

A Review on Nutritional and Antioxidant Values, and Medicinal Properties of *Trigonella foenum-graecum* L.

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Abstract

Reactive oxygen species (ROS) are concerned for many diseases including diabetes mellitus, atherosclerosis, inflammatory disease, carcinogenesis and aging. In treatment of these diseases, antioxidant therapy has gained much importance. Recent research is now being aimed to find naturally occurring antioxidants of plant. In India, *Trigonella foenum-graecum* L. (fenugreek) is an important medicinal plant and its leaves and seeds have been used in various illnesses and as a health tonic since very long time. Fenugreek is known to have hypoglycemic, hypocholesterolaemic, antioxidant potency, digestive stimulant action, and hepatoprotective effect. Recent research demonstrated that fenugreek is a valuable medicinal plant of multipurpose uses and may be used for preparing various products such as steroidal hormones. To enhance the contents of therapeutic substances in fenugreek, breeding and biotechnology practices have been applied with considerable success and have also contributed to pharmaceutical industry income. In this short review, we will summarize nutritional and antioxidant values, and medicinal properties of fenugreek together with breeding and biotechnological practices that are being made in hope to increase its metabolites' contents.

Keywords: Antioxidants; Disorders; Reactive oxygen species; *Trigonella foenum-graecum* L.

Introduction

In aerobic organisms, the biological system produces harmful intermediates called reactive oxygen species (ROS) through catabolic processes. Excess ROS in the body can lead to the cumulative damage to proteins, lipids, and DNA, resulting in so called oxidative stress [1]. It is defined as the inequality between ROS and antioxidants in favor of the oxidants [2]. In human being, majority of the diseases are mainly related to oxidative stress caused by ROS [3]. Elevated level of ROS causes many diseases like arthritis and connective tissue disorders to carcinogenesis, aging, physical injury, infection and cardio vascular malfunction [4,5]. In treatments of these diseases, antioxidant therapy has gained much importance. Antioxidants have been reported to prevent oxidative damage caused by ROS and may also prevent the occurrence of diseases such as cancer and aging [6]. Antioxidants can interfere in the oxidation process by reacting with ROS, chelating, catalytic metals, and also by acting as ROS scavengers [7,8]. Therefore, recent research is now being aimed to find the naturally occurring antioxidants of plants. In this regard, the search for antioxidants from natural sources has received much attention, and efforts have been made to identify new natural resources for active antioxidant compounds. In addition, these naturally occurring antioxidants can be formulated as nutraceuticals that can help to prevent oxidative damage occurring in the body. Natural compounds from some plants have been extensively studied in the past few years for their antioxidant and ROS scavenging properties [9]. In traditional Indian medicine system, *Trigonella foenum-graecum* L. (fenugreek) has been used extensively for curing several disorders. India is the major producer of fenugreek and it has been mainly used for culinary and medicinal purposes. In this short review, we will summarize nutritional and antioxidant values, and medicinal properties of *Trigonella foenum-graecum* L. together with breeding and biotechnological practices that are being made in hope to increase its metabolites' contents.

Edible Plant Parts

The young leaves and seedling sprouts of fenugreek are eaten as

greens. The fresh or dried leaves have a bitter taste and a strong unique odor and are used to flavor other dishes. The seeds are widely used as spice and fresh shoot and leaves as a vegetable and culinary spice.

Trigonella foenum-graecum L. Nutritional Value

The nutrient composition of fresh fenugreek leaves and mature seed is given in Table 1 adopted from Srinivasan [10]. Fenugreek leaves provide a good amount of various minerals and vitamins. They are especially rich in choline. Seeds are aromatic, bitter, carminative, galactogogue and antibacterial. It constitutes 50% unavailable carbohydrates (fiber) making its highest concentration among all the natural sources of fiber. The fiber portion consists of insoluble (30%) and soluble (20%) fraction which is mostly galactomannan [10]. Total lipids extracted from fenugreek seeds amounted to be 7.5% of the dry seeds [11], and consisted of 84.1% neutral lipids, 5.4% glycolipids and 10.5% phospholipids. Fenugreek contains approximately 4 to 8% saponins and about 1% alkaloids, which contributing to its bitterness.

Trigonella foenum-graecum L. Antioxidant Activity

Studies of Shubhashini et al. [6] and Bukhari et al. [12] revealed that extracts of the fenugreek seeds exhibited antioxidant activity as assayed by 1,1-diphenyl-2-picryl-hydrazyl (DPPH[•]) scavenging activity, total phenolic contents (TPCs), flavonoid content, chelating activity and reducing power. The results suggested that the fenugreek extracts could act as an effective source of antioxidants. Anuradha and Ravikumar [13] showed that supplementation of fenugreek seed powder to diabetic rats

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| Component | Fresh fenugreek leaves | Fenugreek seeds |
|----------------|------------------------|-----------------|
| Moisture | 86.0 g | - |
| Protein | 4.4 g | 30 g |
| Fat | 1.0 g | 7.5 g |
| Fiber | 1.0 g | 50 g |
| Sapogenins | - | 2 g |
| Trigonelline | - | 380 mg |
| Ca | 395 mg | 160 mg |
| Mg | 67 mg | 160 mg |
| P | 51 mg | 370 mg |
| Fe | 16.5 mg | 14 mg |
| Na | 76 mg | 19 mg |
| K | 31 mg | 530 mg |
| Cu | 0.26 mg | 33 mg |
| S | 167 mg | 16 mg |
| Cl | 165 mg | 165 mg |
| Mn | - | 1.5 g |
| Cr | - | 0.1 mg |
| Choline | 1.35 g | 50 mg |
| Vitamin C | 52 mg | 43 mg |
| β-Carotene | 2.3 mg | 96 µg |
| Thiamine | 40 µg | 340 µg |
| Riboflavin | 310 µg | 290 µg |
| Nicotinic acid | 800 µg | 1.1 mg |
| Folic acid | | 84 µg |

Values expressed per 100 g.

Table 1: Composition of fresh fenugreek leaves and mature fenugreek seeds, adopted from Srinivasan [10].

normalized the elevated lipid peroxidation and improved susceptibility to oxidative stress associated with depletion of antioxidants in liver, kidney and pancreas. Further, Ca²⁺ ATPase activity in liver was also protected by the aqueous extract to nearly 80% of the initial activity. However, in normal rats, this treatment resulted into enhanced antioxidant status with reduction in lipid peroxidation. The result suggested that the soluble portion of the seeds could be responsible for enhancing antioxidant property in diabetic rats. Chatterjee et al. [14] showed that the methanolic extract of fenugreek and turmeric have high phenolic content and prevent lipid peroxidation suggested a possible role of phenolic constituents in preventing lipid radiolysis and gamma-irradiation did not bring about any significant changes in the fatty acid profile of fenugreek and turmeric. In another study, Sushma and Devasena [15] found that treatment of germinated fenugreek seed extract to rats with cypermethrin induced hepatic and renal toxicity, can restored antioxidant status and enzymatic activities to near normal levels. The extract elevated the decreased activities of superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx) and glutathione-S-transferase (GST) and the lowered levels of glutathione and total phospholipids in liver and kidneys. The extract reduced the enhanced activities of phospholipases A (PLA) and C (PLC) in liver and kidneys and serum marker enzymes: aspartate transaminase (AST), alanine tansaminase (ALT), alkaline phosphatase (ALP), lactate dehydrogenase (LDH) and gamma glutamyl transferase (GGT). It was demonstrated that fenugreek protected against selenite-induced oxidative stress in experimental cataractogenesis *in vitro* and *in vivo* [16]. Furthermore, it significantly restored antioxidant enzymes such as SOD, CAT, GPx, and GST and non-enzymatic antioxidant: glutathione and decreased malondialdehyde levels in rats' lenses in culture medium supplemented with selenite together with fenugreek aqueous extract. Thus, fenugreek extracts-mediated alterations in biochemical processes prevented cataractogenesis *in vivo*, as evidenced from absence of

cataract in rat's eyes in fenugreek treated group as opposed to 72.5% in the control group. These studies clearly reveal role of fenugreek's antioxidant property in protecting organisms against various disorders induced by stress as well as naturally occurring.

Trigonella foenum-graecum L. Medicinal Properties

Dietary fibers are well known for their benefits to persons with diabetes mellitus. In India and other countries, fenugreek seeds used a condiment, serve as an important source of dietary fiber and are beneficial in the context of diabetes [17]. Raju et al. [18] reported that continuous feeding of 1% fenugreek seed powder (FSP) and 0.05% and 0.1% diosgenin suppressed total colonic Aberrant Crypt Foci (ACF) and reduced the number of multicrypt foci indicating that diosgenin has potential to prevent colon cancer. Besides, treatment with fenugreek seed extract (10-15 µg mL⁻¹) has been shown to inhibit growth of breast, pancreatic and prostate cancer cell lines (PCa) [19]. 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 [20]. In other study, Singh et al. [21] reported that when 4-hydroxyisoleucine (50 mg kg⁻¹), isolated from fenugreek seeds, given orally to type II diabetic mice, it lowered their elevated blood glucose, plasma insulin, triglycerides, total cholesterol, LDL and elevated lowered plasma high-density lipoprotein-cholesterol level. It indicates that 4-hydroxyisoleucine could improve the insulin sensitivity and glucose uptake in peripheral tissue in mice.

Genetic, Breeding and Biotechnology

Considering importance of fenugreek in addressing various problems, it is requisite to enhance diosgenin content of seed for steroidal industry, protein content for human and animal feeding, mucilage (galactomannan) content with appropriate ratio of mannose/galactose and aromatic and spicy substances for industrial uses [22-24]. To achieve this, effects of mutagens such as UV-irradiation, ethyl-methanesulphonate (EMS), methyl-methanesulphonate (MMS), and sodium azide (NaN₃) studied on tissue cultures of fenugreek and about two-to three-fold increased steroidal sapogenin was noticed [22,25,26]. Fenugreek tissue and cell cultures have been used for either plant regeneration or for the production of secondary products of economic interest. Among products, diosgenin and trigonelline are of high therapeutic properties. The demand for fenugreek metabolites, mainly with a higher diosgenin and trigonelline content, prompted more directed tissue culturing efforts [25]. In this context, Rezaeian [27] analyzed and compared the accumulation of diosgenin during different stages of growth of leaf, shoot apical meristem (SAM), and root apical meristem (RAM) callus culture of fenugreek with different concentration of 2,4-dichloro-phenoxyacetic acid (2,4-D) and found 30% maximum diosgenin levels in callus regenerated in 1 mg L⁻¹ of 2,4-D than mother plant. In another study, ELNour et al. [28] reported that callus induction of *Trigonella foenum-graecum* L. on Murashige and Skoog (MS) and B₅ media supplemented with 2.0 mg L⁻¹ NAA was better and thus may be utilized for faster growth of fenugreek and hence metabolites production.

Future Perspective

Though ROS are normal metabolic products of aerobic organisms and involved in regulation of many key physiological processes, however, their enhanced levels have been implicated in development of various diseases. This situation is further worsened by increasing pollution due to industrialization and ever increasing population. In

recent years, tremendous progress has been made in medical sciences to cure various diseases such as arthritis, connective tissue disorders, cancers, infection, cardio vascular malfunction etc. through chemical and physical medications. Though chemical and physical medications have been proved very effective in curing such diseases but they also produce irreparable side effects. This forces scientists to look after the drugs of plants origin for curing diseases with little or no side effects. Since ancient time, *Trigonella foenum-graecum* L. has been extensively used for curing such diseases. This plant contains antioxidants and two chemicals of therapeutic use i.e. diosgenin and trigonelline which have been found effective for curing various diseases in animal system. Further, research is needed to deeply investigate the potential of chemical constituents of *Trigonella foenum-graecum* L. in preventing lethal diseases of human being. Besides this, efforts are also needed to enhance the contents of diosgenin and trigonelline and antioxidants in this plant for its maximum utilization in pharmaceutical industries.

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