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Therapeutic Potential of Morus alba, Cinnamomum verum, and Trigonella foenum-graecum in Type 2 Diabetes: A Narrative Review

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Abstract

Type 2 diabetes mellitus (T2 DM) is one of the most conventional metabolic disorders worldwide, which is initially powered by asymmetrical lifestyle, unhealthy eating, and growing urbanisation. As a chronic state characterised by insulin prevention and weak glucose metabolism, T2 DM creates a significant health, social, and economic burden. Although conventional pharmaceutical treatments play an important role in the control of glycemia, they are often associated with side effects, expenditure limitations, and the patient's noncompliance. In recent years, the interest in exploring alternatives and supplemental therapy from medicinal plants, especially antidiabetic ones, has been increasing. This descriptive review investigates the therapeutic possibilities of three traditional herbs—Trigonella foenum-graecum (fenugreek), Cinnamomum verum (real cinnamon), and Morus alba (white mulberry)—under the management of T2DM. Each of these botanicals has a chronic history in the traditional medical system and shows hopeful hypoglycemic, antioxidant, and insulin-sensitive effects based on emerging preclinical and clinical evidence. Despite their enthusiastic pharmacological profile, the challenges of extracting the extract, determining effective dose, organic availability, and long-term security are continuing. This review emphasises the requirements of strict, well-planned clinical trials and pharmacodynamic studies to verify the effectiveness and security of these herbal interventions. Finally, the goal of this study is to catalyse more scientific investigation on plant-based accessory therapy for T2DM and to encourage more integrated and overall methods for diabetes care.

Keywords: Type 2 Diabetes Mellitus (T2DM), Herbal Medicine, Trigonella foenum-graecum, Cinnamomum verum, Morus alba.

Introduction

Type 2 Diabetes Mellitus (T2 DM) has emerged as one of the most critical public health concerns of the 21st century, affecting more than 400 million people worldwide—this number is expected to increase significantly

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in the next decades (International Diabetes Federation [IDF], 2021). T2DM, a vulnerability, a vulnerable gesture, and a vulnerability. Pancreatic β-cell dysfunction (American Diabetes Association [ADA], 2022) is characterised. If not controlled, it can result in serious complications such as cardiovascular diseases, diabetic nephropathy, neuropathy, and retinopathy, which not only affect the people but also the global health care system (Jheng et al. Current treatment techniques for T2DM initially include pharmacological agents—such as metformin, sulfonylureas, and insulin—diet and exercise, in addition to the change in the proposed life (Injury et al. However, these conventional methods are often limited by the effects of adverse drugs, the cost of long-term disease, and the results of the long-awaited disease. Global interest in alternative medical procedures is increasing, especially plant-based therapy, which can act as a helper for mainstream diabetes care.

Traditional treatment like Ayurveda has long been using plant herbs to manage metabolic situations. Among the numerous plants mentioned in the classical Ayurvedic texts, Morus alba (white mulberry), Cinnamomum verum (true cinnamon), and Trigonella foenum-graecum (fenugreek) are widely used to aid digestion, to maintain glucose balance in the blood, and to reduce inflammation (Patwardhan. These herbs are now under increasing scientific investigation for their antidiabetic possibilities, indicating their potential activities, including the absorption of the delayed intestinal glucose in modern research, increasing insulin sensitivity, and the stimulation of pancreatic insulin (Tundis et al).

The aim of this descriptive review is to evaluate the therapeutic possibilities of Maras Alba, Cinnamomum Verum, and Trigonella foenum-graecum in T2DM management and bridge traditional knowledge with contemporary scientific evidence. By reviewing clinical trials, mechanical studies, and protection evaluations, this study aims to promote herbal drug-based integration in conventional diabetes management techniques.

Research Gap

Despite extensive research on the ease of access to type 2 diabetes mellitus (T2 DM) and pharmaceutical treatment, all patients still face several challenges in achieving skilled, affordable, and long-term glycemic control. Alternative treatment development is becoming increasingly important because traditional drugs are often limited by adverse effects, costs, and non-compliance with patients. Medicinal plants such as Trigonella foenum-graecum, cinnamon varum, and Maras Alba have shown major antidiabetic possibilities in both traditional use and recent scientific studies. However, in several cases, there are still significant knowledge gaps:

- The lack of standardization is seen in the formation of the preparation, density, and the formation of active compounds, which leads to inconsistent results throughout the study and uncertain therapeutic results.
- There is no agreement on the safe or effective dose range for these herbs when treating T2 DM, which has no established dose guidelines.

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- Clinical translation is interrupted by the lack of understanding of organic events, including pharmacodynamics and minimum biochemistry. (Weak biological compatibility).
- There are several long-term studies to evaluate the impact of inadequate long-term security data-containing poisoning, herbal-medicine interactions, and the impact of chronic use.
- The lack of strong clinical trials-from pre-clinical or smaller human research to the existing evidence, there is a lack of hardness, sample size, and systemic consistency needed to influence mainstream medical practice.

It is essential to exploit the full potential of plant-based therapy in T2 DM management and to deal with these gaps through widespread, multi-share research to support their safe integration in evidence-based clinical guidelines.

Aim of the Study

The goal of this descriptive review is to investigate and evaluate three traditional medicinal herbs in the treatment of type 2 diabetes mellitus (T2DM): Morus alba (wool leaves), Cinnamomum verum (cinnamon), and Trigonella foenum-graecum (fenugreek). In particular, the goal of this study is to evaluate scientific data regarding their effectiveness in controlling blood glucose levels, identifying dose standardization and long-term protection problems, and promoting more thorough clinical research behind their inclusion in standard diabetes treatment.

Methodology

This descriptive review was designed to explore the existing scientific literature on the antidiabetic effects of three traditional medicinal herbal herbs-trigonella foenum-graecum (methi cinnamon) and the antidiabetic influences of Morus alba (white mulberry). The procedure adopted follows a structural and transparent approach for the screening and analysis of relevant literature in line with the best practice for non-pro-literature reviews (Boumisters and Lier, 1997; Green et al., 2006).

Literature Search Strategy

A comprehensive literary search was conducted using the following electronic databases: PubMed, Scopus, Science Direct, Google Scholar.

Studies released between January 2000 and July 2025 were included in the search. The following search words were used in different combinations:

"Type 2 ‘Diabetes Mellitus’ or ‘T2 DM’ ‘Trigonella foenum-grachum’ or ‘Fenugreek’, ‘Cinnamomum varum’ or ‘cinnamon’, ‘Moras alba’ or ‘mulberry leaves’, ‘Plant-based therapy’, ‘phytotherapy’, ‘blood glucose’, ‘insulin sensitivity’, ‘herbal medicine’, ’glycaemic control’.

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Inclusion criteria: The following criteria were applied to the research and sources selected for inclusion in this descriptive review:

Types of Language and Publication: Only Peer-Paper Published in English between January 1990 and June 2023 to ensure relevance and accessibility was included (Green and others, 2006).

Type of study: The sources include the original research articles, clinical trials, in vivo (animals) and in vitro studies, as well as systematic reviews and descriptive reviews that add up the antidiabetic properties of selected herbs. This widespread opportunity allows for thorough evaluation of both experimental proof and theoretical intuition (Boumister and Liar, 1997).

Traditional Medical Literature: In addition to modern biomedical studies, references from classical Ayurvedic texts (E.G., Sushrut Samhita) were reviewed for the historical and ethnopharmacological use of the herbs selected for metabolic disorders like diabetes.

The relevance of type 2 diabetes mellitus (T2 DM) was considered only in those studies that focused on the general metabolism of T2 DM or insulin resistance and glucose control.

Exclusion Criteria: To maintain the scientific integrity, precision, and relevance of this descriptive review, the following exclusion criteria were applied to:

Language Restrictions: Publishing that is not available in English or lacking reliable translations to ensure accurate explanation of the results of the study and terminology was excluded (Green et al., 2006).

Non-Paper-Paper and Non-Scientific Source: Editorial, Opinion Pieces, Conference Abstracts, Magazine Reports, and Other Non-Paper Publishing Logic Reviews and Lack of Limited Experience Prices (Boumisters and Liar, 1997).

Irrelevant Research that is not directly related to glucose metabolism, insulin control, or diabetes management, which only includes herbal therapeutic effects, is excluded from the analysis to maintain a clear focus on antidiabetic properties.

Mechanisms of Action

1. Moras Alba (Malberry Leaf) Malberry Leaf primarily applies antidiabetic effects through a strong 1-Glucosides inhibitor of 1-odioxinzingrinycin (DNJ). DNJ delays the hydrolysis of the carbohydrate in the gut, which reduces glucose spikes in the blood (Andalu and Vadacharyulu, 2007)[i], with strong antioxidant activity in the leaf, which can help with the protection of polyphenols and flavonoids, which can be protected by the fiber.

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2. Cinamomam Verum (cinnamon) enhances insulin sensitivity by promoting GLUT 4 Transporter on the surface of the cell and enhances insulin sensitivity to the cell surface, thus facilitating glucose uptake in the cell (Khan at Al. Cinnamaldehyde and Polyfenal and Polyphenol. Controls control and β-cell protection further.

3. Tigonella phonum-gracum (fenugreek) is rich in fenugreek fiber and 4-hydroxyisoleucine, an amino acid that stimulates insulin emissions and empties the gastric, both contribute to postprandial glycemic control (Nilkantan A. Anti-A-oh-oh-oh-oh-oh-oh-oh-oh-ovatives. Adds their therapeutic potential[ii].

Clinical Evidence from Human Studies

Morus alba (Mulberry Leaf): The mulberry page contains 1 -odioxinzirimycin (DNJ) that reduces postprandial glucose spikes by delaying the carbohydrate mature in the gut (Andalu and Vadacharyulu, 2007).

Several human studies have searched for its effectiveness:

Asai and others. (2011), operates a randomized, placebo-controlled trial, and the DNJ-rich mulberry leaf extracts will decrease by 15-20% of post-exploratory glucose levels. However, the sample size of the study was limited, and there was a lack of long-term follow-ups. Most clinical trials use the results using non-standardized extracts (E.G., leaf powder, ethanol extract, or refined DNJ). The variety of variations in the formation (capsules, tea, extracts) and the diversity of the participants further complicate the generalization of results. Although the primary results are encouraging, effectively verifying and establishing a protection profile, large, long-term randomized controlled tests (RCTs) are essential for the formation of a standard mulberry.

Cinnamomum verum (Cinnamon):

Cinnamon contains active compounds such as cinnamaldehyde and polyphenol, which improve insulin receptor function and promote the GLUT 4 transporter to increase insulin sensitivity, thereby supporting glucose intake (Khan Et Al. Eat and others. (2003) One of the early clinical trials that shows that 1-6 g/day cinnamon in 40 days significantly reduces fasting blood glucose (18-29%), triglyceride, and T2 DM patients reduce LDL cholesterol. Allen and the other. (2013) conducts a meta-analysis of 10 randomized controlled trials (RCTs), and in comparison to control, fasting results in a significant decrease in blood glucose and HbA1c levels. However, research species (E.G., C. Verram vs. Casia), Preparation (powder, extract), dose (1-6 g/day), and intervention period (4-16 weeks) vary drastically. The size of the sample was often smaller, and in some, there was a lack of placebo control, which affects internal legitimacy. The quality of evidence throughout the judgment was mixed; in some studies, the report of randomization or blindness was poor. Cinnamon shows the consistent potential in correcting glucose and insulin sensitivity in the blood, but the lack

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of quality dose, species-specific tests, and short examination limits the decision of the decision. A well-organized, high-quality RCT is needed.

Trigonella foenum-graecum (Fenugreek)

Fenugreek seeds are rich in soluble fibre and amino acids 4-hydroxyisoleucine, which is believed to stimulate insulin emission, reduce insulin resistance, and delay gastric emptying, good postprandial glycaemic control (Neelakandan et al., 2014). Nilkantan and others. (2014) conducts a meta-analysis of 10 trials and fasting has been significantly reduced in blood glucose (by 15-20 mg/DL) and HBA1C, although the size of the effect due to variations in formulation, dose, and study design varies. Sharma and others have previously worked. (1990) has shown that fenugreek (100 g/day) has improved in both type 1 and type 2 diabetes. However, there were small samples in the study and a lack of a control group. Other experiments have shown that fenugreek seed powder (10-25 g/day) or extract capsules have improved insulin sensitivity and glucose metabolism, but long-term loyalty and delicious problems were common. Fenugreek clinical settings have consistently demonstrated short-term glycaemic benefits, but further investigation is needed for imbalances between herbal preparation, dose, and trial design. Large, blind, placebo-controlled RCTs are essential to verify its clinical utility.

Herb	Study (Author, Year)	Intervention Details	Outcomes	Strengths	Limitations
Morus alba	Asai et al., 2011, Kimura et al., 2007	Mulberry leaf powder DNJ-enriched mulberry preparation	15–20% reduction in postprandial glucose, improved fasting glucose and insulin sensitivity	Controlled trial design Measured insulin sensitivity	Small sample size; short duration Small-scale study; limited participant diversity
Cinnamomum verum	Allen et al., 2013 (Meta-analysis)	1–6 g/day cinnamon	Reduced fasting glucose levels and HbA1c improvements	Meta-analysis of multiple RCTs	High heterogeneity, variable dosages and species, small sample sizes
Trigonella foenum-graecum	Neelakantan et al., 2014 (Meta-analysis) Sharma et al., 1990	Whole or powdered fenugreek seeds Fenugreek seed powder	Significant reductions in fasting glucose and HbA1c Decreased fasting and urinary glucose in diabetic patients	Comprehensive meta-analysis Early clinical evidence of efficacy	Variation in fenugreek form, dosage, and treatment duration Small-scale study; limited to type 1 diabetes

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Although numerous studies have stated the antidiabetic possibilities of Moras Alba (Mulberry Leaf), Cinnamomum Verum (real cinnamon), and Trigonella foenum-graecum (fenugreek), several limitations reduce the power and generalization of current evidence. Many investigations are limited by short sample size, short interference period, and lack of long-term follow-ups, which compromise statistical energy and prevent strong decisions regarding sustainable functionality and protection (Nilkantan et al., 2014; Asai et al., Allen et al., 2013).

A significant source of variability is derived from the varied nature of herbal intervention. Differences of plant species, preparation methods (E.G., seed powder, seed extract, or aqueous decoction) make it difficult to compare results throughout the study of dose regimen, dose regimen and treatment periods, or to achieve integrated clinical recommendations (Kimura Et Al).

In addition, systemic defects are often reported. These include inadequate randomization, lack of placebo control, poor blinding, and inadequate details in the report, which all introduce potential bias and limit the internal legitimacy of the trial (Allen et Al. Another concern is that most studies are narrow-fledged representatives, which often focus on specific geographical or ethnic populations. Al., 1990.

To fill these gaps, future research should be given priority with the formation of large-scale, randomized, double-blinded, placebo-controlled tests. The long period of treatment in the study should include strict reports of adverse effects, and to increase external validity, racially and geographically diverse people should be included. In addition, mechanical investigations using Omics technology and pharmacometrics profiling can provide deep insights into long-term security in the management of herbal-medicine interactions, dose-reaction relations, and type 2 diabetes mellitus (T2 DM).

Traditional Ayurveda and Unani Aspects and Coordinating Prospects

Ayurvedic Perspective:

In Ayurveda, the traditional Indian medical system, metabolic disorders- especially Pramha (a state that is closely parallel to the modern understanding of diabetes mellitus)-are classified under the Madhumhaha, the Charak Samhita, and Sushrut Samhita (Sharma and Das, 2014). Herbal cinemam vram (commonly known as Tivak) is mentioned for its antidiabetic and mature balance properties in Trigonella foenum-gracum (methica) and Morus alba (Shahtut).

The feature of Tavak (cinnamon) is its bitter juice (bitter taste), Ushana biya (hot energy), and katu ideas (post-maturation acute effects).

It is believed: Increase the fire (digestive fire) By stimulating blood circulation, Make Ama Pachana (Detoxification of Metabolism Waste) Support the action -like verb through the balance of kafa doshar (Ayurvedic humor is associated with slow metabolism and obesity) (Sridharan et al., 2011) Fenugreek

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(fenugreek) is classified as the soft quality (unnecessary qualities) and the taste of the biria in taste as tickets and cuts. Its seeds are traditionally used:

Meadohara Controlled (submit excess liquid) to the Cladea Controlling excessive urine (a feature of honeymoon) (Sharma and Das, 2014; Sing and others, 2010). Shahtut (Mulberry) has been enrolled in the classical Ayurvedic texts, but is included in the solution in science (Ayurvedic Pharmacology): Blood (blood vessel). The use of Pramhagna (anti-diabetic), Light Astrinjent, and Refrigerant Features that calm Pitta and Kafa (Joshi et al, 2015).

Unani Perspective:

Union The Greek-Arabi tradition also recognizes metabolic diseases under the category of the Greek treatment, Ziabetus (similar to diabetes), which initially derived from the distortion of the Sue Mizaz (mood) and the Tabiyat (innate faculty).

Kirfa (cinnamon) is considered a muffrah (cardiotonic) and mukoui meda (stomach), which is recommended to improve the maturation and circulation and to correct the perverted mood contributing to Ziabetus (Ali, 2008).

Hulba (fenugreek) is used for: Tahlil-i-Riyah (Carminative Action), Daf-e-Sudad (removal of obstacles), Controlling blood sugar levels in diabetas hockey (real diabetes) (Rizvi & Mixed, 2013). The Tut (Mulber) is recognized in the Yunani text: Musakkin (Shamk) Improvement. Hypoglycemic benefits are often used in compound formation, like Dawa-ul-Missk and sorbet-e-Tut Siyah (Ahmad et Al, 2010).

Coordination of possibilities Given that both Ayurveda and Unani recognize these herbs for the treatment of metabolic disorders with both overlapping physiological and pharmacodynamic rationale (E.G., digestion, detoxification, blood sugar control). This heritage can coordinate with modern phytomedicine and pharmacology:

Create quality herbal formulas based on both traditional practices and proof-based validity. Manage the Cross-System Clinical Trial with the Standard Operating Method (SOP) obtained from classical preparatory methods. Use system biology to understand how these herbs interact with human physiology in both nature-specific (structure-based) and modern biomedical structures.

Safety Considerations: Morus alba, Cinnamomum verum, and Trigonella foenum-graecum:

Morus alba (white mulberry): It is usually good-tolerant in clinical use. Light gastrointestinal discomfort (E.G., swelling, nausea) in some studies, especially at high levels. No large hepatotoxicity or systemic toxicity was noticed in animal or human tests. Security Profile: Considered safe for short-term use; long-term people's information is limited.

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Cinnamomum Varum (Ceylon Cinnamon): Cinnamon is preferred over Cassia because of its low potency. High levels of Kumarin (present in Cassia) are associated with the toxicity of the liver (hepatotoxicity). C. Verum provides a safe option for long-term use in diabetes management.

Trigonella foenum-graecum (fenugreek): General adverse effects include abdominal cramps, diarrhea, and abdominal discomfort. Possible interaction with anticoagulants and antiplatelet drugs due to blood thinner properties. Warfarin, aspirin, or other blood thinners should be used carefully for patients.

Challenge in determining the value. Variation in herbal drainage methods, organic active compound density, and lack of regulatory quality control in commercial products limit the reproducibility and clinical consistency. Good manufacturing practice (GMP) and the need for phytochemical standardization to ensure therapeutic security and effectiveness.

Results

The review synthesizes findings from 72 peer-reviewed studies (1990–2023), including randomized clinical trials, in vivo and in vitro experiments, and traditional medical texts, focused on the antidiabetic properties of Trigonella foenum-graecum, Cinnamomum verum, and Morus alba.

Glycemic control: Three herbs have shown significant possibilities to reduce the levels of fasting blood glucose (FBG) post postprandial glucose (PPG), and glycated haemoglobin (HbA1c). Multiple human tests have stated that insulin sensitivity and the effectiveness of beta-cells, a statistically significant improvement. Herbal means. B. G reduced hba1c reduced additional effect Trigonella phonam-gracum delayed to empty the gastric of 20-25 mg/dl 0.5-1.0%, reduces insulin resistance Cinnamomum Verum improves 15-24 mg/DL 0.4-0.9% lipid profile, antioxidant and anti-inflammatory Moras alba prevents 18-30 mg/dl 0.3-0.8% α-glucosidez, reduces PPG spike (Data collected from Nilkantan and others, 2014; Ransingh and others, 2013; Kim and others, 2011; Mahmud and others, 2022).

Mechanisms of Action:

Pre-clinical and clinical data reveal a variety of processes through which these botanicals exert antidiabetic effects:

Fenugreek (T phonam-gracum): enhances peripheral glucose consumption through enhanced GLUT-4 expression and contains 4-hydroxyisoleucine, which is a compound known to stimulate insulin secretion.

Cinnamon (C Verum): insulin receptor enhances autophosphorylation and corrects the glycogen synthesis activity.

Mulberry (M alba): It is a 1-glucoside inhibitor that delays carbohydrate digestion.

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Antioxidant and inflammatory power: Most reviewed research ensures significant antioxidant properties of three herbs, reducing oxidative stress-T2 DM complexity.

Parameter fenugreek cinnamon white Superoxide Dismutase Malondialdehyde (MDA) TNF-α/IL-6 level is strong evidence of moderate evidence. Medium proof.

Security profile and side effects

Cinnamomum Verum was shown to be safe at moderate levels (1-6 g/day) with minimum hepatotoxic risk compared to C Cassia due to low polyphenol content (Wang et al., 2013). Trigonella foenum-gracum causes light gastrointestinal disruption in some tests and has possible interactions with anticoagulants (Busch et al., 2003). Moras alba was usually well tolerated, sometimes light swelling and nausea was reported (Andalu et al., 2001).

Limitations in Current Evidence

Despite Promising Outcomes, Several Limitations Were Evident Across Studies: Small Sample Sizes (Often <60 Participants) Lack of Long-Term Follow-Up (> 6 months), Inconsistent standardization of herbal preparations, Methodological Weaknesses, Such As Absence of Placebo or Double-Blinding, Limited DIVERSITY in Participant Demographics.

Discussion

The results of these reviews emphasize the possibilities of Trigonella foenum-graecum, Cinnamomum zeylanicum, and Morus alba as promising accessory therapy in the management of type 2 diabetes mellitus (T2 DM). Three botanies have shown significant antidiabetic activity in various pre-clinical and clinical studies, which supports their chronic use in traditional medical systems such as Ayurveda and Unani. This category explains the results, discussing compatibility and inconsistencies with previous research, and highlighting extensive effects.

Outcome

The results reveal that the selected botanicals effectively align the familiar pathophysiology of fasting blood Glucose (FBG) post postprandial glucose (PPG), and glycated hemoglobin (HbA1c) T2 DM. Tigonella phonum-gracum shows insulinotropic properties, perhaps responsible for its unique amino acids, 4-hydroxyisoleucine, which increases glucose-based insulin emission (Busch et al., 2003; Nilkantan et al. Improves insulin sensitivity through processes such as glucose transporter (GLUT 4) expression (Kin et al., 2003). Moras alba, 1-atiosinzirimycin (DNJ), prevents the intestinal α-glucosidace activity by the presence of the intestine, thereby reducing the PPG spikes (Andalu and Varadacharyulu, 2002; Kim et al.

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In addition, the antioxidant properties of these herbs are displayed through the modulation of oxidative stress markers such as maladialdehyde (MDA), and enzymatic antioxidants, such as superoxide dismutase (SOD), play an important role in reducing diabetes-induced oxidative damage (2013).

Compared with the current literature:

Current results are mainly compatible with previous meta-analyses and systematic reviews. Nilkantan and others. (2014) confirmed that fenugreek supplements lead to significant HbA1c and FBG reduction. Similarly, a meta-analysis by Ranninghe and others. (2012) found that cinnamon significantly reduces FBG and improves lipid profiles in T2DM patients. Kim and others. (2011) Due to DNJ, the mulberry leaf provides initial evidence to support the PPG-hurrying effect. These searches provide credibility to the therapeutic potential of these herbs.

However, some studies have found inconsistent results. For example, Allen and others. (2013) No significant changes were found in glycemic markers after cinnamon supplements, perhaps due to the difference in species (Cassia vs. Verum), dose, or period. In addition, the organic availability of active compounds like saponin and flavonoid varies across the preparation, which affects the clinical results (Garuenwald et al).

Impact for clinical practice:

Despite strong evidence, the translation of these results into regular clinical practice is lacking. In the main concern:

Lack of Standardization: Variation in the drainage method, the part of the plant, and the dose form affects the formation and reproduction (Welch, 2004). Security and Interaction: Although C Verum is usually safe, high levels of cassia cinnamon can cause hepatotoxicity (Wang et al. Methi can interfere with anticoagulants, and mulch may cause light gastrointestinal discomfort (Busch Et Al).

Patient acceptance and consent: Herbal therapy can improve loyalty due to the natural benefits of the felt, although suspicion is due to a lack of regulatory supervision.

However, when used as a nine-alternative alternative to allopathic drugs, these botanicals provide a hopeful way to increase glycemic control and reduce long-term complications.

Prospective Research Paths:

This review strengthens the requirements of large, double-blind, placebo-controlled randomized clinical trials with long-term follow-ups. Should Future Studies: Use a standard extract to ensure consistency. Use pharmacokinetic and pharmacodynamic profiling to better understand the absorption and metabolism. Evaluate the multi-national and age-diversified population to improve generalization. Check the cinemistic effects when combined with standard antidiabetic drugs. Evaluate the impact on long-term security, cost-effectiveness, and diabetes complexity (E.G., neuropathy, nephropathy). In addition, integration of herbal

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medicines with digital health equipment for observation and consent can lead to a revolution in personalized diabetes care.

Conclusion

Type 2 Diabetes mellitus remains a terrifying global health challenge, which has intensified due to modern lifestyle and is a significant burden. Although conventional pharmacotherapy is essential, its limitations highlight the requirements of the complementary method. Traditional herbs such as fenugreek (Trigonella foenum-gracum), cinnamon (Cinnamomum zeylanicum), and white mulberry (Morus alba) provide historical use and the emerging scientific evidence that shows hypoglycemic, antioxidant, and insulin-sensitive properties. However, to translate this possibility into a valid clinical practice, it will have to overcome considerable obstacles, including extract standardization, dose optimization, organic availability, and extensive long-term security evaluation. Strict, well-planned clinical trials and detailed pharmacoeconomic studies are urgently needed to ensure the efficacy, safety, and optimal use of botany. This review emphasizes the significant promise of these herbs and aims to stimulate more high-quality research, which eventually brings us way to more integrated and overall techniques in T2 DM management.

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