Review Article

Fenugreek Galactomannan: A Potential Therapeutic Approach for Diabetes Management

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Abstract Diabetes mellitus is a prevalent chronic disorder characterized by elevated blood glucose levels resulting from inadequate insulin production or utilization. The rising global incidence, particularly in developing countries, underscores the urgent need for alternative therapeutic options beyond conventional treatments, which often have undesirable side effects and high costs. Natural plant-based remedies, such as fenugreek (Trigon Ella foenum-graecum L), have garnered attention due to their promising glycemic control properties. Rich in dietary fibers, phytochemicals, and bioactive compounds including galactomannan, fenugreek exhibits multifaceted therapeutic effects, including anti-diabetic, anti-inflammatory, and antioxidant activities. The primary mechanisms involve delaying gastric emptying, inhibiting carbohydrate absorption, and enhancing insulin secretion and sensitivity. Preclinical studies in rodents demonstrate fenugreek's capacity to improve blood glucose and lipid profiles, alongside promoting beneficial modulation of gut microbiota. Human trials suggest that fenugreek's soluble fiber, particularly galactomannan, significantly lowers fasting blood glucose levels. However, despite encouraging results, most evidence remains from animal models, and comprehensive clinical trials are needed to establish optimal dosages, long-term safety, and mechanisms of action conclusively. Understanding fenugreek's therapeutic potential could provide a cost-effective, natural adjunct or alternative to existing anti-diabetic medications, contributing to better management of blood glucose and reducing diabetic complications. Continued research and standardized human studies are essential to transitioning fenugreek-based therapies from experimental to mainstream clinical use.

Keywords: Blood glucose levels, Diabetes mellitus, Fenugreek seeds, Natural alternative

How to cite this article: Binitha PP. Fenugreek galactomannan: a potential therapeutic approach for diabetes management. JRDC 2025;8(1):

Source of funding: Nil; **Conflict of Interest:** None

INTRODUCTION

Diabetes is a chronic disease caused by increased blood glucose levels due to the body's inability to produce insulin, insufficient secretion of insulin, or ineffective utilization of insulin. The absence or insensitivity to insulin leads to hyperglycemia, a hallmark of diabetes. The global incidence of diabetes is rising rapidly, posing significant public health Challenges, particularly in developing Countries. As of 2021, approximately 80% of the 537 million people living with diabetes are in developing nations.[1]

NEED FOR ALTERNATIVE THERAPIES

Conventional treatments for diabetes, such as sulfonylureas, metformin, and sodium-glucose cotransporter 2 (SGLT-2) inhibitors, are associated with side effects and high costs. For instance, sulfonylureas may cause hypoglycemia and weight gain, metformin can lead to gastrointestinal disturbances and lactic acidosis, and SGLT-2 inhibitors are linked to urogenital infections. These limitations, coupled with the high cost of medications, necessitate the exploration of alternative therapies. Extensive research by Leiherer et al 2013 has highlighted the potential of natural substances in plants to treat diabetes mellitus and manage diabetic complications.[2]

Fenugreek, a legume rich in dietary fibers and phytochemicals, has been recognized for its potential in glycemic control. It contains approximately 25% dietary fiber, including gum and other volatile chemical constituents that enhance food digestion and stabilize food textures (Meghwal & Goswami, 2012).[3] Fenugreek seeds are also rich in bioactive compounds such as alkaloids, saponins, amino acids, and minerals, making them a vital nutraceutical and therapeutic agent (Aasim et al., 2018).[4]

Fenugreek (Trigon Ella foenum-graecum L) is an annual plant from the legume family, traditionally used in India and Mediterranean countries for its medicinal properties. The seeds contain 45–60% carbohydrate (mainly galactomannan), 6–10% lipid, and 20–30% protein. Therapeutic properties include anti-diabetic, anti-obesity, anti-inflammatory, anti-hyperlipidemia, antioxidant, and antimicrobial activities (Rao et al., 1996; Raghu ram et al., 1994).[5,6]

Galactomannan, a water-soluble polysaccharide in fenugreek seeds, constitutes 25–45% of the dry seed weight. It has stabilizing, thickening, and emulsifying properties, making it valuable in pharmaceuticals and nutraceuticals. Its physicochemical characteristics support its use in various food products and therapeutic applications (Gonda et al., 2023; Faisal et al., 2024).[7,8]

MECHANISMS OF ACTION IN BLOOD GLUCOSE REGULATION

Galactomannan delays gastric emptying and carbohydrate absorption, inhibiting digestive enzymes and promoting regular bowel movements. This aids in regulating blood glucose levels (Yao et al., 2020).[9]

Fenugreek's galactomannan improves insulin secretion and sensitivity, serving as a potent nutraceutical for hyperglycemia management (Kumar et al., 2014; Luo et al., 2023).[10,11] Fenugreek modulates gut microbiota, reversing high-fat diet-induced changes and improving glycemic control (Knott et al., 2017; Bruce-Keller et al., 2020).[12,13]

PRECLINICAL AND CLINICAL EVIDENCE

Studies on mice and rats demonstrate fenugreek's role in improving glycemic control and lipid profiles, modulating gut microbiota, and reducing fasting glucose levels (Shtriker et al., 2018; Evans et al., 1992).[14,15]

Human trials suggest that fenugreek's soluble fiber fraction, rich in galactomannan, plays a crucial role in reducing blood glucose levels. However, studies that are more extensive are required to fully elucidate its mechanisms and establish standardized dosages. The studies reviewed highlight the potential of fenugreek in regulating blood glucose levels.

While the findings are promising, further research is essential to elucidate the molecular mechanisms, establish the optimal dosage, and evaluate the long-term safety and efficacy of Fenugreek supplementation. Although these results suggest a positive role for fenugreek in glycemic control, it is important to note that most of the evidence is derived from animal studies. Robust clinical trials involving human subjects are necessary to validate these effects conclusively.

CONCLUSION

Fenugreek exhibits significant potential as a natural adjunct in managing diabetes, owing to its rich composition of dietary fibers, bioactive compounds, and its demonstrated mechanisms of improving glycemic control. Preclinical studies support its role in enhancing insulin sensitivity, delaying carbohydrate absorption, and modulating gut microbiota, which collectively contribute to improved blood glucose levels. Human trials further indicate that fenugreek's soluble fiber, particularly galactomannan, plays a crucial role in reducing fasting blood glucose. However, most evidence stems from animal studies, underscoring the need for more extensive clinical research to determine optimal dosages, long-term safety, and molecular mechanisms. Nevertheless, fenugreek's accessibility, affordability, and multifaceted therapeutic properties make it a promising alternative or complementary therapy for diabetes management. Future well-designed human trials are essential to establish standardized guidelines and validate its efficacy, potentially offering a safer, natural approach to combat the rising global burden of diabetes.

REFERENCE

1. Magliano DJ, Boyko EJ, Atlas ID. What is diabetes? In: IDF Diabetes Atlas. 10th edition. International Diabetes Federation; 2021;54-61.
2. Leiherer A, Mundlein A, Drexel H. Phytochemicals and their impact on adipose tissue inflammation and diabetes. Vasc Pharmacol. 2013;58(3):3–20. doi 10.1016/j.vph.2012.09.002.
3. Meghwal M, Goswami TK. A review on the functional properties, nutritional content, medicinal utilization, and potential application of fenugreek. J Food Process Technol. 2012;3(1):1-10. doi:10.4172/2157-7110.1000181.
4. Aasim M, Baloch FS, Nadeem MA, Bakhsh A. Fenugreek (Trigonella foenum-graecum L.): An underutilized edible plant of the modern world. In: Global Perspectives on Underutilized Crops. Cham: Springer; 2018. p. 381–408. doi:10.1007/978-3-319-77776-4_12.

5. Rao PU, Sesikeran B, Rao PS, Naidu NN, Rao VV, Ramachandran EP. Short-term nutritional and safety evaluation of fenugreek. Nutr Res. 1996;16:1495–505. doi.org/10.1016/0271-5317(96)00163-7.
6. Raghuram TC, Sharma RD, Sivakumar B. Effect of fenugreek seeds on intravenous glucose disposition in non-insulin dependent diabetic patients. Phytother Res.1994;8(2):83-86. doi.org/10.1002/ptr.2650080206.
7. Gonda S, Szűcs Z, Plaszkó T, Cziaky Z, Kiss-Szikszai A, Sinka D et al. Quality-controlled LC-ESI-MS food metabolomics of fenugreek (Trigonella foenum-graecum) sprouts: Insights into changes in primary and specialized metabolites. Food Res Int. 2023;164:112347. doi.org/10.1016/j.foodres.2022.112347.
8. Faisal Z, Irfan R, Akram N, Manzoor HMI, Aabdi MA, Anwar MJ et al. The multifaceted potential of fenugreek seeds: From health benefits to food and nanotechnology applications. Food Sci Nutr. 2024;12:2294–2310. doi: 10.1002/fsn3.3959.
9. Yao D, Zhang B, Zhu J, Zhang Q, Hu Y, Wang S et al. Advances on application of fenugreek seeds as functional foods: Pharmacology, clinical application, products, patents, and market. Crit Rev Food Sci Nutr. 2020 Jan;60(14):23422352.doi 10.1080/10408398.2019.1635567.
10. Kumar P, Bhandari U, Jamadagni S. Fenugreek seed extract inhibits fat accumulation and ameliorates dyslipidemia in high-fat diet-induced obese rats. Biomed Res Int. 2014;2014:606021. doi: 10.1155/2014/606021.
11. Luo W, Deng J, He J, Yin L, You R, Zhang L, et al. Integration of molecular docking, molecular dynamics, and network pharmacology to explore the multi-target pharmacology of fenugreek against diabetes. J Cell Mol Med. 2023; 27:1959–1974. doi:10.1111/jcmm.17787.

12. Knott EJ, Richard AJ, Mynatt RL, Ribnicky DM, Stephens JM, Bruce-Keller A. Fenugreek supplementation during high-fat feeding improves specific markers of metabolic health. Sci Rep. 2017;7:12770. doi.org/10.1038/s41598-017-12846-x
13. Bruce-Keller AJ, Richard AJ, Fernandez-Kim SO, Ribnicky DM, Salbaum JM, Carmouche R et al. Fenugreek counters the effects of high-fat diet on gut microbiota in mice: Links to metabolic benefit. Sci Rep. 2020;10:1245. doi.org/10.1038/s41598-020-58005-7.
14. Shtriker MG, Hahn M, Taieb E, Nyska A, Moallem U, Tirosh O et al. Fenugreek galactomannan and citrus pectin improve several parameters associated with glucose metabolism and modulate gut microbiota in mice. Nutrition. 2018;46:134–142.e3. doi: 10.1016/j.nut.2017.07.012.
15. Evans AJ, Hood RL, Oakenfull DG, Sidhu GS. Relationship between structure and function of dietary fibre: a comparative study of the effects of three galactomannans on cholesterol metabolism in the rat. Br J Nutr. 1992 Jul;68(1):217-29. doi: 10.1079/bjn19920079.