



Fenugreek (*Trigonella Foenum-Graecum*) : A Review On Its Nutraceutical Properties And Utilization In Various Food Products.

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Abstract

Fenugreek (*Trigonella foenum-graecum*) is a legume and it has been used as a spice throughout the world to improve the sensory quality of foods. The plant contains active constituents such as alkaloids, flavonoids, steroids, Saponins etc. *Trigonella foenum-graecum* Linn. (*fabaceae*), a spice seed used to flavour, color and texture of food and it is employed in various medicinal purposes in traditional systems. Fenugreek is an medicinal plant that use in disease some therapy. This plant use for blood lipids and sugar decreasing in diabetic and non diabetic peoples and have antioxidant and antibacterial activity. The plant contains active constituents such as alkaloids, flavonoids, steroids, Saponins etc. Fenugreek is known to have antidiabetic, anticarcinogenic, hypocholesterolemic, antioxidant, and immunological activities. The antimicrobial activities were evaluated using two different methods: agar disc diffusion and agar-well diffusion method. The photochemistry of fenugreek is discussed in this paper along with its economic importance, historical applications, qualities, immunological effects, blood sugar-regulating effects, antioxidant, anticancer, antibacterial, and antifungal qualities. The study highlights the possibility of fenugreek seed extract as a source of antibacterial and anticancer compounds. This research examines the nutraceutical qualities of fenugreek and how it's used in different product innovations.

Key Words: Fenugreek seed, pathogenic bacteria, breast cancer, antibacterial effect, antioxidant.

Fenugreek (*Trigonella foenum-graecum*) is a legume and it has been used as a spice throughout the world to improve the sensory quality of foods. It is a medicinal plant that is used in therapy to cure some disease. The plant contains active constituents such as alkaloids, flavonoids, steroids, Saponins etc. Fenugreek is known to have antidiabetic, anticarcinogenic, hypocholesterolemic, antioxidant, and immunological activities. Modern research has recognized fenugreek as a valuable medicinal plant with potential for curing diseases and also as a source for preparing raw materials of pharmaceutical industry, like in steroidal hormones. Use of fenugreek has been found to be lethal against hazardous bacteria, specifically coli forms, *Pseudomonas* spp., *Shigella dysenteriae* and *Salmonella typhi*. These properties probably make fenugreek a valuable ingredient in food and pharmaceutical applications. (R. Yasmeen 2019)

In the present study, Fenugreek plants obtained from two different cultivars, one from Saudi Arabia and another from Yemen, were screened for phytochemical active constituents and investigated for antimicrobial properties against a selection of gram-positive and gram-negative pathogenic bacteria. Five different solvent seed extracts from each cultivar were tested. The results of the study demonstrated that the

chloroform and methanolic extracts possessed significant antibacterial activity against *Escherichia coli* ATCC25922, *Pseudomonas aeruginosa* ATCC27853, *Staphylococcus aureus* ATCC25923, *Salmonella typhi* ATCC14027 and *Klebsiella pneumonia* ATCC700603. The antimicrobial activity of the extracts was investigated using the agar well diffusion method. The results of the antimicrobial analysis identified *Shigella sonnei* as the most sensitive pathogen to the crude extracts of Fenugreek seeds obtained from Saudi Arabia and with the largest zones of inhibition. (Mona S. Alwhibi 2014)

The pharmaceutical industry has produced a large number of new antibiotics over the last three decades, but resistance to these antibiotics by microorganisms has increased. Statistically, WHO estimates that medicinal plants are the primary medicine for 2/3 of the world's population. Recent studies focus on plant research all over the world to extract appropriate and efficient antimicrobial drugs. Fenugreek (*Trigonella foenum-graecum* Linn.) is an annual herb which has widely been consumed throughout the world as a food, a food additive and in the traditional remedies science civilizations. This study was aimed preliminary to investigate in vitro antimicrobial activity of fenugreek seeds against Gram-negative and Gram-positive bacteria and other microorganisms such as *Escherichia coli* (*E. coli*), *Proteus vulgaris* (*P. vulgaris*), *Staphylococcus aureus* (*St. aureus*), *Candida albicans* (*C. albicans*), *Staphylococcus epidermis* (*St. epidermis*), *Staphylococcus saprophyticus* (*St. saprophyticus*) using two different solvents: aqueous extractions (cold, hot & boiling) and methanol extractions. The antimicrobial activities were evaluated using two different methods: agar disc diffusion and agar-well diffusion method. The results indicated 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. (Rehab R Walli 2015)

The research aimed to investigate the antimicrobial activities and phytochemical screening of methanolic and petroleum ether extracts of seeds and callus derived from hypocotyls and cotyledons explants of fenugreek (*Trigonella foenum-graecum*). Antimicrobial activities were tested against standard microorganisms, *Bacillus subtilis* (NCTC 8236 G+Ve), *Staphylococcus aureus* (ATCC 25923 G+v), *Escherichia coli* (ATCC 25922 G-V), *Pseudomonas aeruginosa* (ATTC 27853 G-V), *Aspergillus niger* (ATCC 9763) and *Candida albicans* (ATCC7596) using paper disc diffusion method. Callus was induced from hypocotyls and cotyledons explants on MS medium supplemented with 2mg/l of different auxins (2, 4-D or NAA) + 0.5 mg/l Kinetin. The petroleum ether extract of *T.foenum- graecum* seeds showed highest antimicrobial activity compared to methanolic extracts. Antibacterial activity of petroleum ether extract of *T.foenum-graecum* seeds were recorded (17±0.33mm) and (15±0.57mm) of inhibition zone against *Escherichia coli* and *Staphylococcus aureus* respectively by concentration 250 mg/ml. Petroleum ether extract of seeds showed antifungal activity against *Aspergillus niger* and *Candida albicans* with maximum zone of inhibition (20±0.88 mm) against *Aspergillus niger* by concentration 250 mg/ml and (17±0.57mm) of inhibition zone against *Candida albicans* by concentration 250 mg/ml. Methanolic extracts of hypocotyls and cotyledons showed antimicrobial activities against *Staphylococcus aureus* by concentration 250mg/ml with inhibition zone 11±0.0mm and 12± 0.5 respectively whereas, inhibition zone 10±0 mm was recorded against *Escherichia coli* compared to methanolic extracts of seeds which were ineffective except weak antifungal activity against *Candida albicans*. The petroleum ether extract of *T.foenumgraecum* seeds showed activity higher than Ampicillin/Sulbactam 20mcg/disc and Ciprofloxacin 5 mcg/disc against *Staphylococcus aureus*, also methanolic extracts of hypocotyls and cotyledons derived callus showed activity equal Ampicillin/Sulbactam 20mcg/disc and Ciprofloxacin 5 mcg/disc against *Staphylococcus aureus*. The petroleum ether extract of *T.foenum-graecum* seeds showed activity higher than Ampicillin/Sulbactam 20mcg/disc and Ciprofloxacin 5 mcg/disc against *Staphylococcus aureus*, also methanolic extracts of hypocotyls and cotyledons derived callus showed activity equal Ampicillin/Sulbactam 20mcg/disc and Ciprofloxacin 5 mcg/disc against *Staphylococcus aureus*. Phytochemical screening for both seeds and callus extracts indicated the presence of various Secondary metabolites like alkaloids, flavonoids, tannins, phenols, saponins and terpenoids. (Mawahib et.al. 2015)

Trigonella foenum-graecum Linn. (*fabaceae*), a spice seed used to flavour, color and texture of food and it is employed in various medicinal purposes in traditional systems. *Trigonella foenum-graecum* commonly known as fenugreek is a plant extensively used as source of antidiabetic compounds from its seeds. It has been acutely lower postprandial glucose levels. Number of laboratory research gives the information about the biological actions of fenugreek. The aim of the study was to screen the medicinal and antibacterial activities of distilled water, methanol, acetone; ethanol extract of the spice. The invitro antibacterial activity was performed by agar well diffusion method. Methanol, acetone, ethanol and distilled water extract of Fenugreek revealed an elevated antimicrobial activity against *Bacillus Subtilis* and *Candida parapsilosis* at lower concentration of the crude extract. The results obtained in the present study suggest that the methanol extract of *Trigonella foenum L.* revealed a significant scope to develop a novel broad spectrum of antibacterial herbal formation. In the phytochemical analysis, there is absence of anthraquinones by extracting with distilled water and glycosides by methanol. (O Sita Kumari 2016)

In this research, some plant seeds powder was evaluated to find their potential effect to rule diseases of food poisoning. Antimicrobial effect of five plant seeds was examined contra *Bacillus cereus*, *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella. Pneumonia* and *Candida albicans* by using well diffusion method. Antimicrobial activity studies revealed high potential activity of plant seeds powder of *Nigella sativa L.*, *cucurbita pepo*, *Sesamum radiatum*, *Trigonella foenum-graecum*, *Linum usitatissimum* with variable efficiency contra tested microbial strains with concentration of 100 mg/ml, except *Sesamum radiatum* scored no effect. The *T. foenum* and *N. sativa* seed powder showed the largest inhibition zone (24-20 mm) contra *K. pneumonia*, followed by *S. aureus* (20-18 mm) and *C. albicans* (15mm) respectively. The five plant seeds powder exhibited bacteriostatic and bactericidal effects with MIC's 20 and MBC 40 mg/ml against *K. pneumonia*, and MIC's 40 and MBC 60 mg/ml against *S. aureus*. The results of this study indicated that plants seeds powder have promising antimicrobial activities and their potential applications in food process. It could be utilized as a natural medicinal alternative instead of chemical substance. (Abu-Zaida 2022)

The phenylpropanoid pathway (PPP) was stimulated in fenugreek sprouts through the pentose phosphate and shikimate pathway, by natural elicitors such as Fish Protein Hydrolysates (FPH), Lactoferrin (LF) and Oregano Extract (OE). Among treatments 0.5 ml /L FPH elicited fenugreek sprouts had the highest phenolic content of 0.75 mg/g FW on day 3 of germination which was approximately 25 % higher than control on the same day. The antioxidant activity estimated by β -carotene assay was highest for LF and OE elicited sprouts on day 2 and 4, respectively with an antioxidant protection factor (APF) of 1.47 for both. In all treatments and control, higher antioxidant activity was observed during early germination, which correlates to higher phenolic content, suggesting that initially phenolics are antioxidant in nature. This increased activity also correlates with high guaiacol peroxidase (GPX) activity indicating that the polymerized phenolics required for lignification with growth have antioxidant function. The antioxidant activity as estimated by β -carotene and 1,1-diphenyl-2-picryl hydrazyl (DPPH) assays indicate that fenugreek sprout extract can quench the superoxide free radical and also possibly scavenge the hydrogen peroxide generated in the reaction mix. OE elicited the highest levo dihydroxy phenylalanine (L-DOPA) synthesis of 1.59 mg/g FW, followed by FPH with 1.56 mg/g FW and LF 1.5 mg/g FW all on day 2 which was 24.5 %, 23 % and 20 % higher than control, respectively. Higher L-DOPA content was observed in the elicited fenugreek sprouts during early germination, correlating to high phenolics and antioxidant activity, suggesting that L-DOPA also contributes to the high antioxidant activity. The glucose-6- phosphate dehydrogenase (G6PDH) activity was higher during early germination (day 1-4) and gradually decreased during later stages (day 5-8) for all treatments and control. The early increase is possibly due to the carbohydrate mobilization from the cotyledons directed towards the high nutrient requirements of the growing sprout. As mobilization occurred, an allosteric feedback inhibition by sugar-phosphates is suggested, as lower G6PDH activity was observed on days 6-8. The elevated levels of GPX during early germination coincide with the higher phenolic synthesis; SOD activity and antioxidant activity suggests the

elevated production and quenching of reactive oxygen species by elicitation. High antimicrobial activity against peptic ulcer-linked *Helicobacter pylori* was observed in the fenugreek sprout extract from control and LF treatments only. We hypothesized that in fenugreek sprouts, simple free phenolics that are less polymerized have more antimicrobial function. (**Reena 2004**)

Development of an efficient system for callus induction on different explants of *fenugreek*. Comparing phenolic, antioxidant and antimicrobial activities of seed and calli of different fenugreek explants. *Fenugreek* is a well-known medicinal plant for pharmaceutical and nutraceutical properties. For callus induction, three explants were used viz. hypocotyl, root, and cotyledons. The explants were cultured on MS medium supplemented with 2, 4-D, NAA and TDZ in different concentrations (0.5-6 mg/L). Antioxidant activity using DPPH and Folin-ciocalteu assays and antimicrobial activity of calli and seed extracts were evaluated. Friable callus was successfully induced on all explants and by all PGRs except 2, 4-D which failed to stimulate callus formation on root explant. Root segment was the better explants in callus induction with maximum fresh weight 5.29 g with TDZ at 2 mg/L and highest callus index was 4.3 with TDZ at 0.5 mg/L. Hypocotyl callus showed the highest phenolic content (246.9 mg GAE/g DW) compared to root callus (243.5 mg GAE/g DW), seed (176.2 mg GAE/g DW) and then cotyledons callus (64.9 mg GAE/g DW) with the lowest value. On the other hand, seed exhibited 44.3% antioxidant activity compared to 34.7%, 24.3% and 16.7% recorded by cotyledons, hypocotyl, and root calli, respectively. Regarding antimicrobial activity of studied fenugreek extracts, hypocotyl callus exhibited the maximum zone of inhibition recorded (19 mm) against *E. coli*. Callus of fenugreek showed potential biological activities over seed-extract. (**Osman 2020**)

Current lifestyle, eating habits, stress, environmental factors and intensive use of synthetic chemicals in food processing and agriculture have radically increased the progression of several human diseases. Globally, researchers have been looking for natural therapeutic substances that can be used to treat or delay the onset of these lifestyle-related disorders. Numerous types of medicinal plants have shown the potential to be frequently used in the therapeutics due to the presence of several bioactive compounds. Among these, fenugreek is an important herb which has been recognized as an imperative medicinal plant by various scientists around the world. This herb has been widely reported as beneficial against numerous diseases such as cancer, hypercholesterolemia, diabetes and inflammation. Due to its medicinal value, the extracts/powders from different parts of fenugreek have been effectively utilized in food and pharmaceutical industries. Accordingly, the present review is an attempt to highlight the important nutritional benefits and curative applications of fenugreek as an effectual therapeutic agent against different diseases. (**Qamar 2020**)

The present study was aimed to investigate the efficacy of fenugreek seeds as a potential natural source of antioxidants and antimicrobials. *Fenugreek* seed (FS) extracts were prepared using ethanol (75%), methanol (75%) and water as extraction solvents. Ethanol (E-FSP), methanol (M-FSP), water (W-FSP) and hot water (HW-FSP) extracts were obtained from ground FS, whilst water extract (W-GeFS) was obtained from germinated FS. The results revealed that all extracts of the ground FS exhibited antioxidant and antimicrobial activities and the extractability of bioactive compounds in the presence of water was higher in germinated seeds (W-GeFS). Highest phenolic (156.3 mg GAE/ g) and flavonoid (38.5 mg CE/ g) contents were found in W-GeFS. It also showed the strongest DPPH radical-scavenging activity of 68 % inhibition at a lower concentration (0.06 mg/ ml). In addition, highest vitamin C equivalent antioxidant capacity (143.28 mg vitamin C/ g) with an IC₅₀ value of 42.1 µg/ ml were found in W-GeFS. Based on disc diffusion method, W-GeFS exhibited highest antimicrobial activity against all tested bacterial pathogens (*Bacillus subtilis*, *Staphylococcus aureus*, and *Escherichia coli*). Thus, it can be concluded from the results that W-GeFS extract from germinating *fenugreek* seeds (W-GeFS) has the potential to be used as a natural source of bioactive compounds with varied applications in food industry especially, for active film packaging purposes to prolong the shelf-life of food products. (**Norziah 2015**)

Phytochemical analysis of leaves and shoot tips of *Trigonella foenum-graecum L* showed the presence of alkaloids, steroids, carbohydrates, terpenoids, flavonoids and quinones. The antibacterial activity of *Trigonella foenum-graecum L*. leaves and shoot tips on *Escherichia coli*, *Staphylococcus aureus* and *Salmonella typhi* were evaluated by agar well diffusion method. Zones of inhibition against *Staphylococcus aureus* and *Salmonella typhi* were observed only in ethanol and methanol leaf and shoot tip extracts of fenugreek. The MIC values ranged from 2.73 and 87.5 mg/ml. (Anbumalarmathi 2016)

Fenugreek is an medicinal plant that use in disease some therapy. This plant use for blood lipids and sugar decreasing in diabetic and non diabetic peoples and have antioxidant and antibacterial activity. The plant contains active constituents such as alkaloids, flavonoids, steroids, Saponins etc. It is an old medicinal plant. It has been commonly used as a traditional food and medicine. Fenugreek is known to have hypoglycemic, and hypocholesterolaemic, effects, Anti-inflammatory effects. Recent research has identified fenugreek as a valuable medicinal plant with potential for curing diseases and also as a source for preparing raw materials of pharmaceutical industry, like in steroidal hormones. Since *fenugreek* is a self-pollinated crop, a mutation breeding method can be used to generate mutants with a determinate growth habit. Irradiation and chemical mutagens can be used to produce point mutations in fenugreek.(Nasroallah 2013)

Traditional use of plants has to investigate their bioactive compounds which have resulted in the detection of significant numbers of properties. Around the world, fenugreek has been used as a spice to improve the sensory appeal of food. It is known or its medicinal plant such as ant diabetic, ant carcinogenic, hypocholeserolaemic, antioxidant and immunological activities. Fenugreek is a medicinal plant that uses in disease some therapy. This plant uses or blood lipids and sugar decreasing in diabetic and non-diabetic peoples and has antioxidant and antibacterial activity. Fenugreek is an annual herb which has widely been consumed throughout the world as a food, food additive and traditional remedies since civilization. Fenugreek seed's powder have traditionally and frequently been used to treat diabetes, menstrual pain, labor pain, arthritis, coughs, congestion, bronchitis, fever, high blood pressure, headache, migraines, diarrhea, flatulence, and other conditions for their usefulness as therapeutic agents. Fenugreek has been identified as a medicinal and aromatic plant with potency for treating disease as well as a source for forming pharmaceutical industry raw materials, such as steroidal hormones. This review paper's primary areas of focus have been fenugreek's antimicrobial activity and phytochemical analysis. Fenugreek is used in the food industry for a number of purposes, including as a food stabilizer. This review covers fenugreek's photochemistry as well as its economic significance, traditional uses, properties, immunological effects, effects on blood sugar levels, antioxidant properties, anticancer properties, antibacterial properties, and antifungal properties. (Patel 2022)

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