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MEDICINAL PLANTS USED IN THE TREATMENT OF DIABETES MELLITUS WORLDWID

Tagaeva Mukhayo Bafoevna
Bukhara State University
PhD in Biological Sciences, Associate Professor
m.b.tagaeva@buxdu.uz

Zaribboyev Ma'rufjon Oybek o'g'li
2nd-Year Master's Student, Bukhara State University
marufjonzaribboyev@gmail.com

Abstract
Currently, diabetes mellitus is one of the most widespread and rapidly developing diseases among both young and adult populations. Significant efforts have been made to prevent this disease. The use of medicinal plants in its treatment, the identification of their components, and the development of pharmaceutical products based on them are progressing rapidly.
This article emphasizes the importance of early diagnosis and treatment of diabetes through effective use of medicinal preparations. Furthermore, it highlights the significance of cultivating medicinal plants through modern biotechnological methods, producing pharmaceutical products, and implementing preventive measures. The use of biotechnology to develop high-quality medicines with effective mechanisms of action is also considered one of the key factors. Numerous reviews related to ongoing developments in this field are presented.

Keywords: berberine, ginsenosides, curcumin, stevioside, gingerol, capsaicin, catechins, simple phenolic compounds, anthocyanins, resveratrol, genistein, and hesperidin.

Introduction

At present, diabetes mellitus is one of the most widespread diseases among the population. Treatment of this disease with highly effective pharmaceutical drugs is often quite expensive. Over the past decade, significant efforts have been made to prevent diabetes, along with the development of new methods for discovering therapeutic compounds. Currently, the production of antidiabetic drugs has been widely established, and the study of natural products with antidiabetic potential has gained great importance. Extracts and bioactive molecules derived from various plants — such as berberine, ginsenosides, curcumin, stevioside, gingerol, capsaicin, catechins, simple phenolic compounds, anthocyanins, resveratrol, genistein, and hesperidin — are used in the treatment of diabetes and exhibit diverse mechanisms of action.
This review discusses medicinal plants and their active components with antidiabetic properties, emphasizing their beneficial aspects. The research also highlights the potential for diabetes management, reduction of complications, and effective use of plant-derived therapeutic agents. The detailed mechanisms of action of these extracts and compounds have

not yet been fully elucidated. Generally, such extracts are derived from plant and animal sources [1].

Currently, the following plants are considered effective in the prevention and treatment of diabetes: Carthamus tinctorius, Ferula assa-foetida, Bauhinia, Gymnema sylvestre, Swertia, Combretum, Sarcopoterium, Liriope, Caesalpinia bonduc, Coccinia grandis, Syzygium cumini, Mangifera indica, Momordica charantia, Ocimum tenuiflorum, Pterocarpus, Tinospora cordifolia, Salvia officinalis, Panax, Cinnamomum verum, Abelmoschus moschatus, Vachellia nilotica, Achyranthes, Fabaceae, Mentha, Asphodelaceae, Andrographis paniculata L., Artemisia herba-alba, Artemisia dracunculus, Azadirachta indica, Caesalpinioideae, Pachira aquatica, Gongronema latifolium, Nigella sativa, Tinosporchiadu (Chrysanthemum morifolium, Zingiber zerumbet, Symphytum, Cactaceae, Symplocos, Perilla frutescens, Terminalia chebula, and Aloe vera). These plants have been found to be effective in controlling and treating diabetes.[2]

Since ancient times, many patients suffering from diabetes mellitus have been treated with medicinal plants. At present, more than 1,200 species of medicinal plants are known to be used in the treatment of diabetes. Although many of these plants help reduce blood glucose levels, some have been found to cause complications related to hyperglycemia. Certain medicinal plants possess antioxidant activity; however, their oxidative properties can also trigger stress conditions that contribute to the development of diabetes and other related diseases[3].

It is well known that the main groups of phytochemicals include alkaloids, aromatic acids, carotenoids, coumarins, essential oils, flavonoids, glycosides, organic acids, phenols, phytosterols, protease saponins, steroids, tannins, terpenes, and terpenoids. Pharmacological studies have shown that these compounds, along with vitamins, exhibit antidiabetic properties. Currently, many countries around the world use medicinal plants in the treatment of diabetes. Scientific research demonstrates that medicinal plants, vitamins, and essential elements can significantly reduce blood sugar levels both before the onset of the disease and during its progression[4] [6].

Today, natural compounds derived from traditional medicinal plants—particularly biologically active substances—are widely used in diabetes therapy. For instance, **metformin**, a well-known antihyperglycemic agent, was originally derived from the medicinal plant Galega officinalis.

Among the hypoglycemic plants and vitamins used to improve immunity and regulate blood sugar levels in humans are Allium sativum (garlic), Momordica charantia (bitter melon), Hibiscus sabdariffa L. (roselle plant), Zingiber officinale Rosc. (ginger), and vitamins **E1, D2,**

[1] Mukhayo Tagaeva, Anorgul Gulova, and Nafisa Koshshaeva. Technology for preparing prototype biopreparations based on microalgae. BIO Web of Conferences 141, 03016 (2024) Agricultural science 2024.
[2] Behzad Moradi1, Saber Abbaszadeh,Somayeh Shahsavari, Mohsen, Alizadeh and Fatemeh Beyranvand The most useful medicinal herbs to treat diabetesBiomed PressAn Open Access Publisher 2014.
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[4] Clement G. Yedjou , Jameka Grigsby , Ariane Mbemi , Daryllynn Nelson , Bryan Mildort , Lekan Latinwo 1 and Paul B. Tchounwou The Management of Diabetes Mellitus Using Medicinal Plants and VitaminsInternational Journal o f Molecular Sciences.2013.

and C. Given that many medicinal plants are affordable, safe, and effective, both developing and developed countries continue to rely on them to meet healthcare needs.

Various plants from around the world have been studied for their antidiabetic effects. In traditional Iranian medicine, numerous medicinal plants—used to treat both type 1 and type 2 diabetes—are known to influence diabetic tissues within the human body. Extracts and essential oils of plants such as Urtica, Trigonella foenum-graecum, Allium sativum, Carthamus tinctorius, Ferula assa-foetida, Bauhinia, Gymnema sylvestre, Swertia, Combretum, Sarcopoterium, Syzygium cumini, Mangifera indica, Momordica charantia, Ocimum tenuiflorum, Pterocarpus, Tinospora cordifolia, Salvia officinalis, Panax, Cinnamomum verum, Abelmoschus moschatus, Vachellia nilotica, Artemisia herba-alba, Artemisia dracunculus, Azadirachta indica, Gongronema latifolium, Nigella sativa, Perilla frutescens, Terminalia chebula, and Aloe vera have been proven effective in controlling and treating diabetes[5].

According to data from the **World Health Organization's International Clinical Trials Registry Platform**[6], numerous studies have confirmed that phytochemicals found in Allium sativum, Momordica charantia, Hibiscus sabdariffa L., and Zingiber officinale possess antihypoglycemic effects and are effective in preventing and managing diabetes. Results also show that consumption of vitamins **C, D, and E,** either individually or in combination, can improve the health of diabetic patients by reducing glucose levels, inflammation, lipid peroxidation, and blood pressure.

Countries in the **Middle East** have a long history of using herbal medicines to treat various diseases, including diabetes. In this region, plants with potential antidiabetic activity—especially those belonging to the Asteraceae and Lamiaceae families—are cultivated and studied using in vivo and in vitro methods[7].

Natural products derived from plants, animals, and microorganisms have been proven beneficial to human and animal health. According to WHO estimates, **about 80% of the population in developing countries** still relies on traditional medicine and plant-based remedies for disease prevention and treatment.

Plant extracts are generally cheaper, clinically effective, and have fewer side effects compared to modern pharmaceuticals. The secondary metabolites obtained from plants—such as steroids, alkaloids, phenolics, lignans, carbohydrates, and glycosides—exhibit diverse biological properties beneficial to human health, including **anti-allergic, antimicrobial, and antioxidant activities.**

Diabetes mellitus is a chronic disease characterized by metabolic disorders in pancreatic β-cells that lead to hyperglycemia. Hyperglycemia may result from insufficient insulin production

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(type 1 diabetes) or insulin resistance combined with inadequate secretion (type 2 diabetes mellitus).

Current diabetes medications primarily focus on controlling blood glucose levels. However, most modern drugs can cause serious side effects during treatment. In recent years, several new bioactive compounds isolated from plants have shown stronger antidiabetic activity and better efficacy than conventional oral hypoglycemic agents[8].

Diabetes affects people of all ages and is a chronic condition with widespread prevalence worldwide. The global increase in diabetes has led to the development of various synthetic drugs, which, while effective, are expensive and often inaccessible in low-income regions.

To better understand the mechanisms of action of medicinal plants, their active phytoconstituents are being isolated and studied in depth. Pharmacologically active phytomolecules derived from antidiabetic plants play a crucial role in diabetes management and therapy, offering new and effective therapeutic approaches[9].

Furthermore, plants continue to produce essential and secondary metabolites—chemical compounds that are vital for modern therapeutic use. Since local populations largely depend on traditional plant-based remedies, it can be concluded that the use of medicines derived from medicinal plants remains of great importance today.

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