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A Comprehensive Review of the Most Important Medicinal Plants Effective in Gestational Diabetes: An In-depth Exploration of Their Pharmacological Mechanisms

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A B S T R A C T

Objective: Gestational diabetes arises due to the body's inability to effectively regulate blood glucose levels, caused by hormonal changes and insulin resistance, and if left untreated, it jeopardizes the health of both the mother and the fetus. This condition is classified into two types: A1 (manageable through diet) and A2 (requiring medication or insulin). Genetic factors and excess weight can also contribute to its onset. The aim of this study is to provide a comprehensive review of the most significant medicinal plants native to Iran that are effective in managing gestational diabetes and to explore their pharmacological mechanisms.

Methodology: For this review, a search was conducted in reliable databases such as PubMed, Scopus, SID, and Google Scholar, as well as traditional Iranian medicine reference books, to gather articles related to medicinal plants effective against gestational diabetes. The medicinal plants related to gestational diabetes in traditional Iranian medicine were selected for this review. The objective of this study was to identify plants that can be used for managing gestational diabetes with minimal side effects.

Results: In traditional Iranian medicine, several medicinal plants have been recommended for the management of gestational diabetes, including *Trachyspermum ammi* (L.) Sprague, *Foeniculum vulgare* Mill., *Origanum vulgare* L., *Myrtus communis* L., *Eucalyptus globulus* Labill., *Zingiber officinale* Roscoe, *Salvia officinalis* L., *Cinnamomum verum* J. Presl, *Aloysia citrodora* Paláu, *Lippia citriodora* Kunth, *Cucurbita pepo* L., *Artemisia absinthium* L., *Artemisia herba-alba* Asso, *Juglans regia* L., *Cuminum cyminum* L., *Vicia faba* L., *Olea europaea* L., *Thymus vulgaris* L., *Mentha piperita* L., *Cuminum cyminum* L., *Rosmarinus officinalis* L., *Solanum melongena* L.. These plants have been used for controlling gestational diabetes in traditional Iranian medicine.

Conclusion: Gestational diabetes, as a common condition during pregnancy, requires careful and effective management to prevent serious complications for both the mother and the fetus. In traditional Iranian medicine, many medicinal plants are recognized as adjunctive treatments for managing gestational diabetes. The use of these plants could serve as a natural and cost-effective strategy alongside standard medical treatments, particularly in cases of gestational diabetes. However, it is crucial that the consumption of these plants be supervised by a healthcare professional to avoid any potential side effects or drug interactions.

Keywords: Gestational Diabetes, Medicinal Plants, Traditional Iranian Medicine, Pharmacological Mechanisms, Blood Sugar Control, Insulin Resistance

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Introduction

Insulin resistance and hyperglycemia are more common in pregnant women [1]. Insulin is a hormone that converts blood sugar into glycogen and stores it in cells [2]. During pregnancy, hormones secreted by the placenta and fetus reduce the body's sensitivity to insulin. In most cases, the body compensates for this by increasing insulin production. However, in some women, insulin production is insufficient, and blood sugar levels rise. This condition is known as gestational diabetes [3]. In some pregnant women, blood sugar levels increase in the middle of pregnancy, leading to gestational diabetes. This complication typically occurs between the 24th and 28th weeks of pregnancy. According to CDC reports, the prevalence of gestational diabetes is estimated to be between 2% and 14% [14]. During pregnancy, hormonal changes can reduce insulin effectiveness and increase blood sugar, which can result in gestational diabetes in some women. Risk factors include excess weight, family history of diabetes, and the use of certain medications [5].

Diabetes, as a condition of multifactorial origin including genetic and environmental factors, accounts for 3.5% of the mortality cases because of non-communicable chronic [6]. Gestational diabetes is usually asymptomatic, but in some cases, mild symptoms such as excessive thirst, frequent urination, dry mouth, fatigue, blurred vision, and genital itching or infections may occur [7]. Risk factors for gestational diabetes include family history, overweight, and high-risk pregnancies. Early diagnosis is essential to prevent maternal and fetal complications [8]. Untreated gestational diabetes can have significant consequences for the baby, including macrosomia (high birth weight), increased risk of respiratory disorders such as respiratory distress syndrome, neonatal hypoglycemia, and a higher likelihood of obesity and type 2 diabetes later in life [9]. Gestational diabetes is typically diagnosed between the 24th and 28th weeks of pregnancy, and women with risk factors should be screened before the 15th week. Diagnosis is made through a two-step blood glucose test after glucose consumption [10].

A suitable diet for gestational diabetes includes a balanced intake of proteins, complex carbohydrates, healthy fats, and fiber [11]. This diet should be consumed regularly in small meals throughout the day to properly control blood sugar [12]. Processed foods and sugary beverages should be avoided to reduce the risks associated with gestational diabetes [13]. While gestational diabetes cannot be fully prevented, the risk of developing it can be reduced by maintaining healthy habits such as consuming fiber-rich, low-fat foods and engaging in regular physical activity. Maintaining a healthy weight before pregnancy and consulting with a healthcare provider about appropriate weight gain during pregnancy can also prevent gestational diabetes and type 2 diabetes [14]. Gestational diabetes is a condition characterized by elevated blood sugar during pregnancy, and its treatment includes a healthy diet, exercise, and in some cases, insulin therapy. Blood sugar control and monitoring fetal health are essential to prevent serious complications such as preterm birth and high birth weight [15].

Traditional Iranian Medicine, with its deep-rooted history, has long advocated the use of medicinal herbs for treating various ailments [16]. In traditional medicine, medicinal plants are recommended for managing gestational diabetes to help lower blood sugar levels [17]. Dietary modifications, including the consumption of vegetables, whole grains, and natural anti-inflammatory foods, combined with mild exercise, can aid in blood sugar control and improve the pregnant woman's condition [18]. Green tea, cinnamon, bitter melon, and other medicinal plants have been shown to be effective in reducing blood sugar and controlling gestational diabetes. These plants can be consumed as teas, powders, or supplements to help regulate blood sugar levels [19]. This study aims to provide a comprehensive review of the medicinal plants native to Iran that are effective in managing gestational diabetes and explore their pharmacological mechanisms.

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Methodology

In this review, a search was conducted in reputable databases including PubMed, Scopus, SID, and Google Scholar, as well as in reference books of traditional Iranian medicine, to gather articles related to medicinal plants effective in treating gestational diabetes. Medicinal plants known in traditional Iranian medicine for controlling, managing, and treating gestational diabetes were selected for an in-depth review. The inclusion criteria for this study included articles and resources that specifically address the medicinal plants native to Iran and their effects on treating gestational diabetes. Conversely, sources with insufficient or unrelated information were excluded from the study.

Results

Traditional Iranian medicine uses various medicinal plants to control gestational diabetes, helping regulate blood sugar levels and improving the health of both the mother and the fetus. Notable plants include *Trachyspermum ammi* (L.) Sprague, *Foeniculum vulgare* Mill., *Origanum vulgare* L., *Myrtus communis* L., *Eucalyptus globulus* Labill., *Zingiber officinale* Roscoe, *Salvia officinalis* L., *Cinnamomum verum* J. Presl, *Aloysia citrodora* Paláu, *Lippia citriodora* Kunth, *Cucurbita pepo* L., *Artemisia absinthium* L., *Artemisia herba-alba* Asso, *Juglans regia* L., *Cuminum cyminum* L., *Vicia faba* L., *Olea europaea* L., *Thymus vulgaris* L., *Mentha piperita* L., *Cuminum cyminum* L., *Rosmarinus officinalis* L., *Solanum melongena* L.. These plants have been used in traditional Iranian medicine to manage gestational diabetes and are employed as natural treatments to reduce the complications of the condition. Further results on medicinal plants used for managing gestational diabetes in traditional Iranian medicine are detailed in Table 1.

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Table 1: Medicinal Plants for Gestational Diabetes [17-31]

Persian Name	Scientific Name	Plant Family	Used Part	Traditional Use	Mechanism of Action
Zanayan	*Trachyspermum ammi* (L.) Sprague	Apiaceae	Seed	Consumed as tea or extract	Enhances insulin sensitivity, reduces blood glucose, anti-inflammatory effect on pancreatic tissue
Fennel	*Foeniculum vulgare* Mill.	Fabaceae	Seed	Consumed as tea or extract	Improves glucose metabolism, enhances insulin secretion, anti-inflammatory properties
Shirazi Thyme	*Origanum vulgare* L.	Lamiaceae	Leaf	Consumed as tea or extract	Reduces blood glucose, inhibits carbohydrate-digesting enzymes, antioxidant and anti-inflammatory effects
Myrtle	*Myrtus communis* L.	Myrtaceae	Leaf	Consumed as leaf extract or tea	Improves glycemic control, enhances insulin activity, antioxidant properties
Eucalyptus	*Eucalyptus globulus* Labill.	Lauraceae	Leaf	Consumed as decoction or extract	Reduces blood glucose and oxidative stress, improves insulin sensitivity
Ginger	*Zingiber officinale* Roscoe	Zingiberaceae	Root	Consumed as decoction or powder	Enhances insulin secretion, improves glucose uptake, anti-inflammatory and antioxidant effects
Sage	*Salvia officinalis* L.	Lamiaceae	Leaf	Consumed as tea or extract	Improves insulin sensitivity, regulates blood sugar, anti-inflammatory properties
Cinnamon	*Cinnamomum verum* J. Presl	Lauraceae	Bark	Consumed as decoction or powder	Enhances glucose uptake by cells, improves insulin signaling, antioxidant and anti-inflammatory
Lemon Verbena	*Aloysia citrodora* Paláu	Verbenaceae	Leaf	Consumed as tea or extract	Reduces blood glucose, modulates carbohydrate metabolism, anti-inflammatory effect
Lemon Balm	*Lippia citriodora* Kunth	Verbenaceae	Leaf	Consumed as tea or extract	Improves insulin sensitivity, reduces hyperglycemia, antioxidant effects
Pumpkin	*Cucurbita pepo* L.	Cucurbitaceae	Fruit	Consumed raw or dried	Lowers blood glucose, enhances insulin secretion, anti-inflammatory effects
Wormwood	*Artemisia absinthium* L.	Asteraceae	Leaf and root	Consumed as decoction or extract	Enhances insulin action, inhibits gluconeogenesis, anti-inflammatory and antioxidant effects

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White Wormwood	*Artemisia herba-alba* Asso	Asteraceae	Leaf	Consumed as decoction or powder	Reduces blood sugar levels, enhances insulin sensitivity, antioxidant activity
Walnut	*Juglans regia* L.	Juglandaceae	Fruit	Consumed as tea or powdered seeds	Improves glucose metabolism, reduces oxidative stress, anti-inflammatory effect
Black Cumin	*Cuminum cyminum* L.	Apiaceae	Seed	Consumed as tea or powdered seeds	Enhances insulin secretion, improves glucose uptake, anti-inflammatory and antioxidant properties
Broad Bean	*Vicia faba* L.	Fabaceae	Seed	Consumed as tea or powdered seeds	Stimulates insulin release, improves glycemic control, antioxidant effects
Olive	*Olea europaea* L.	Oleaceae	Fruit	Consumed raw or dried	Enhances insulin sensitivity, reduces hyperglycemia, anti-inflammatory and antioxidant
Thyme	*Thymus vulgaris* L.	Lamiaceae	Leaf	Consumed as tea or extract	Regulates blood glucose, enhances insulin activity, antioxidant properties
Mint	*Mentha piperita* L.	Lamiaceae	Leaf	Consumed as decoction or extract	Lowers blood sugar, improves insulin sensitivity, anti-inflammatory effects
Rosemary	*Rosmarinus officinalis* L.	Lamiaceae	Leaf	Consumed as decoction or extract	Improves glucose metabolism, enhances insulin sensitivity, reduces oxidative stress
Eggplant	*Solanum melongena* L.	Solanaceae	Fruit	Consumed raw or dried	Lowers blood glucose, improves insulin signaling, anti-inflammatory and antioxidant effects

Figure 1 provides a visual summary of the mechanisms of medicinal plants for gestational diabetes.

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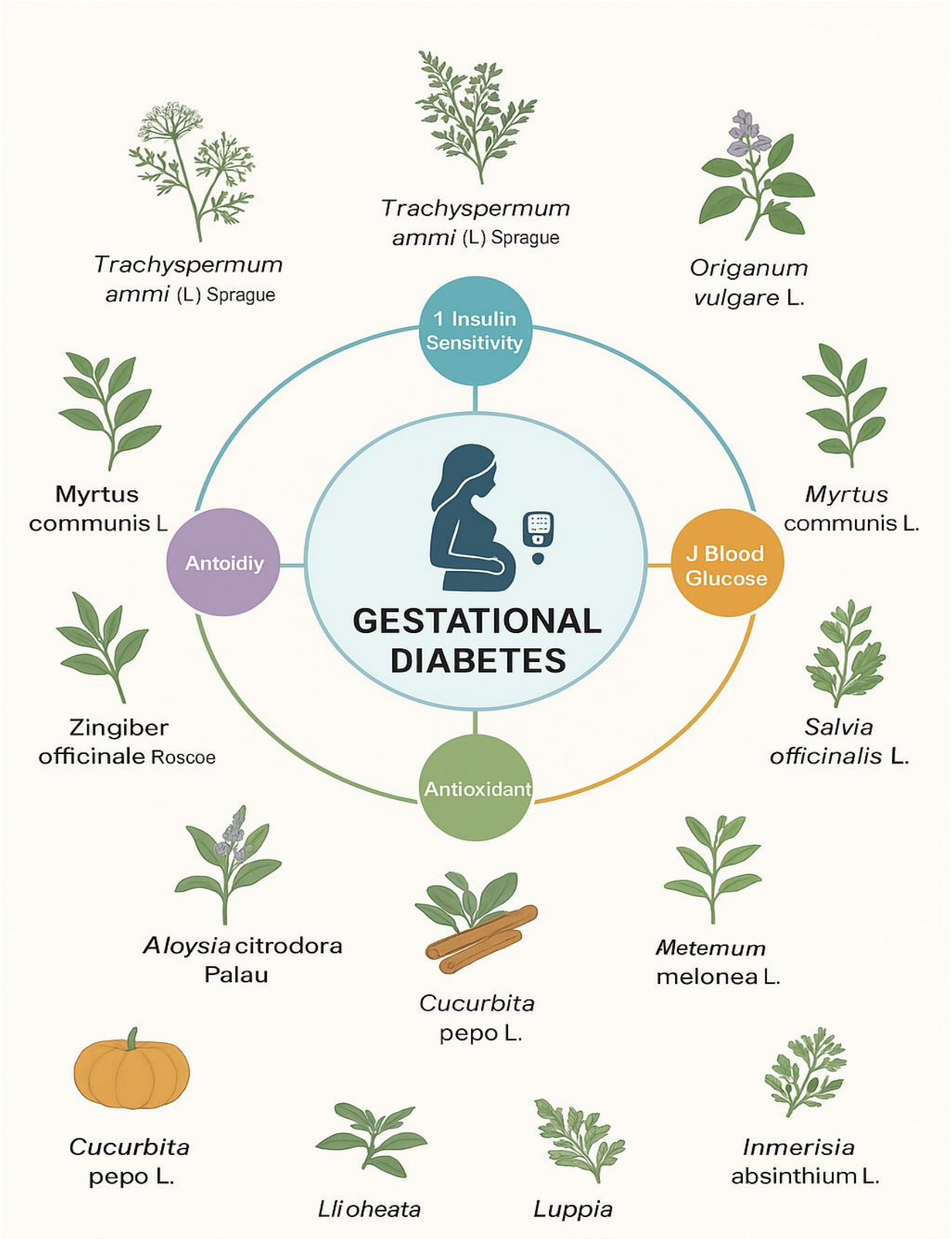

Figure 1: Visual Representation of Antidiabetic Mechanisms of Medicinal Plants

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Discussion

Diabetes is a metabolic disorder characterized by impaired insulin production or function, leading to elevated blood glucose levels. Gestational diabetes is a form of diabetes that develops during pregnancy and typically resolves after childbirth. However, it can pose risks to both the mother and the baby. Proper control and timely medical care can help prevent serious complications associated with this condition [35].

Research indicates that over 1200 plant species with anti-diabetic properties have been identified. The most significant active compounds found in these plants include imidazolines, alpha-lipoic acid, flavonoids, and saponins. The mechanisms of action of these compounds involve stimulating insulin secretion, antioxidant activity, enzyme inhibition, and the suppression of glucose biosynthesis [36]. A review study exploring the use of medicinal plants in diabetes management highlights several plants, such as *Allium cepa*, *Allium sativum*, *Gymnema sylvestre*, and *Silybum marianum*, as effective treatments. The study also emphasizes the potential risks of using these plants unwittingly, such as drug interactions and fluctuations in blood glucose levels [37]. Another investigation examines the role of plants such as garlic, onion, fenugreek, milk thistle, and green tea in managing diabetes. It underscores the importance of cautious usage to prevent adverse drug interactions and challenges in blood sugar control. The study also points to the significance of dietary changes and alternative treatments in preventing and managing Type 2 diabetes and assisting in the treatment of Type 1 diabetes [38].

A review of clinical trials on medicinal plants for diabetes treatment in Iran from 2010 to 2020 reveals that certain plants, including cinnamon and cumin, have shown positive effects on blood glucose levels and HbA1c [39]. Several medicinal plants, such as *Apium graveolens*, *Alyssum desertorum, Arctium lappa, Avena sativa, Berberis integerima, Cerasus microcarpa, Crataegus aronia, Allium schoenoprasum, Urtica dioica, Phlomis aucheri, Salvia aethiopis, Melilotus officinalis, Tragopogon pratensis, Euphorbia helioscopia, Salvia officinalis*, and *Salix aegyptiaca*, have been used in West Azerbaijan, East Azerbaijan, and Ardabil provinces for treating diabetes. These plants have long been employed in traditional medicine in these regions due to their anti-diabetic properties [40].

Further research has reported that 282 plant species from 63 families have been documented for treating diabetes in Iran. Urtica dioica, along with Citrullus colocynthis, *Teucrium polium*, *Juglans regia*, and *Trigonella foenum-graecum*, are among the most frequently used plants in diabetes treatment. Phylogenetic relationships between the plant families and their parts used for diabetes treatment have shown significant correlations based on evolutionary plant patterns [41]. A total of 85 studies (18 human trials and 67 animal studies) have examined 62 plants, with randomized controlled trials (RCTs) assessing the quality of studies using the Jadad scale. Among the RCTs, the best results in blood sugar control were found with *Aloe vera*, *Citrullus colocynthis*, *Plantago ovata*, *Silybum marianum*, Rheum ribes, and Urtica dioica [42]. In Urmia, medicinal plants such as *Achillea millefolium* L., *Alyssum desertorum* Stapf., *Arctium lappa* L., *Avena sativa* L., *Berberis integerima* Bunge., *Cerasus microcarpa, Cinnamomum verum, Citrullus colocynthis* (L.) Schrad., *Crataegus aronia* (L.) Bosc ex Dc., *Juglans regia, L. album L., and Sanguisorba minor* Scop. are utilized for treating diabetes [43]. Medicinal plants such as Nigella sativa, Aconitum napellus, Agaricus albolutescens, and Euphorbia cedrorum, among others, are used for gestational diabetes [44]. In many diseases and disorders [45-49], turning to nature and embracing traditional or natural therapeutic approaches can serve as a beneficial and complementary strategy helping to alleviate symptoms, support overall well-being, and enhance patients' quality of life [50].

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Conclusion

Gestational diabetes is a common concern during pregnancy that requires careful monitoring and treatment to prevent serious complications for both the mother and the fetus. In traditional Iranian medicine, numerous medicinal plants are recognized as complementary treatments for managing gestational diabetes. These plants can be beneficial as natural and cost-effective alternatives alongside conventional medical treatments, especially in the case of gestational diabetes. However, the use of these plants should be supervised by a qualified healthcare provider to prevent potential side effects and interactions with other medications.

Statements and Declarations

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Competing interests

The authors have no competing interests to declare that are relevant to the content of this article.

Ethics approval

This study was performed in line with the principles of the Declaration of Helsinki.

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