Analysis of the Chemistry, Pharmacology and Application Characteristics of Fenugreek

Ke-Ke CHU, Jing-Yi QIAO and Ming-San MIAO*
Henan University of Chinese Medicine, Zhengzhou, China
*Corresponding author

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Abstract. Fenugreek is the seed of leguminous. Steroidal saponins, flavonoids, alkaloids, coumarins and other chemical constituents have been isolated from it. It has hypoglycemic, anti-lipid, anti-tumor, anti-ulcer and other biological activities. In this paper, the chemical constituents, pharmacological action and application of fenugreek were summarized, so as to lay a theoretical foundation for the efficient development and utilization of fenugreek plant resources.

1. Introduction

Fenugreek, also known as rue grass, bitter in flavour, warm in nature, non-toxic, into the liver, kidney two meridians, with recuperating the kidney yang, cold-dampness effect. Fenugreek is an annual herb of Trigonella. It was first recorded in Materia Medica of Jia You Reign. It is a traditional Chinese medicine[1], which is rich in Henan, Anhui, Sichuan and other places. As a homologous product of medicine and food, fenugreek contains a variety of active ingredients and nutrients, and has rich medicinal and nutritional value. Its seeds can be used as medicine. Its fruit can be used as a condiment. Its green leaves can be used as a vegetable. Its hay can expell parasite. Recent studies have shown that fenugreek mainly contains steroidal saponins, flavonoids, alkaloids, coumarins and other components, with high economic value and nutritional value. In this paper, the chemical constituents, pharmacological effects, clinical and dietary applications of fenugreek are systematically analyzed in order to promote the future research and clinical application of it.

2. Chemical Constituents

At present, 33 saponins, 20 flavonoids and alkaloids, 5 coumarins, as well as amino acids, polysaccharides and enzymes, have been isolated from the seeds, stems, leaves, young buds and aboveground parts of the fenugreek. Its main components are saponins, followed by flavonoids and alkaloids.

2.1 Saponins

Fenugreek contains a large number of saponins, which have been extracted to 33 components, mainly "spirosterol" and "furosterol" as sapogenins. Among them, 24 steroidal saponins were 23 furosteroidal saponins and 1 spiro steroidal saponins. Diosgenin is the most abundant steroidal saponin, about 6% to 1%, even up to 2% under the optimum growth conditions. Therefore, fenugreek is often used as a raw material for steroid hormone synthesis, a well-known perfume widely used in the world, and a potential resource[2]. The results showed that the content of steroidal saponins in fenugreek seeds is the highest, which indicated that the content of steroidal saponins in different tissues and organs is very different.

2.2 Flavonoids

Another abundant component in the seeds of fenugreek is flavonoids. Studies have shown that the content of total flavonoids in fenugreek is about 7.86%[3], and there are more than ten flavonoids and flavonoid glycosides. The content of orientoside and Vitexin in fenugreek from different areas was determined by HPLC. It was found that fenugreek from Jiangsu Province had the lowest...
content, while that from Shaanxi Province was the lowest. This indicates that there is a great difference in the flavonoid content of fenugreek in different areas\textsuperscript{[4]}.

2.3 Terpenoids

Terpenoids is rich in fenugreek. Seven triterpenoids were isolated from fenugreek by Shang Mingying et al. The structures of six compounds were identified as lupin alcohol, 31-norcyclical altinol, betulin, betulinic acid, soybean saponin I and soybean saponin I methyl ester. Another compound was identified as oleanolic triterpenoid saponin with three sugars\textsuperscript{[5]}.

2.4 Alkaloids

Up to now, four alkaloids including gentianine, carpaine, choline and ttrigonelline have been detected from fenugreek seeds, and the main structural types of the four alkaloids are pyridine or piperiderine derivatives.

2.5 Amino Acid

Fenugreek seeds contain abundant proteins and amino acids. The contents of 18 kinds of amino acids in fenugreek seeds were determined by HPLC-FLD with DBCEC-Cl as derivative reagent. The results showed that there were many kinds of amino acids in fenugreek seeds with high content of essential amino acids and reasonable and balanced composition\textsuperscript{[6]}.

2.6 Coumarin

The above ground parts of fenugreek have been identified to contain scopolamine, scopolamine and so on\textsuperscript{[7-8]}.

2.7 Other

The whole plant and seed of fenugreek contained 0.014% essential oils, 7% fat and 28% mucus\textsuperscript{[9]}. The seeds of fenugreek are also rich in minerals. More than 50 mineral elements have been identified, 11 of which are essential for human body\textsuperscript{[10]}.

3. Pharmacological Action

3.1 Hypoglycemic

Diabetes mellitus is a metabolic disease characterized by hyperglycemia caused by insulin secretion deficiency or insulin dysfunction. Studies have shown that fenugreek has a good therapeutic effect on diabetes mellitus, in which the three most active components are polysaccharides, saponins and flavonoids in turn. When the ratio was 3:6:1, it could lower blood sugar, improve lipid metabolism, inhibit non-enzymatic glycosylation of protein, and protect the function of pancreas and kidney. Fenugreek combined with valsartan has a good effect on reducing proteinuria and blood sugar in patients with early diabetic nephropathy, and has a good drug tolerance. It can be used as a therapeutic strategy for early diabetic nephropathy in clinical promotion\textsuperscript{[11-12]}.

3.2 Hypolipidemic

Fenugreek seeds contain abundant macroelements and trace elements, among which vanadium, chromium and manganese play an important role in regulating cholesterol metabolism. Vanadium can inhibit the synthesis of cholesterol in the liver and promote its decomposition. Chromium has a direct or indirect effect on lipid metabolism and can accelerate the catabolism and excretion of cholesterol to thereby reducing serum cholesterol levels\textsuperscript{[13]}.

3.3 Anti-Oxidative Stress

Renal ischemia-reperfusion injury is a series of damage caused by renal ischemia and reperfusion, which can lead to damage of renal structure and function, and aggravate the disease. Oxidative stress injury is one of the main mechanisms of renal ischemia-reperfusion injury. The results
showed that the extract of fenugreek can increase the activity of superoxide dismutase, help to improve the oxidative damage of renal ischemia-reperfusion injury in rats, and enhance the anti-oxidative stress ability of the body\textsuperscript{[14]}.

3.4 Antitumor

Cancer is now one of the leading causes of death in the world. Many studies have reported that fenugreek seeds have anti-tumor effects. The chemical constituents of fenugreek with anticancer activity are phytoestrogens and Diosgenin. Studies have shown that diosgenin in breast cancer can inhibit cyclooxygenase-2 to promote cell apoptosis and play an anti-cancer role; in liver cancer cells can achieve anti-tumor effect by blocking cell cycle; in esophageal cancer, it can inhibit the invasion and migration of tumor cells by inhibiting the activity of p38 protein to achieve anti-tumor effect\textsuperscript{[15]}.

3.5 Protective Effects on Acute Chemical Liver Injury

Liver is the most important metabolic organ of the human body. When a certain amount of drugs is taken for a long time, it will cause the accumulation of drugs and metabolites, and then cause direct damage to the liver. Huang Yuping et al. found that polysaccharide of fenugreek can significantly reduce the serum SGPT activity in mice with acute liver injury induced by carbon tetrachloride and paracetamol, indicating that fenugreek polysaccharide has obvious protective effects on membrane structure and function damage, protein synthesis and metabolism disorders and liver cell necrosis caused by lipid peroxidation of biofilm\textsuperscript{[16]}.

3.6 Anti-Ischemia

Fenugreek contains steroidal saponins, choline, lecithin and other bioactive components, in which choline and lecithin can improve the neurological dysfunction of senile dementia patients and enhance memory. Li Linlin et al. found that the total saponins of fenugreek could significantly prolong the average survival time and the time of brain breakage and wheezing in mice with acute incomplete cerebral ischemia, suggesting that the total saponins of fenugreek had protective effect on cerebral ischemia. Zhang Lei and others found that fenugreek saponins can resist scopolamine-induced memory impairment, improve memory consolidation deficits caused by sodium nitrite protein synthesis inhibitors, but also have the effect of anti-alcohol memory impairment\textsuperscript{[17,18]}.

3.7 Other

The gel isolated from the seeds of fenugreek seeds has significant anti gastric ulcer activity, which is due to its inhibitory effect on gastric acid secretion and gastric mucosal glycoproteins. In addition, fenugreek seed extracts can effectively reduce mucosal damage by improving the antioxidant capacity of gastric mucosa and preventing lipid peroxidation induced by alcohol\textsuperscript{[19]}.

4. Application Research

4.1 Officinal

Fenugreek is traditionally used with the form of processed products which are mainly fried and processed with excipients. Fenugreek is often used in combination with other Chinese medicines to treat diseases. For example, Buguzhi pills made of fenugreek and fructus psoralea have the effect of warming kidney and enhancing yang, dispelling cold and dehumidifying, and are used to treat kidney deficiency and cold, bone impotence and so on\textsuperscript{[20]}. In recent years, it has been used as an industrial raw material for extracting diosgenin and used in the production of hormone drugs\textsuperscript{[21]}. It can be seen that the use of fenugreek is extensive, and its medicinal value is high.

4.2 Food Application\textsuperscript{[22]}

Sowmya and Rajyalakshm reported that fenugreek soluble fiber is an excellent substrate for large intestine microbial fermentation. Its galactomannan composition has characteristics of
emulsification and stabilization. Therefore, flour with 8% - 10% fenugreek dietary fiber is often added to produce baked goods, such as bread, pizza, muffins and cakes. The application of fenugreek in flour makes it possible to produce functional foods. Fenugreek seed powder and fenugreek leaf powder have been used in the development of snacks and foods. In one study, about 1.78% fenugreek seed powder and 0.66% fenugreek leaf powder were mixed with raw materials, and the products showed good results in color, flavor, texture and comprehensive quality. Therefore, fenugreek can be used in the form of defatted polysaccharides to develop snack products with acceptable physical and sensory characteristics and low glycemic index.

4.3 Other

Fenugreek is widely used in skin care products besides its medicinal and edible products[23]. For a long time, it has been regarded as one of the indispensable raw materials for skin care products. Yang Peili and other studies found that the physical and chemical properties and stability of skin care products after adding the extract of fenugreek seeds are in line with the requirements of China's industry standards, so that skin care products have antibacterial, moisturizing and sun protection effect. In addition, the food industry also uses fenugreek as the raw material to extract spices. It is widely used in coffee, flavor, tobacco and candy production as a special flavor additive.

5. Discuss

Fenugreek is not only a kind of health herbal medicine, but also a cooking vegetable. The National Cuisine Association has listed fenugreek as one of the special nourishing health vegetable varieties. As a traditional Chinese medicine for tonifying the kidney, fenugreek is mainly used for the treatment of lower abdominal cold pain, lumbago and backache caused by insufficiency of kidney-YANG[24]. At present, there have been some studies on resources and chemistry of fenugreek, but its medicinal use is still relatively shallow. In addition, fenugreek and its extracts have a variety of obvious pharmacological effects, and rich resources, low prices, with broad application prospects. Therefore, the vast number of medical practitioners should give full play to the advantages of traditional Chinese medicine, develop its application prospects, and better serve human health.

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Reference


