 2003) [12].

Fenugreek extracts at different levels (100–500 mg/kg) have been shown to reduce depression by blocking the MAO (monoamine oxidase) A and B inhibitor clorgyline and increasing neurotransmission (Hannan *et al.*, 2003) [10]. Fenugreek (100 mg/kg) may also reduce the risk of Parkinson's disease by preventing rotation and restoring MDA (malondialdehyde) and CNS (Substantia nigra compact) neuron levels (Hannan *et al.*, 2007) [10].

Impact on the treatment of Asthma

Asthma, one of the most common lung disorders, causes inflammation and constrictions of the bronchial tubes, making breathing difficult. As a supplement to treat mild asthma, the fenugreek seed extract was tested for effectiveness and safety (Razi and Al-Havi, 2001) [29]. Aqueous extracts of fenugreek seed improved lung function and quality of life in patients with mild asthma, in comparison to placebos and honey syrups. According to the study, fenugreek seed extract increased forced expiratory volume in one second (FEV1) and FEV1/FVC heights by 10%, which led to a necessary drop in serum IL-4 levels (Razi and Al-Havi, 2001) [29]. Study results suggest that fenugreek aqueous extract can be useful in the treatment of moderate asthma with only a few side effects. During the trial, fenugreek improved lung function through its action on lung secretions and by acting as a lung tonic once a simple grouping was chosen to more attentively observe the herb's special effects or adverse effects (Razi and Al-Havi, 2001) [29].

Uses of fenugreek seed in food

The high protein and fiber content of fenugreek, notably the soluble dietary fiber called gum, and its neutral detergent properties can alter the texture of meals. Foods' organoleptic qualities are also influenced by fiber content as well as flavoring elements (IM and Maliakel, 2008) [14].

Soluble fibers can be used in yogurt, dairy products, cereal bars, and nutritious drinks. It is possible to combine soluble fiber powders or total dietary fiber powders with fruit juices, spice blends, and seasonings (Srinivasan, 2006) [38]. For direct supplementation, it is also available as tablets and capsules. As well as pizza, bread, bagels, muffins, cake mix, noodles, tortillas, flatbreads, fried and baked corn chips, milkshakes, soups, dressings, sweets, and candy, it could also be used to fortify bakery flour (IM and Maliakel, 2008; Srinivasan, 2006) [14, 38].

Fenugreek serves as a stabilizer, glue, emulsifier, and gum for food preparation in general. Fenugreek gum gains molecular weight by eliminating the associated proteins (Madhava *et al.*, 2011; Singh and Garg, 2006) [21, 37].

Fenugreek gum becomes more viscous with a rise in gum concentration or a decrease in the amount of linked residual protein. Proteins reduced the tension at the oil-water interface significantly, but they had no noticeable effect on fenugreek gum's surface activity (Madhava *et al.*, 2011; Singh and Garg, 2006) ^[21, 37].

Fenugreek seed flour was tested for its antioxidant and antibacterial properties in beef burger preparation (Hegazy, 2011) ^[13]. As an alternative to soybean flour, beef patties were made using 3%, 6%, 9%, and 12% fenugreek seed flour (Hegazy, 2011) ^[13]. Additionally, this substitution resulted in an increase in microbiological quality in comparison with the control sample, as well as an increase in essential amino acids, and caused the retention or improvement of physiochemical quality criteria (pH, water holding capacity, cooking shrinkage, and TBA contents) during freezing (Hegazy, 2011) ^[13]. A study was conducted to determine batter flow characteristics using fenugreek seed husk (FSH). By increasing FSH from 0 to 15%, muffin batter viscosity increased from 32,500 to 38,000 cps (Hegazy, 2011) ^[13].

Conclusion

There have been numerous studies on the health benefits of fenugreek seeds as well as practical uses in recent years. Fenugreek has significant medicinal properties, is high in fibre and protein, and has significant bioactive compounds. According to several studies, fenugreek has antidiabetic, antioxidant, anticarcinogenic, hypoglycemic, and hypocholesterolemic properties. Fenugreek is recommended as part of a regular diet and can be added to foods to make functional foods due to its numerous health benefits.

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