A Mini-review of Galactomannas and Diosgenin in Fenugreek

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ABSTRACT

Introduction: Galactomannans are polysaccharides similar to cellulose and starch. Methods: A literature search was conducted in Medline, Scopus, PubMed and Google scholar databases. The keywords were fenugreek, health benefits, bioactive components, galactomannans, diosgenin and pharmaceutical science. Results: Fenugreek galactomanan is a heteropolysaccharide which reduces blood glucose level as normalize the surface activities inside the small intestine. They are also used in food products in order to increase the thickness of the water content. The most important health benefits of galactomanna are reduction in LDL cholesterol levels in hypercholesterolemic, blood lipids, as well as to reduce blood pressure and fibrinolysis. Diosgenin is an isoprostane derivative and the product of acids or enzymes hydrolysis process of dioscin and protodioscin.

Conclusion: Diosgenin shows biological activities including antioxidant, anti-diabetes, anti-inflammatory, anti-cancer and anti-adipogenic effects. Key words: Fenugreek, Health Benefits, Bioactive Components, Galactomannans, Diosgenin, Pharmaceutical Science.

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INTRODUCTION

Traditional Chinese Medicine (TCM) has a history of thousands of years. It is formed by summarizing the precious experience of understanding of life, maintaining health and fighting diseases accumulated in daily life, production and medical practice.\textsuperscript{1,8} Among the species of medicinal plants, some are confined to folk medicine and some are used as occasional or local substitutes for the main species listed in the Materia Medica.\textsuperscript{4,5} Fenugreek (\textit{Trigonella foenum graecum} L.) is an annual, self-pollinating legume grown as a spice, medicinal crop with nutraceutical properties and as a forage legume crop.\textsuperscript{7} It is grown annually in India, Ethiopia, Egypt, Turkey, northern Africa, the Mediterranean, western Asia, northern Iran and in Canada. Major chemical constituents reported from fenugreek are shown in Table 1. Researchers have investigated multifaceted therapeutic benefits of fenugreek seeds against a variety of ailments including, diabetes, cancer, hyperlipidemia, inflammation, neurotoxicity, hepatotoxicity, ulcers, wound, bacterial effects and many studies have also documented its toxicological profile.\textsuperscript{7} The most important medicinal properties of fenugreek are presented in Table 2. Pharmacological and therapeutic benefits of fenugreek is presented in Table 3.

GALACTOMANNA

Galactomannans are polysaccharides that are isolated commercially from the seeds of guar, carob, fenugreek and tara plants.\textsuperscript{9} Galactomannans (GM) are the most widely used polysaccharides after cellulose and starch.\textsuperscript{10} Fenugreek galactomannan is a heteropolysaccharide which is readily soluble in water and is very effective in reducing blood glucose levels and normalize the surface activities inside the small intestine.\textsuperscript{11,12} The galactomannans have variable galactose:mannose (G:M) ratios and distribution of galactopyranosyl units along the mannan chains.\textsuperscript{13} Galactomannan has lower water holding capacity compared to guar gum.\textsuperscript{14} One of the most important usage of galactomannans is that they are used in food products in order to increase the thickness of the water content. The galactomannan has a mannose backbone grafted with galactose units. Jiang \textit{et al.}\textsuperscript{15} reported that the main component of fenugreek seeds is galactomannan structurally composed of a 1\textrightarrow4 beta-D-mannosyl backbone substituted by a single galactose unit α-linked at the C-6 oxygen. Doyle \textit{et al.}\textsuperscript{16} found that the solubility of galactomannans increase with increasing content of galactose. Trigonelline and Galactomannan is shown in Figure 1.

HEALTH BENEFITS OF GALACTOMANNA

The soluble nature of galactomannan fiber from fenugreek has been linked to numerous human health benefits, including the reduction in LDL cholesterol levels in hypercholesterolemic, the reduction of blood lipids, blood pressure and fibrinolysis in healthy men.\textsuperscript{17} Hannan \textit{et al.}\textsuperscript{18} also reported that it has significant role in improving glucose homeostasis in type 1 and type 2 diabetes by delaying carbohydrate digestion and absorption. Rampogu \textit{et al.}\textsuperscript{19} revealed that galactomannan can be ascribed as potential drug candidate against breast cancer and type 2 diabetes rendered by higher molecular dock scores, stable molecular dynamics (MD) simulation results and lower binding energy calculations. Kamble \textit{et al.}\textsuperscript{19} discovered that the low molecular weight galactomannans (GAL) fraction from fenugreek seeds (LMWGAL-TF) had promising dose-dependent anti-hyperglycemic effects in animal chronic metabolic disorder diabetes mellitus (DM) models. Hamden \textit{et al.}\textsuperscript{20} indicated that fenugreek galactomannan displays a number of promising properties and attributes for future application as therapeutic agents in biotechnology and bioprocess-based technologies. Majed \textit{et al.}\textsuperscript{21} noted that galactomannan from fenugreek seed showed prebiotic potential which may play an important role in modulating gut flora by acting as substrate to beneficial microbes.

DIOSGENIN

Diosgenin (25R-spirosten-3b-ol), is an isoprostane derivative, a compound that has attracted tremendous interest over the last decade.\textsuperscript{22} It is a steroidal sapogenin and the product of acid or enzyme hydrolysis process of dioscin and protodioscin, mostly from \textit{Dioscorea} and \textit{Trigonella} species. Diosgenin is a biologically active phytochemical responsible for
Table 1: Major chemical constituents reported from fenugreek.  

1- Major polysaccharides: Galactomannans (consisting of galactose and mannose in the ratio of 1:1).
3- Dihydroxy steroidal sapogenins (minor sapogenins): Yuccagenin, gitogenin and neogitogenin.
4- Spirostanol saponins: Graecunin-B, C, D, E and G.
5- Triterpenoids.
6- Alkaloids: Trigonelline (methylene derivative of nicotinic acid).
7- Flavonoids: Kaemfrol, afroside, quercetin, isoquercitrin, vitexin, isovitexin, orientin and luteolin.
8- Isoflavonoid phytoalexins: Medicarpin, maackiaian, vestitol and sativan.
9- Kaempferol glycosides: Lilyn.
10- Phenolic compounds: Scopoletin, chlorogenic, caffeic acids, p-coumaric acids, hypericromone, coumarin and trigocoumarin.
11- Stercal sapogenin-peptide ester: Fenugreekine.

Table 2: The most important medicinal properties of fenugreek.  

1- Anti-diabetic and cholesterol lowering properties.
2- Anti-hyperthyroidism
3- Against thyroxine-induced hyperglycaemia.
4- Protection in cases of ethanol induced toxicity.
5- Anti-cancer effects.
6- Gastro-protective effect.
7- Antioxidant property.
8- Antinociceptive property.
9- Antimicrobial property.
10- Anthelmintic property.
11- Anti-sterility and anti-androgenic effects.
12- Anti-allergic property.
13- Wound healing property.
14- Anti-inflammatory and antipyretic actions.

Table 3: Pharmacological and therapeutic benefits of fenugreek.  

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<th>Disease/Disorders</th>
<th>Description</th>
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| Diabetes                     | 4-hydroxyisoleucine (amino acid) stimulates insulin production thereby control blood sugar level  
Polyphenolic compounds exhibit anti-diabetic effects  
Curative effects of fenugreek seed powder is a potential neuropathic medicine in diabetes |
| Cancer                       | Polyphenolic compounds from seed possess anti-carcinogenic activities        |
| Hypercholesterolemia         | Anti-oxidants from seeds control high blood cholesterol                     |
|                               | Flavonoids from ethyl acetate extracts of seeds exhibit hypcholesterolemic abilities |
| Myocardial infarction        | Trigonelline (anti-oxidant) detoxification of free radicals, high lipid peroxidation and enzymes prevents Myocardial injuries |
| Skin irritation              | Seeds extract reduces the skin irritation and pain                           |
|                               | Seed powder paste produces skin healing, moisturizing, smoothening, whitening |
| Indigestion and flatulence   | Reduces swelling and pain                                                   |
| Inflammation                 | Mucilage from seed detoxify the oxidants and free radicals to reduce inflammation |
| Anemia                       | Prevents red blood cell oxidation                                           |
|                               | being rich in iron (Fe) seeds are valuable to reduce anemia                 |
|                               | Restoration and Fe nutrition in iron deficiency patients                     |
| Immunodeficiency             | Natural antioxidants help to strengthen immune system                        |
|                               | Immunomodulatory and Immune stimulatory effects                             |
| Aging                        | Antioxidants improves reduces cell death and aging                           |
| Kidney disorders             | Protects functional and histopathologic abnormalities of kidney in diabetic patients |
|                               | Reduces catalase (CAT) contents and superoxide dismutase (SOD) activity in hypercholesterolemia patients |
|                               | Inhibit accumulation of oxidized DNA to prevent kidney injuries             |
| Others                       | Respiratory disorders, bacterial infection, epilepsy, gout, chronic cough, paralysis, dropsy, piles, heavy metal toxicity, liver disorders and arthritis |
different type of pharmacological activities, including as a functional food. Chen et al. found that diosgenin (3-O-{(β-D-glucopyranosyl-(1→3)-[β-D-glucopyranosyl-(1→6)-β-D-glucopyranosyl-(1→4)-[α-L-rhamnopyranosyl-(1→2)-β-D-glucopyranoside], CAS RN 512-06-1) is one of the most important precursors in the synthesis of steroidal drugs. The structures of diosgenin and 4-hydroxyisoleucine is presented in Figure 2.

**HEALTH BENEFITS OF DIOSGENIN**

Diosgenin has recently been shown to exert antiproliferative and proapoptotic actions on rheumatoid arthritis synoviocytes as well as on cancer cells in vitro and in vivo. It has been reported that diosgenin, which is a steroidal sapogenin, exhibited biological activities including antioxidant, anti-diabetes, anti-inflammatory, anti-cancer and anti-adipogenic activities. Haratake et al. concluded that diosgenin can improve skin collagen content by shifting the dynamics of the fibroblasts from proliferation to differentiation via cell cycle arrest. They therefore revealed a new therapeutic potential of diosgenin for human breast cancer metastasis therapy. Khosravi et al. observed that diosgenin improves sperm count, motility and viability, in addition to preventing of damage to seminiferous tubules in diabetic animals. Kanchan et al. found that diosgenin is a promising candidate in diabetes-associated complications through its antioxidant and anti-inflammatory activity. Chen et al. showed that diosgenin could also be a potential agent for treating human liver cancer.

**CONCLUSION**

Traditional medicine can be integrated into medical practice with western pharmaceutical sciences. Fenugreek is an annual forage legume mostly produced in Asia and Euro-Asia. It is also known as an important forage and spice crop. The important medicinal properties of fenugreek are anti-diabetic and cholesterol lowering properties, anti-hyperthyroidism against thyroxine-induced hyperglycaemia, protection in cases of ethanol induced toxicity, anti-cancer effects, gastro-protective effects, antioxidant properties, antinociceptive properties, antimicrobial properties, anthelminthic properties, anti-sterility and anti-androgenic effects, anti-allergic property, wound healing property and anti-inflammatory and antipyretic actions. Fenugreek galactomannan is a heteropolysaccharide which reduce level of blood glucose level, normalize the surface activities inside the small intestine; they are also used in food products in order to increase the thickness of the water content. The most important health benefits of galactomannan are reduction in LDL cholesterol levels in hypercholesterolemic, blood lipids, blood pressure and fibrinolysis. It displays a number of promising properties and attributes for future application as therapeutic agents in biotechnology and other pharmaceutical sciences. Diosgenin is an isoprostane derivative, it is a steroidal sapogenin and the product of acids or enzymes hydrolysis process of dioxcin and protodioscin. Diosgenin shows different biological activity like antioxidant, anti-diabetes, anti-inflammatory, anti-cancer and anti-adipogenic. All in all, in conclusion as fenugreek seed is a rich source of so many important chemicals like complex carbohydrates (galactomannan), steroidal sapogenins (diosgenin) and other bioactive components, it can be considered as an important medicinal crop for both humans and animals.

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**CONFLICT OF INTEREST**

The authors declare no conflict of interests.

**ABBREVIATIONS**

TCM: Traditional Chinese Medicine; GM: Galactomannans; MD: Molecular Dynamics; LMWGAL-TF: Low Molecular Weight Galactomannans Fraction from Fenugreek Seeds; DM: Diabetes Mellitus; CAT: Reduce catalase; SOD: Superoxide dismutase.

**REFERENCES**

Shahrajabian, et al.: Chemical Components of Fenugreek


PICTORIAL ABSTRACT

- Traditional medicine can be integrated into medical practice with western pharmaceutical sciences.
- Fenugreek is an annual forage legume mostly produced in Asia and Euro-Asia. It is also known as an important forage and spice crop.
- The important medicinal properties of fenugreek are anti-diabetic and cholesterol lowering properties, anti-hyperthyroidism against thyrxine-induced hyperglycemia, protection in cases of ethanol induced toxicity, anti-cancer effects, gastro-protective effects, antioxidant properties, antinociceptive properties, antimicrobial properties, anthelmintic properties, anti-sterility and anti-androgenic effects, anti-allergic property, wound healing property and anti-inflammatory and anti-pyretic actions.
- Fenugreek galactomannan is a heteropolysaccharide which reduce level of blood glucose level, normalize the surface activities inside the small intestine; they are also used in food products in order to increase the thickness of the water content.
- The most important health benefits of galactomanna are reduction in LDL cholesterol levels in hypercholesterolemic, blood lipids, blood pressure and fibrinolysis. It displays a number of promising properties and attributes for future application as therapeutic agents in biotechnology and other pharmaceutical sciences.
- Diosgenin is an isoprostane derivative, it is a steroid sapogenin and the product of acids or enzymes hydrolysis process of dioscin and protodioscin. Diosgenin shows different biological activity like antioxidant, anti-diabetes, anti-inflammatory, anti-cancer and anti-adiopigenic. All in all, in conclusion as fenugreek seed is a rich source of so many important chemicals like complex carbohydrates (galactomannan), steroidal sapogenines (diosgenin) and other bioactive components, it can be considered as an important medicinal crop for both humans and animals.
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