

# The Role of Medicinal Plants in Addressing Food Insecurity and Diabetes

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## ABSTRACT

Food insecurity and diabetes mellitus (DM) are interlinked global challenges that disproportionately affect vulnerable populations, especially in low- and middle-income countries. Food insecurity exacerbates poor dietary habits and psychological stress, contributing to the onset and progression of diabetes. Concurrently, diabetes, a chronic metabolic disorder characterized by hyperglycemia, imposes severe health and economic burdens. In this context, medicinal plants offer a dual-purpose solution: as nutrient-rich resources that support food security and as therapeutic agents for diabetes management. With approximately 50,000 plant species used globally for medicinal purposes, many possess bioactive compounds such as alkaloids, flavonoids, and phenolics with documented antidiabetic and antioxidant properties. Ethnobotanical studies across regions like Morocco, Malaysia, and sub-Saharan Africa highlight the significance of these plants in traditional healing systems. Despite their therapeutic promise, challenges persist regarding scientific validation, safety, and regulatory oversight. This paper explores the intersection of food insecurity and diabetes and examines the role of medicinal plants in addressing both issues simultaneously. It calls for integrative research, public health interventions, and policy frameworks that elevate the role of medicinal plants in modern healthcare and food systems.

**Keywords:** Food insecurity, diabetes mellitus, medicinal plants, bioactive compounds, traditional medicine, phytochemicals, nutrition, public health.

## INTRODUCTION

Food insecurity is the lack of physical and economic access to sufficient, safe, and nutritious food that meets dietary needs and food preferences for active and healthy living. Globally, around 800 million people suffer from hunger and 2.8 billion experience moderate or severe food insecurity, leaving only about 1 billion who are food secure [1-4]. Food-insecure individuals are more likely to report poor nutritional intake, weaker feelings of community belonging, and higher levels of stress. Chronic food insecurity can impair health and emotional wellbeing due to inadequate intake of essential nutrients, vitamins, and minerals, highlighting the urgent need to improve food security worldwide [5-8]. Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia due to insulin secretion and/or action defects. Globally, approximately 463 million people aged 20-79 are living with diabetes, a figure projected to rise to 700 million by 2045. In regions such as Belize and Central America, the interplay of food insecurity and diabetes disproportionately affects indigenous populations, underscoring the need for heightened awareness and culturally adapted interventions [9-10]. Medicinal plants encompass any plant utilized for therapeutic purposes or as precursors in drug production. Despite their widespread application, often there is scant information on their efficacy and safety. As defined by the World Health Organization, medicinal plants serve as a source of substances with potential therapeutic effects and can be classified into three categories: plants used directly as crude drugs, plants yielding purified active compounds, and plants providing phytopharmaceuticals [11-13]. Throughout history, a large portion of human medicine has been derived from plant origins, used in treatments, cosmetics, nutritional supplements, and preparations aimed at preventing or alleviating ailments. Currently, approximately 50,000 species of medicinal plants are employed globally [14-19].

### Understanding Food Insecurity

Food insecurity, defined as having limited or uncertain access to adequate food, can increase the risk for chronic health conditions such as diabetes and depression. Food insecurity is strongly linked to poor psychosocial outcomes including higher risk of depression, anxiety, perceived stress, and diabetes-specific distress. It may exacerbate self-doubt, worry, shame, and guilt, with those who experience more severe food insecurity showing substantially increased risk of these mental health problems [20-26]. Depression, which often co-occurs with reduced food access, is itself a risk factor for diabetes development. Food insecurity may also contribute to inflammation through nutritional, behavioral, and mental health pathways, elevating markers of chronic disease risk. Among individuals with type 2 diabetes (T2D), it is associated with increased insulin resistance and greater chronic inflammation [27-32]. Persistently, these difficulties concentrate in underserved populations, thereby heightening their vulnerability. Policies and programmes that support food security, healthy diets, and physical and mental health are urgently needed to encourage population-wide reductions in diabetes incidence and disparities. Interventions such as produce prescription programmes and the Special Supplemental Nutrition Program for Women, Infants and Children (known as WIC) can be employed to address both food insecurity and diabetes. Moreover, 'food is medicine' entails integrating specific food and nutrition interventions into health care systems to improve health outcomes [33-39].

### Definition and Scope

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by hyperglycaemia resulting from defects in insulin secretion or action. The global number of people living with diabetes is increasing; forecasts estimate that by 2030 there will be 366 million individuals with diabetes. Existing medications target the control of blood glucose but may cause various undesirable side effects [40]. Traditional medicine plays an important role in the management of diabetes, and some plant products have been reported to exhibit greater efficacy than existing drugs. Plant secondary metabolites such as steroids, alkaloids, phenolics, lignans, carbohydrates and glycosides contribute to the biological properties of plants and exhibit antiallergic, anticancer, antimicrobial, anti-inflammatory, antidiabetic and antioxidant activities. The intentional use of plants dates back to the beginning of civilization, and herbal medicines remain the most important therapeutic agents in both developing and developed countries. Several plant species are employed locally for the treatment of diabetes, but many have not been scientifically evaluated. The World Health Organization (WHO) advocates further investigation of plants used in traditional medicine for possible integration into modern health-care systems [10-15].

### Global Statistics

Diabetes mellitus (DM) is an endocrine metabolic disorder characterized by hyperglycemia resulting from a deficiency in insulin secretion and/or action. The global costs of diabetes and its consequences are large and will substantially increase by 2030. Even if countries meet the international targets, the global economic burden will not decrease [16-18]. Herbal drugs can play an effective role in lowering the global economic burden because these are cost effective and, by implication of recent advanced technologies like nanotechnology, can achieve a higher therapeutic index. Traditional medicine continues to provide a significant basis for health care worldwide, with many herbs and medicinal plants utilised as natural remedies to treat various ailments. With approximately 382 million individuals having diabetes worldwide and a predicted increase to 592 million by 2035, medicinal plants have been investigated for alternative treatments [19-24]. Conventional medicines used to treat diabetes mellitus are often limited in efficacy, costly, and associated with detrimental side effects. Plants and herbs are effective and safe alternatives well recognised by the World Health Organization (WHO). Medicinal plants form the basis of a number of pharmaceutical products for the treatment of diabetes. An ethnobotanical survey carried out with 193 informants in the Taza region of Morocco identified 46 plant species used to treat diabetes, mainly from the Lamiaceae, Asteraceae, and Fabaceae families. Data analysis showed ten species with high use and citation values, including *Salvia officinalis* and *Marrubium vulgare*. Four plants *Cytisus battandieri*, *Urginea maritima*, *Plantago ovata*, and *Ziziphus jujube* are reported for the first time for diabetes treatment in this context. Leaves were the most used part of medicinal plants, primarily prepared by decoction, followed by powder and infusion. In vitro and in vivo tests have been conducted on several of these plants for their antidiabetic effects [25-28].

### Impact on Health and Nutrition

The influence of health and nutrition on individual feeding capabilities is significant, while food issues greatly impact health. Nutrient deficiencies lead to under-nutrition and health problems, with diet choices increasingly linked to chronic diseases. The plant kingdom offers numerous bioactive compounds

beneficial for health, with about 80% of the population in developing countries relying on traditional medicine for disease prevention and treatment. Secondary metabolites like steroids, alkaloids, and phenolics exhibit various biological activities including anti-inflammatory and antioxidant effects [29-34]. Diabetes mellitus (DM) is a chronic disorder characterized by glucose metabolism issues, categorized into insulin-dependent (type I) and non-insulin-dependent (type II) forms. Current treatments focus on blood-glucose control, but many have serious side effects or diminish in effectiveness over time. Traditional medicine remains vital for treating DM, highlighting its historical significance. Recently, bioactive plant compounds have emerged as promising alternative DM treatments, often demonstrating superior efficacy compared to some clinical drugs. The World Health Organization identifies DM prevention as critical to global health; thus, medicinal plants could play a crucial role in addressing this challenge. Numerous bioactive compounds have been identified, with their therapeutic mechanisms actively researched, enhancing the relevance of various medicinal plants in DM treatment [35-38].

### **Diabetes: A Growing Concern**

Diabetes mellitus (DM) is a complex metabolic disorder characterized by elevated blood glucose levels resulting from defects in insulin secretion, action, or both. Globally, the incidence of diabetes is rising steadily due to factors such as population growth, aging, urbanization, obesity, and sedentary lifestyles. Projections estimate that by 2030, approximately 366 million individuals will be affected, underscoring the urgency for accessible and effective treatments. Current therapeutic strategies have notable limitations: insulin injections are necessary for total insulin deficiency, while orally active agents such as glucosidase inhibitors (acarbose, miglitol, voglibose) reduce glucose absorption by inhibiting carbohydrate degradation; metformin promotes glucose uptake by peripheral tissues; and sulfonylureas stimulate pancreatic insulin secretion [39-40]. However, these synthetic drugs can be associated with high costs and adverse effects including hypoglycemia, weight gain, gastrointestinal discomfort, and hepatotoxicity. The rising global prevalence imposes a substantial economic burden that is projected to increase further, even with enhanced disease control targets. Herbal remedies offer a cost-effective and safer alternative that can contribute to alleviating this burden, particularly when enhanced by emerging technologies such as nanotechnology that improve therapeutic indices. Medicinal plants constitute a valuable source of phytochemicals polyphenols, tannins, alkaloids, carbohydrates, terpenoids, steroids, and flavonoids that provide promising leads for the development of new antidiabetic agents. Among these, Momordicine I and II stimulate insulin secretion; trans-tiliroside lowers blood glucose and lipid levels; Eleutherinoside A exhibits  $\alpha$ -glucosidase inhibitory activity; Kaempferol-3-neohesperidoside has insulin-mimetic effects; Bergenin displays hypolipidemic, antioxidant, and  $\beta$ -cell regenerative properties; flavones from *Callistemon lanceolatus* reduce blood glucose; Marrubiin increases insulin levels; germacrane sesquiterpenes from *Tithonia diversifolia* enhance glucose uptake; and Alisol F and B act as  $\alpha$ -glucosidase inhibitors. Scrophuside, isolated from *Scrophularia ningpoensis*, represents another antidiabetic phytoconstituent for consideration. The World Health Organization advocates the exploration of herbal medicines to address unmet medical needs; nevertheless, scientific validation of safety and efficacy remains an essential prerequisite for their widespread adoption [11-12].

### **Medicinal Plants: An Overview**

Mankind has turned to medicinal plants to satisfy its health needs since ancient times. These plants were predominantly found in abundance in the vicinity of human civilization during their early origin. Therefore a vast number of plants were selected for medicinal requirements. The knowledge regarding these plants was transmitted to the succeeding generations only by oral communications. Medicinal plants are characterised by their richness in bioactive compounds and e.g. other phytochemicals that serve to protect human bodies from a wide range of health disorders. Medicinal plants serve as a cheaper alternative to synthetic drugs, thus a large number of developing countries continue to use traditional medicine for primary health care. Almost 75% of the whole world herbal medicine have been developed based on folk medicine practitioners and the demand towards plant based antidiabetic medicines is increasing globally. Asian countries (China, India and Japan) with enormous medicinal plant species are among the highest exporters. In addition to the use of synthetic drugs, there is an urgent need to develop new agents for the treatment of diabetes, especially plant-derived ones having novel mode of action. Medicinal plants have a huge impact in the treatment of major health concerns and a proper emphasis is required to promote their usage. Trend of shifting back into the natural way of life ensured the position of medicinal plants in the modern world. Careful control of the cultivation and production is an essential part in order to maintain the quality of the products and thus to gain the consumer trust [13-14].

### Medicinal Plants in Food Security

In the last three decades of the twentieth century, natural product research on anti-diabetes has focused on extracts rather than individual constituents. While some plant species like *O. stamineus* and *Ficus deltoidea* have identified bioactive compounds, this is not widely reported. Medicinal plants are used globally as alternative medicines for various diseases, and studies suggest many species exhibit hypoglycaemic activity. In Malaysia, specific plants are recognized by traditional healers for treating diabetes, and some have demonstrated this activity. Medicinal plants are crucial for food security, offering essential nutrients and bioactive compounds, with many ethnomedicinal studies highlighting their role in rural healthcare. In South Africa, ethnoveterinary medicine has historical roots, providing vital animal health care, particularly for rural livestock owners. In the Mopani district of Limpopo, these remedies are more accessible than conventional veterinary medicine. Medicinal plants also offer an alternative source of antimicrobials against drug-resistant microorganisms, potentially aiding in the development of new chemotherapeutic agents for animal diseases. In Senegal, over 100 plant species from more than 40 families are used for ruminant health, managing diseases like diarrhea and respiratory infections. Evaluations reveal these plants possess significant biological activities against various pathogens, highlighting their medicinal value for both animals and humans [15-16].

### Medicinal Plants in Diabetes Management

Diabetes mellitus (DM) stands as an increasingly prevalent metabolic disorder that has emerged over the years as a significant public health concern recognized across the globe. Recent estimates indicate that approximately 537 million individuals currently live with diabetes, a figure that underscores the critical nature of this health issue. This complex and multifaceted disease is characterized by either an absolute deficiency or a relative deficiency in insulin secretion or action, which ultimately results in hyperglycemia, a medical term that refers to elevated levels of glucose in the bloodstream. The most common forms of diabetes, specifically type 1 and type 2, arise from distinctly different underlying processes; type 1 diabetes is primarily due to the autoimmune destruction of pancreatic  $\beta$ -cells that produce insulin, while type 2 diabetes typically results from a condition known as insulin resistance, wherein the body's cells become less responsive to insulin's effects. The range of complications associated with diabetes is extensive and far-reaching, encompassing a variety of serious conditions such as peripheral neuropathy, nephropathy, cardiovascular disease, retinopathy, gastroparesis, and an increased susceptibility to infections. These complications not only contribute to the overall morbidity associated with diabetes but also significantly impact the mortality rates that are observed in individuals diagnosed with this disease. Effective management of diabetes necessitates a comprehensive, multidisciplinary approach that is aimed at reducing the hyperglycemic state and preventing the onset of additional comorbidities. This holistic approach is crucial for ensuring a prolonged lifespan and significantly enhancing the overall quality of life for individuals currently living with diabetes, thereby allowing them to lead more fulfilling and healthier lives [17-18].

### Challenges in Utilizing Medicinal Plants

Despite the widespread and universal use of various medicinal plants in the management and treatment of diabetes, significant challenges and obstacles continue to persist in this important area of health care. Most participants involved in studies have reported using these beneficial plants either solely on their own or alongside the more conventional and commonly prescribed medicines that are typically recommended by healthcare professionals. The medicinal plants in question are often affordable and widely available in numerous regions around the world, making them accessible to a larger segment of the population interested in alternative healing options. Although these time-honored plants may offer potential health benefits for managing diabetes, it is crucial to recognize that traditional medicines can also have adverse effects that may not be immediately apparent or well understood. The limited knowledge surrounding their physiological effects complicates efforts to accurately assess whether these treatments are ultimately more beneficial or harmful in nature. Therefore, further comprehensive research is critically needed to identify specific bioactive compounds present in these plants, and to thoroughly determine the overall efficacy and safety of these medicinal plants in the context of diabetes management [19-20].

### Future Directions

The poverty-stricken segments of society urgently need improved access to effective and affordable medicines, together with timely health services that can cater to their specific needs. Historically, humankind has relied on natural products as the primary source of medication for various ailments. For centuries, traditional ethnomedicinal healing approaches across cultures have utilized a diverse range of

natural materials, particularly medicinal plants, to help in mitigating issues such as diabetes. When examining indigenous uses of plants for managing diabetes and searching for novel anti-diabetic molecular entities, emphasis must not only be placed on already known compounds but also on exploring different chemical species that have yet to be identified and characterized. Most participants in studies have commonly used medicinal plants and traditional medicines to manage their diabetes, often utilizing these remedies either on their own or in conjunction with conventional medicines prescribed by healthcare professionals. These traditional remedies are generally more affordable and locally available, making them appealing options for those in need. While traditional medicines do hold potential benefits for individuals, they also come with risks of adverse effects that cannot be overlooked. The limited knowledge regarding their physiological effects complicates efforts to conduct thorough assessments of their safety and efficacy. It's imperative that research efforts focus on identifying and cataloging bioactive compounds found within these plants and determining their significant physiological impacts on human health, which could lead to safer and more effective treatment options [21-22].

### CONCLUSION

The convergence of food insecurity and the global diabetes epidemic necessitates innovative, culturally sensitive, and sustainable health strategies. Medicinal plants represent a valuable, yet underutilized, resource that addresses both dietary deficiencies and chronic disease management. With their wealth of bioactive compounds and accessibility in many underserved regions, medicinal plants offer an affordable and holistic complement to modern medicine. However, their integration into mainstream healthcare and food systems must be underpinned by rigorous scientific evaluation, community education, and robust regulatory frameworks. Bridging traditional knowledge with biomedical research can empower communities, reduce health disparities, and advance global goals in nutrition and disease prevention. Therefore, promoting the strategic use of medicinal plants holds significant promise for improving public health outcomes and food resilience in the face of growing global challenges.

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