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Pharmaceutically Important Fenugreek.

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ABSTRACT

The interest in the study of medicinal plants as a source of pharmacologically active compounds has increased worldwide. Medicinal plants have been considered as important sources of drugs production due to the presence of bioactive compounds. There is also an increasing tendency to utilize herbal products to supplement the diet mainly with the intention of improving the quality of life. In the recorded history, Fenugreek is considered as one of the world's oldest known medicinalherband Egyptians were the ones to discover several fenugreek benefits. Fenugreek (Trigonellafoenum-graecum Linnaeus) is an important herb and spice; its dried seeds have wide application in food and beverages as a flavoring additive as well as in medicines. Pharmacological properties attributed to fenugreek have been reported to be associated with its unique phytochemicals. It is a rich source of calcium, iron, carotene and other vitamins.The dominant and characteristic aroma compound in fenugreek is 3-hydroxy-4-5-dimethyl-2(5H)-furanone (sotalone) of which 3-25mg/kg is present in the seeds. Fenugreek seeds have hypoglycaemic, hepatoprotective, anticarcinogenic, immune-modulatory, larvicidal, antihelmentic, antibacterial, anti-inflammatory, antipyretic, antimicrobial, antioxidant, antilithogenic, antifungal, hypocholesterolaemic, antinociceptive effects. Antidiabetic effects of fenugreek seeds ameliorate most metabolic symptoms associated with type-1 and type-2 diabetes in both humans and relevant animal models by reducing serum glucose and improving glucose tolerance.

Key words: Fenugreek, antidiabetic, antibacterial, pharmaceutical.

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INTRODUCTION

The traditional medicine system based on natural products continues to play an important role in treatment of many diseases especially the infectious diseases. Indian traditional medicine system relies on plants and their parts to treat various diseases for health. Hundreds of herbs are known to be used for various diseases including many infectious diseases. Considered as a "green medicine", Fenugreek (*Trigonellafoenum-graecum*Linnaeus) is one of the oldest medicinal plants with potential applications in the natural health product industry. It is a self-pollinating, annual leguminous crop, which is native to the India subcontinent and the Easter Mediterranean region [1]. It is cultivated in central Asia, central Europe, northern Africa, North America and parts of Australia. The largest producer of fenugreek in the world is India. The major fenugreek producing states in India are Rajasthan, Gujarat, Uttaranchal, Uttar Pradesh, Madhya Pradesh, Maharashtra, Haryana, and Punjab. Rajasthan produces the lion's share of India's production, accounting for over 80% of the nation's total fenugreek output.

Dried or fresh leaves of fenugreek are used as a herb and the seeds are used as a spice. Fresh leaves, sprouts, microgreens are used as vegetables. The young plants are used as pot herbs or as herbal medicine. It is a main ingredient in many Indian curries. It imparts flavour, colour and aroma to foods, making it a highly desirable supplement for use in culinary applications. As a spice, it constitutes one of the many ingredients that make up curry powders [2].Dried fenugreek leaves are called kasurimethi, used as an herb in a wide variety of dishes and breads. Sprouted seeds and microgreens are used in salads. When harvested as microgreens, fenugreek is known as *SamudraMethi* in Maharashtra. The present article incorporates the study of phytochemical constituents, traditional uses and pharmacological properties of fenugreek.

Unique Phytochemicals

Fenugreek has drawn much attention as a potential functional food and natural health product or ingredient therein. Medicinal properties attributed to fenugreek have been reported to be associated with its unique phytochemicals [3] such as polysaccharides, complex carbohydrates, galactomannans, steroidal sapogenins, amino acids: 4-hydroxyisoleucine [4,5]L-tryptophan,lysine; fibre, protein, fatty acids, vitamin C, niacin and potassium. It is rich source of calcium, iron, carotene and other vitamins. Researches show that fenugreek contains steroidal saponins, occurring mainly as furostanol 3,26-diglycosides such as trigofoenosides A-G. On hydrolysis the saponins yield 0.6-1.7% of spirostanol, sapogenins consisting mainly (about 95%) of diosgenin and its 25β-epimeryamogenin in a 3:2 ratio, together with tigogenin and others. Steroidal saponin peptide esters such as fenugreekine are also present. Mucilage polysaccharide consisting mainly of galactomannan (25-45%) with a backbone of β-(1→4) linked manose residues, branches of α-(1→6) galactosyl residues and a small portions of xylose. Other constituents include: trigonelline (coffearine, the N-methyl betaine of nicotinic acid) protein (rich in tryptophan and lysine), saponin hydrolyzing enzymes, proteinase inhibitors which act on human trypsin and chymotrypsin, scopoletin and other coumarins, flavone glycosides, sterols

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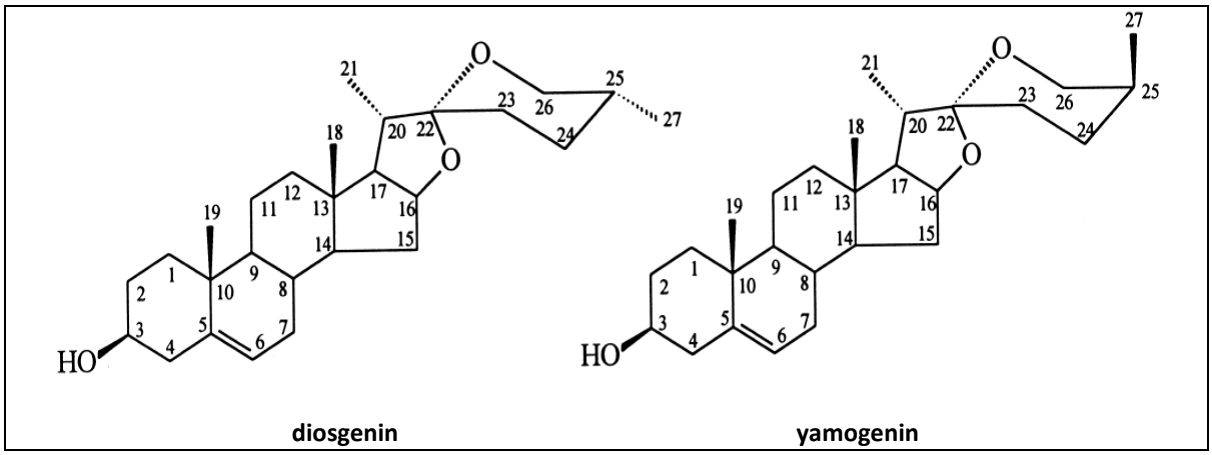
(cholesterol, β-sitosterol), lecithin and choline. A small amount (<0.01%) of volatile oil is present, in which alkanes, terpenes, oxygenated and aromatic compounds have been identified. The dominant and characteristic aroma compound in fenugreek is 3-hydroxy-4-5-dimethyl-2(5H)-furanone (sotalone) of which 3-25mg/kg is present in the seeds.

Figure 1: Chemical structures of diosgenin and yamogenin



Traditional uses

Fenugreek as a functional food

Fenugreek is recognized as the principal source of soluble dietary fiber in the plant. Dietary fiber is known to have the potential to reduce risk of cardiovascular disease and to protect against some cancers through the reduction of low density lipoprotein (LDL) and total cholesterol. In Egypt, supplementation of wheat flour with a small percentage of fenugreek flour has been reported to enhance the nutritional quality of bread as well as its organoleptic characteristics [6,7]. Sharma and Chauhan [8] reported improved physicochemical, nutritional and rheological properties of bread made from wheat flour supplemented with fenugreek flour. Fenugreek seeds are most commonly used in everyday life as a spice and a seasoning in soups and curries. Galactomannan (mucilage or gum) in fenugreek acts as a thickener or stabilizer in foods such as soups, sauces and ice-cream [9-11] ther alkaloid, trigonelline that has been extracted from fenugreek contributes to its distinctive odour. Trigonelline can be used in the manufacture of imitation maple syrup and artificial flavoring for licorice, vanilla, rum and butterscotch [12].

Fenugreek as a traditional medicine

Fenugreek seeds and leaves have been used as part of traditional medicinal purposes. [13]. Fenugreek contains phytochemicals such as steroids, flavonoids and alkaloids, which have been identified, isolated and extracted by the pharmaceutical industry to serve as raw materials for the manufacture of hormonal and therapeutic drugs[14]. In ancient Rome, it was used as an aid to induce labour during childbirth and delivery [15] and in China, it was used as a tonic and

treatment for weakness and edema (tissue swelling due to excess lymph fluid) of the legs [13]. Polysaccharides form the mucilage (galactomannan) present in the plant, and are finding wider applications in the food, pharmaceutical, cosmetics, paint and paper industries [1]. Fenugreek seeds may be roasted or left raw, ground into a paste and applied to skin to help in cases of eczema, rash or other causes of inflammation. This is one of the more historical medicinal uses of fenugreek and the practice is still in use today in many countries. In Ayurveda, both fenugreek seeds and leaves are used to prepare extracts or powder for medicinal use. Extractable oil from fenugreek represents about 6-8% of the seed weight and because of being strongly scented, it is used as an insect repellent for grains and clothes. In cosmetics, traces of the oil are used in perfumes.

Fenugreek as a forage crop

During the ancient Greek period, fenugreek was cultivated as a forage crop. The high forage value of fenugreek is attributed to its rich content of protein, vitamins, and amino acids along with its good digestibility in cattle. The seeds contain diosgenin, a growth and reproduction hormone. The combination of the above factors in fenugreek is thought to improve growth rates and feed utilization efficiency in beef cattle [Alberta Agriculture and Rural Development, 2007 Fenugreek]. In another study [16], fenugreek seed was supplemented into a dairy cattle diet and was reported to significantly improve the fatty acid profile in the milk produced, an increase in the polyunsaturated fatty acid (*i.e.* linoleic, linolenic and conjugated linolenic acids) concentrations was observed. The study also found that the fenugreek fed cattle had a 4% reduction in blood cholesterol concentration as well as a 19 % decrease in milk cholesterol levels compared to controls, potentially extending health benefits to human consumers of the milk.

Pharmacological activities

Trigonellaseeds have been documented for their multiple pharmacological activities [17].Seeds are bitter, mucilaginous, aromatic, tonic, emollient having anticarcinogenic [18], anti-inflammatory [19], hypoglycaemic [20], Hepatoprotective [21], immuno- modulatory [22], larvicidal [23], wound healing[24], anthelmentic, antibacterial [25], anti-inflammatory, antipyretic[19], antimicrobial[26], antioxidant[27], anti-lithogenic[28], anti-fertility, antifungal[29], hypocholesterolaemic [30-33], anti-nociceptive, hypercholesterolemic, antileukemic[16,34]effects.

Antidiabetic effects of fenugreek

Fenugreek seed in powder or germinated form exhibits anti-diabetic properties. Antidiabetic effects of fenugreek seeds ameliorate most metabolic symptoms associated with type-1 and type-2 diabetes in both humans and relevant animal models by reducing serum glucose and improving glucose tolerance. It is reported that the alkaloidal extract of fenugreek in streptozotocin induced hyperglycemic rats prevented the increased blood glucose level,

reduced lipid profile to almost normal and showed antioxidant effect on the tissues of liver and kidney[35].

The hypoglycemic effects of fenugreek have been reported that amino acid 4-hydroxyisoleucine in fenugreek seeds increased glucose induced insulin release in human. It was observed that 4-hydroxyisoleucine extracted from fenugreek seeds has insulin tropic activity [36]. This amino acid appeared to act only on pancreatic beta cells and 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 not very clear [37]. Fenugreek seeds exert hypoglycemic effects by stimulating glucose dependent insulin secretion from pancreatic beta cells, [38] as well as by inhibiting the activities of alpha-amylase. It is considered that the hypoglycemic effect of fenugreek is thought to be largely due to its high content of soluble fiber, which acts to decrease the rate of gastric emptying thereby delaying the absorption of glucose from the small intestine. The cases suggest fenugreek reduced post-prandial hyperglycemia in the case of diabetics, but less so in case of non-diabetics. It has proved that galactomannan blocks intestinal absorption of glucose. Water soluble fiber increases the viscosity inside the intestine and inhibits absorption of glucose.

Hyper-, hypocholesterolaemic effects

Supplements of fenugreek seeds were shown to lower serum cholesterol, triglyceride, cholesterol and low-density lipoprotein, total cholesterol, VLDL-C in both raw and cooked form[39,40]. Studies reported [41,42] the decrease in triglycerides and total cholesterol level of the diabetics by taking fenugreek seeds as fenugreek contains dietary fiber which have effect on lipoprotein cholesterol due to its association with absorption and transport of lipids [43]. These effects may be due to sapogenins, which increase biliary cholesterol excretion leading to lowered serum cholesterol levels. The lipid lowering effect of fenugreek might also be attributed to its estrogenic constituent, indirectly increasing thyroid hormone [44]. The quality and quantity of protein in the diets have a direct effect on the levels of cholesterol. Generally plant protein appears to lower cholesterol level [45]. The plant protein in fenugreek is 26%, so it might exert a lipid lowering effect [46]. The lipid-lowering potential of diosgenin [47] decreased the elevated cholesterol in serum LDL and HDL fractions in cholesterol fed rats, and had no effect on serum cholesterol in normolcholesterolemic rats. In addition, diosgenin inhibited cholesterol absorption, and suppressed its uptake in serum and liver, and its accumulation in the liver [48].

Anticarcinogenic effects of fenugreek

Recent pharmocological investigation of the seed extract of this plant revealed anticancer properties [49,50]. The effect of fenugreek seeds observed in 7,12- dimethylbenz (α) anthracene (DMBA)-induced breast cancer in rats [46], the ethanolic extract of fenugreek showed antineoplastic effect on the growth of MCF-7 cells (an estrogen receptor positive breast cancer cell line) by reducing cell viability and degrading cellular DNA into fragments[10]. In-vitro

study revealed that diosgenin inhibited cell growth and induced apoptosis in the HT-29 human colon cancer cell line [45].

Antioxidant effects of fenugreek

Researches showed that fenugreek bears potential of a powerful antioxidant property in which the presence of flavonoids and polyphenols have been found to be responsible for the same.[51,52]. Polyphenol rich fenugreek seeds showed protective effects against hydrogen peroxide-induced oxidation by protecting the erythrocytes from haemolysis and lipid peroxidation [53]. Fenugreek has been reported to accelerate the process of wound healing via its antioxidant potential in injured rats [54]. Recent studies reported that the fenugreek extract has shown antioxidant and anti-mutagenic property by acting as scavenging free radicals [55].

Antibacterial activity of fenugreek

Worldwide report shows that fenugreek plant possess strong antibacterial activity[56-58] containing effective antibacterial agents against human pathogens and revealed a significant scope to develop a novel broad spectrum of antibacterial herbal formulation. The potential for developing antibacterial into medicine appears rewarding from both the perspective of drug development and the perspective of phytomedicine [59].

Anti-inflammatory effects of fenugreek

Fenugreek showed its anti-inflammatory property probably due to the presence of saponins and flavanoids because flavonoids act as antioxidant and potential inhibitors of cyclooxygenase, lipoxygenase, and nitric oxide synthase [60, 61, 62]. It may be suggested that the presence of diosgenin in fenugreek plays a key role in producing anti-inflammatory action probably by acting the precursor of various steroid hormones such as progesterone and cortisone preventing inflammation.

Antiarthritic effects of fenugreek

Vyaset. al[63] reported this activity of fenugreek as arthritis is a systemic inflammatory disease associated with generation of oxidative stress that produced vascular disfunction characterized by synovial proliferation and inflammation, and subsequent destruction of joints [64].

Effects on obesity

Obesity is one of the major risk factor due to the abnormal growth of adipose tissue [65].It is reported that supplementation of fenugreek seed extract reduces the body and adipose tissue weight [66, 67]. Fenugreekseeds contain a high proportion (40%) of soluble fiber. This fiber forms a gelatinous structure 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.

CONCLUSION

Fenugreek has an extensive variety of actions which are likely to protect human body against various disorders. It has the potential to ameliorate diabetes mellitus, cancer, oxidative stress, obesity, inflammation, bacterial action etc. It decreases body fats and is effective on obesity. In spite of various actions of fenugreek on chronic disorders, the relevant clinical applications and mechanism of action is still to be the area of research.

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