ORIGINAL ARTICLE

Herbal Interventions in Diabetes Management: A Review of the Glucose-Lowering Effects of African Bush Mango

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ABSTRACT

Background: Diabetes mellitus (DM) is a metabolic disorder resulting in hyperglycaemia due to impaired insulin synthesis, secretion, or action. Current guidelines implementing pharmacological and lifestyle interventions often come with high costs, adverse effects, and limited accessibility. The use of herbal medicines is gaining popularity among patients due to their easy accessibility and low cost.

Methods: This was a narrative review. A detailed electronic search of published articles, from 2005 to 2025, on diabetes mellitus care and treatment using herbal medications was conducted. Searches were performed on PubMed, Cochrane libraries, Google and Semantic Scholar. Advanced Boolean searches were utilized for focused results, limited to English language peer-reviewed articles. The criteria for selecting herbal products reviewed in this article for the management of DM include the existence of enough evidence describing their efficacy in at least two to three clinical trials in addition to experimental studies which provide valid and valuable information on the product.

Results: It was found that certain herbs were commonly used in the treatment of DM, and includes *ginger (Zingiber officinale*), black seed *(Nigella sativa*), jujube (*Ziziphus jujuba*), turmeric (*Curcuma longa*), and African bush mango (*Irvingia gabonensis*). Bioactive compounds from these plants, such as flavonoids, polyphenols, alkaloids, and saponins, exhibit hypoglycaemic effects by enhancing insulin secretion, reducing insulin resistance, and regulating glucose metabolism. Clinical trials indicate that ginger and black seed improve insulin sensitivity and lipid profiles, while turmeric from curcumin improves glycaemic control and possesses anti-inflammatory effects. *Irvingia*

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gabonensis, rich in soluble fibre, has demonstrated potential in weight management, reduction in lipids, and blood glucose control, further supporting its role in diabetes care.

Conclusion: Despite promising evidence supporting the use of herbal medicines like African Bush Mango in diabetes care, their integration requires policies that ensure standardized quality control, rigorous clinical trials to evaluate long-term safety, efficacy and herb-drug interactions, and enable clinician education on evidence-based use.

INTRODUCTION

Diabetes mellitus (DM) is the most common heterogeneous metabolic disorder of carbohydrate, fat and protein metabolism affecting all age-groups, sex and race. DM is essentially characterized by insufficiency of insulin secretion and insulin receptor or post-receptor events with derangement in carbohydrate, protein and lipid metabolism resulting in chronic hyperglycaemia with the fasting blood glucose concentration equal or greater than 126 mg/dl taken at least on two separate occasions.[1,2] Diabetes damages the blood vessels in the eyes, kidneys, and nerves and is a primary cause of heart attacks and strokes.[3] Considering its increasing prevalence, attendant co-morbidities (such as obesity, ischaemic heart disease, diabetic nephropathy, diabetic neuropathy and immuno-suppression which are often associated with high mortality and morbidity) and the heavy economic and social burdens, diabetes mellitus is now considered a global health concern.[3]

Globally, DM caused 1.5 million deaths in 2019. [2] Over 14 million adults in Africa suffer from DM.[3] West Africa has the highest number of DM cases with Nigeria (3.2 million diabetics) and Côte d'Ivoire (421 023 diabetics) holding first and second place, respectively.[3] Based on the prediction from the International Diabetes Foundation, DM will affect almost 600 million individuals by 2035. [4] Uncontrolled diabetes-related complications, such as dysglycaemia and dyslipidaemia, can progress to more serious problems, including micro and macrovascular complications with a significant reduction in the quality of life, resulting in potentially fatal events.[5] Management of DM comprises of conventional pharmacological therapy and non-pharmacological therapy such as dietary changes and increased physical activity which are part of standard interventions for treating metabolic abnormalities in diabetic patients. However, in low-resource settings, the high cost of these medications, combined with limited accessibility to health facilities, poses significant challenges.[5, 6, 7] For instance, insulin therapy can be expensive, leading to poor adherence to treatment. The financial burden patients face managing lifelong diabetes worsens health disparities, making it expedient to explore cost-effective and locally available alternatives, usually in the form of alternative and complementary approaches.[8,9] In response to this global health challenge, the WHO Expert Committee on diabetes mellitus in 2002 recommended an urgent and further evaluation of the folkloric methods of managing the disease because of high mortality and morbidity arising from its attendant complications. Therefore, there has been a significant increase in the search for complementary and alternative medicine (CAM) strategies for improving the management of type 2 diabetes mellitus (T2DM) and its complications. These strategies include the use of herbal products and plants and functional foods. [5,10] According to the National Centre for Complementary and Alternative Medicine in the United States, complementary and alternative medicine (CAM) refers to a subset of the medical community, medical practices, and medical products that are not included in traditional medicine. While alternative medicine is used in place of traditional therapy, complementary medicine is utilized in conjunction with it.[11]

Search of the literature have shown that several herbs and fruits such as the *Irvinigia gabonesis* (African Bush Mango) exhibit antidiabetic properties. These herbs and fruits contain bioactive

compounds such as flavonoids, polyphenols and alkaloids which can help regulate blood glucose levels, improve insulin sensitivity and offer anti-oxidative benefits as well as cause weight-loss in overweight diabetic individuals.[12,13] Additionally, some herbs such as berberine, garlic, ginger, jujube, turmeric, sativa, tulsi, bitter lemon and fenugreek have applications in providing hypoglycaemic effects, reducing blood sugar levels in both animal models and clinical trials.[14]

There are different types of DM, this review focused on T2DM, the other types were discussed in the DM overview section. Regardless of the type, management of DM is expensive and limitations such as poor accessibility to health facilities, high cost of medications, and rigid treatment regimen which are associated with the use of conventional antidiabetic drugs, as well as adverse effects of these drugs pose major challenges to patients, affecting compliance to medications. For patients who require insulin therapy and need regular administration of the insulin, the treatment can be expensive and inconvenient. Herbal treatments offer a compelling substitute and additional benefit to prescription medications. The use of herbal medicines is gaining popularity among patients due to their easy accessibility and low cost. More patients are seeking out therapies that are thought to be easily accessible and in line with their cultural inclinations. [15]

METHODOLOGY

Search strategy

This was a narrative review. A narrative review chosen over a systematic review or meta-analysis as it allows for a broad thematic exploration of herbal interventions for diabetes, accommodates the heterogeneity of studies that vary in design and outcomes, enables discussion of mechanisms and traditional uses beyond clinical efficacy, while integrating emerging research from multiple disciplines. To achieve this, a detailed electronic search of published articles in English language was conducted, with the search period limited to between 2005 and 2025 to ensure the articles' recency. The search focused on diabetes mellitus care and treatment using herbal medications. Searches were performed on PubMed, Cochrane libraries, Google, and Semantic Scholar. Advanced Boolean searches were employed to obtain focused results, limited explicitly to English-language articles. The search terms used include *Irvingia gabonensis* OR African Bush Mango AND Type 2 diabetes or Diabetes Mellitus.

Eligibility criteria

The criteria for selecting herbal products reviewed in this article for the management of DM include the existence of enough evidence describing their efficacy in at least two to three clinical trials in addition to experimental studies which provide valid and valuable information on the product. Studies that focused only on the toxicity and herbal-drug interactions were also excluded. Editorials, reviews, opinion-based articles and abstracts without available full text were excluded. Articles published in other languages aside English were also excluded.

Screening and Study selection

To guide against bias, Cochrane RoB was used to assess the quality of the study. Two reviewers independently reviewed the titles, abstracts, and full articles. Duplicated and incomplete articles were manually removed, and the remaining articles were assessed based on selection criteria.

RESULTS

It was found that certain herbs were commonly used in the treatment of DM. The commonly used herbal medications include ginger *(Zingiber officinale*), black seed (Nigella sativa), jujube (*Ziziphus jujuba*), turmeric (*Curcuma longa*), and African bush mango (*Irvingia gabonensis*). Bioactive compounds from these plants, such as flavonoids, polyphenols, alkaloids, and saponins, exhibit hypoglycaemic effects by enhancing insulin secretion, reducing insulin resistance, and regulating glucose

metabolism. Clinical trials indicate that ginger and black seed improve insulin sensitivity and lipid profiles, while turmeric from curcumin improves glycaemic control and possesses anti-inflammatory effects. Irvingia gabonensis, rich in soluble fibre, has demonstrated potential in weight management, reduction in lipids, and blood glucose control, further supporting its role in diabetes care.

DISCUSSION

Overview of DM and the Conventional Management

DM has two distinct forms, each with a unique aetiology. First, Type 1 Diabetes Mellitus (T1DM) is classified as an autoimmune disorder. The body's islet cells, which make the hormone insulin, that controls the blood sugar, are attacked by the immune system.[14] As a result, the pancreas either produces insufficient insulin or none for the body's essential processes (metabolism of carbohydrate, proteins and lipids). Approximately 5% of DM cases are Type 1, and typically develops in childhood. The primary cause is the destruction of beta cells by autoantibodies,[16] and the connection between family history and risk for diabetes has been widely recognized as a common cause of T1DM. [17]

T2DM is another type of the disease. It is the most common type as approximately 90% of people with diabetes have this form of diabetes. [18] In this instance, the body's system does not respond to insulin even when the pancreas secretes an appropriate quantity. Insulin resistance is the term used to describe this condition. Mostly, the cause of insulin resistance remains idiopathic. However, obesity and diseases with inadequate insulin production typically lead to type 2 diabetes. [16] Other risk factors of T2DM include overweight or obese, decreased glucose tolerance, insulin resistance and family history. [19] Other types of diabetes might result from pregnancy (gestational diabetes), surgery, and use of certain medicines, various illnesses and other specific causes. [20]

Gestational diabetes is a condition that arises from the body's inability to respond to the insulin hormone like in T2DM. This type of diabetes begins during pregnancy, and in certain situations, it may become absent postpartum. It also has the potential to become chronic. It should be noted that the reason for elevated blood glucose levels during pregnancy is due to hormonal changes, specifically elevated amounts of placental hormones. [20,21]

Conventional Management of Diabetes Mellitus

The main goal of diabetic treatment involves improving the quality of life and lengthening the life expectancy of individuals with diabetes. For such an outcome to be achieved, the delivery of complete, supplementary, and integrated health and social services by diabetes specialists in elementary and secondary settings is needed. The current management practices of DM spans across both pharmacological and non-pharmacological approaches. As a complicated illness, diabetes necessitates careful attention to the prevention, early identification, and treatment of complications, in addition to maintaining ideal control over hyperglycaemia, hypertension, dyslipidaemia, obesity, and other cardiovascular disease risk factors.

To prevent long-term consequences, diabetes and its accompanying complications, as well as the risk factors that contribute to them, must be managed through the prescription of various pharmaceutical and non-pharmacological modalities combined with routine screening. [22] Patients' empowerment and education, in addition to the diverse specialized team's care system, are crucial for the implementation of such initiatives. [23,24] Insulin and/or oral antidiabetic medications are the primary pharmacological therapies utilized to manage hyperglycaemia in T2DM. If the patient's glycosylated haemoglobin (HbA1c) does not drop to goal values, metformin is recommended as the initial course of treatment unless there are contraindications related to hypotension or renal

impairment. The second line of treatment is usually sulphonylurea, and the efficacy of these interventions should be evaluated by accessing the HbA1c levels. The dose needs to be increased if the level is not within control. [22] It is important to inform patients on sulphonylurea about the risk of hypoglycaemia. Patients who receive rapid acting insulin analogues, such as insulin aspart, lispro, and glulisine, are those with uncontrolled hyperglycaemia and unstable lifestyles, such as those who are unable to eat a regular diet or eat a similar amount of food at a similar time due to, for example, shift work.[22] Non-pharmacological interventions for glycaemic control involves efforts targeted at weight control, lifestyle and diet modifications.

Herbal Interventions in DM Management

In Africa, traditional healers who use natural ingredients to treat a wide range of illnesses are typically the ones who give herbal remedies. They do not rely on laboratory tests and use several local techniques to diagnose their patients with diabetes mellitus. They rely on symptoms as a yardstick for arriving at their conclusion of diagnosis to treat the individual with DM. The symptoms include excessive perspiration, obesity, weariness, swollen hands, feet, and stomach, frequent urination, and sexual dysfunction.

DM is currently one of the illnesses that is most treated with traditional remedies made from medicinal plants. This is demonstrated by how frequently ethnobotanical surveys for medicinal plants used in the treatment of DM is emerging in all regions of Africa.[25–29]

The therapeutic use of herbal products in managing DM has garnered significant attention due to their potential to modulate glycaemic indices and lipid profiles. For this comprehensive review, the criteria for selecting herbal products reviewed in this article for the management of DM include the existence of sufficient evidence describing their efficacy in at least two to three clinical trials in addition to experimental studies which provide valid and valuable information on the product. We reviewed and summarized the relevant studies, including in-vitro and experimental studies, clinical trials with proper design, and high-quality review articles and meta-analyses published from 2005 to 2025.

This review looked at the efficacies of the commonly used herbal medications, namely ginger, sativa, jujube, and turmeric, which have been substantiated by a plethora of interventional studies and clinical trials. Each of these herbs possesses unique bioactive compounds that contribute to their glucose lowering and lipid modulating properties. For instance, ginger, with its active constituent gingerol, exerts antidiabetic effects by increasing insulin release and sensitivity. [30] Jujube, with its high fibre content and bioactive saponins, can improve lipid metabolism. Turmeric, containing the potent curcuminoid curcumin, has been associated with both glycaemic control and lipid profile improvement. The review further examines the effective dosages of these herbal remedies, which vary widely depending on the form of consumption—whether as raw herbs, extracts, or standardized supplements. It is crucial to consider the pharmacokinetics and bioavailability of the active compounds to determine the optimal dose that elicits a therapeutic response with little or no adverse effects. The potential side effects were also reviewed, as herbal products, despite their natural origin, are not devoid of toxicities.

Drug-herb interactions are another pivotal aspect of this review, highlighting the importance of understanding how these herbal products might interact with conventional antidiabetic medications. Such interactions can either potentiate or mitigate the effects of the drugs, necessitating careful management and monitoring by healthcare professionals.

In this study, we reviewed the evidence on the bioactive compounds responsible for its antidiabetic properties, mechanisms of action in blood glucose regulation, lipid metabolism, appetite regulation and

weight loss, summarizing significant preclinical and clinical trials demonstrating these effects.

Herbal Medications and Effect on Glycaemic Indices in T2DM

Ginger, *Zingiber officinale*, is a traditional herb from the Zingiberaceae family that has been used for centuries to cure a range of illnesses, including T2DM.[31] Ginger has been reported to have strong potent anti-inflammatory and antioxidant qualities, protecting against oxidative stress and inflammation that lead to the onset of several diseases. [30] The volatile compounds (shogaols, gingerols, paradols, zingerone, and zingiberene) in ginger are responsible for its health benefits. [32] Several studies have demonstrated that these compounds have antidiabetic properties, such as antihyperglycemic and lipid-lowering effects, which can be beneficial for individuals with T2DM. [33] Additionally, studies have shown that ginger consumption significantly reduces insulin resistance and improves insulin levels. A systematic review and meta-analysis revealed that ginger consumption improved fasting insulin and homeostatic measurement assessment (HOMA-IR), which are significant markers of insulin sensitivity. [34] Studies have also shown that ginger may have the ability to improve dyslipidaemia in people with T2DM. For example, a meta-analysis study found that supplementing the diet of individuals with T2DM with ginger significantly improved the lipid profile, leading to significant decreases in TC, LDL-C, and TG levels as well as a significant increase in HDL-C in individuals with T2DM. [34] After using ginger supplements, individuals with T2DM experienced a significant decrease in their FBS and HbA1c, according to a recent meta-analysis of ten RCTs. [35] The meta-analysis revealed that the average decrease in FBS levels was 18.8 mg/dL and the average decrease in HbA1c levels was 0.57% when ginger supplementation was used. Only minor adverse effects, such as mild to moderate stomach discomfort, was noted in certain cases. [36] It might not be appropriate in some patients because it can potentially worsen disorders such gastric reflux disease and interact with blood thinners. [36] It is interesting to note that research on animals suggests that ginger may work in concert with some antidiabetic drugs or other natural products, such as like cinnamon, to potentially increase their ability to decrease blood sugar. [37]

Nigella sativa L. (Ranunculaceae) has been used traditionally to treat DM and has been the subject of several investigations. [38-40] It has been observed that oil from the seed of N. sativa has hypoglycaemic potentials [39]. After taking the oil orally for six weeks, the blood glucose levels in a rat model of streptozocin-induced T1DM was much lower. In a different study, 30 days after oral treatment with of 300 mg of N. sativa seed extract in experimentally induced diabetic rats showed normal levels of fructosamine, haemoglobin, and albumin with blood glucose levels reduced by nearly 81%. Benhaddou-Andaloussi *et al.* [40] in their study showed the antidiabetic activity of ethanolic seed extract of N. sativa seed when given at 2 g/kg bw/day. This effect was achieved by boosting GLUT4 expression in the muscle and via phosphorylating acetyl-CoA carboxylase, a key element of the insulin-independent AMPK signalling cascade. The regulation of hepatic glycolytic and gluconeogenic enzyme activities were also considered as possible mode of action.

Red Dates, *Jujube Ziziphus* or *Ziziphus jujuba*, are members of the Rhamnaceae family. Ziziphus jujube's health-promoting qualities can be attributed to its beneficial effects on the aetiology of various chronic diseases, including liver disease, [41] cancer, [42] and neurological function. [43] Numerous bioactive substances, including alkaloids, amino acids, polyphenols, polysaccharides, fatty acids, saponins, triterpene acids, and nucleotides like cAMP and cGMP, have been found to be present in jujube fruit.[44] Remarkably, research on streptozocin-induced diabetic rat models showed that jujube supplementation had sedative, lipid lowering and antioxidative effects.

Turmeric exhibits hypoglycaemia and hypolipidemic effects in diabetic rats, like many other spices such as like ginger and garlic. [45] In healthy individuals, turmeric also raised postprandial serum insulin levels to regulate blood glucose levels. [46] In southern Asia, curcumin, a primary ingredient in the rhizomatous powder of turmeric (Curcuma longa), is frequently utilized in both food and medicine. Numerous bioactivities, including antioxidant, anti-inflammatory, antidiabetic, and immunomodulatory properties, have been demonstrated by curcumin and the rhizomes of turmeric. [47]

According to Weisberg and colleagues, curcumin, improves glycaemic control in mice models of T2DM and cures several inflammatory and metabolic abnormalities linked to obesity. [48] Following a nine-month course of treatment, Chuengsamarn *et al*.[49] demonstrated that β-cell activity was improved in the curcumin-treated group, as evidenced by reduced C-peptide and higher homeostatic measurement assessment (HOMA)-β. Curcumin, a bioactive component of turmeric, reduces blood glucose by controlling insulin resistance and β-cell activity. [46] Turmeric protein (turmerin), have been shown to possess antioxidant activity and impede the action of α-glucosidase. [50] Overall, β-cell activity, gastrointestinal absorption, and reduction of insulin resistance are likely the ways that turmeric provide its antidiabetic effects.

Irvingia gabonesis (African Bush Mango)

A tropical tree that is indigenous to West and Central Africa. It is a member of the Irvingiaceae family. This tree is well known for producing mango-like fruits, and its seeds—also known as "dika nuts"—are prized for their medicinal and nutritional qualities. [51] Geographically, the tropical regions of West and Central Africa, including Nigeria, Cameroon, Gabon, and the Democratic Republic of Congo, are home to *Irvingia gabonensis (IG)*. The tree grows well in forested areas and is often found in humid, lowland regions. It plays a significant role in both the ecosystem and the livelihoods of local communities, serving as a source of food, income, and medicine.

IG has long been utilized for a wide range of reasons in African traditional medicine. Ailments like diarrhoea, fever, and dysentery are treated with the seeds, bark, and leaves.[52, 53, 54] *IG* was also used in the management of obesity, excessive cholesterol, diabetes reduction of inflammation, and improved digestion in addition to its culinary applications.[52] The bark of the tree is boiled and drunk as a tea to cure digestive problems, and the seeds are also crushed and applied as a poultice for wound healing in many West African communities.

Nutritional Composition

The therapeutic effects of IG are partly attributed to its high nutritional content. The high dietary fibre content of the seeds helps with blood sugar regulation and digestion. They are also a good source of important fatty acids and proteins. The therapeutic potential of the IG is increased by the presence of bioactive substances such as flavonoids, glycosides, alkaloids, and tannins. [53]

IG has a well-known antioxidant quality, flavonoids and tannins and help lower oxidative stress, a factor in the emergence of chronic illnesses like diabetes. The seeds' glycosides may be part of what gives the anti-inflammatory and antidiabetic effects. The combination of these bioactive phytochemicals and high fibre content results in successful blood sugar control, lowering of serum cholesterol, and weight management. [52]

Antidiabetic Properties of Irvingia gabonensis

The antidiabetic effects of IG are attributed to several bioactive compounds, including soluble fibres, flavonoids, tannins, and glycosides. These compounds are important for controlling blood glucose and lipid metabolism. Soluble fibres can help lower blood sugar spikes after meals by slowing down the absorption of sugar; flavonoids, on the other hand, have antioxidant properties that

protect pancreatic beta cells from oxidative damage, promoting insulin secretion and enhancing glucose metabolism.[53, 54, 55] Tannins and glycosides also contribute to the antidiabetic effects of the plant by lowering intestinal absorption of carbohydrates and increasing insulin sensitivity.[54,55] These compounds work in concert to provide a synergistic effect that can help manage diabetes. IG seeds have been demonstrated in a clinical investigation to lower plasma lipids and raise HDL cholesterol.[12] Similar outcomes were seen in a 90-day randomized double-blind placebo-controlled clinical experiment in which administration of IG to patients showed decreased blood cholesterol levels, hyperglycaemia, and reduction in waist circumference.[54] IG fibre extract was found to increase hepatic glycolytic enzyme activity while simultaneously depleting glycogen levels.[53] IG extracts have been shown in several trials to be effective against toxicity from a variety of chemical agents.[55,56,57]

The two main strategies of IG in blood glucose regulation involves an increase in insulin sensitivity and a decrease in fasting blood glucose levels. The distinct effects on blood lipid and lipoprotein concentrations are caused by the distinct fatty acids in IG. Based on earlier research, it has been determined that some vegetable oils and dietary lipids can lower blood glucose levels and helpful in the treatment of diabetes.[58,59]

Potent antioxidant, hypolipidemic, and antidiabetic properties are produced by IG seed oil, which also contain different fat fractions and other substances like phytosterols, leukotrienes, and benzopyranols.[60] The high fibre content in the seeds slows down the emptying of the stomach, so reducing the postprandial glucose rise and moderating the absorption of carbohydrates. The plant's flavonoids enhance insulin action by lowering insulin resistance, a major problem in T2DM.[61,62]

Some studies have demonstrated that the use of IG lowers triglyceride and cholesterol levels.[53, 54, 55] The IG seeds can raise HDL cholesterol and decrease LDL cholesterol, which is especially advantageous for diabetics who frequently have problems with lipid metabolism.[56,58,63] IG is well-known for its appetite regulation and weight loss, which is of importance in DM treatment. It enhances the synthesis and sensitivity to leptin, the hormone in controlling appetite, and promoting weight loss. The ability of IG to reduce weight further amplifies its significance in controlling blood sugar levels and insulin sensitivity, as obesity is a significant risk factor for T2DM.[63,64] In a clinical trial, participants with T2DM who were overweight and receiving IG supplement (150 mg twice daily for a 10-week period) showed significant reduction in body weight, cholesterol, and fasting blood glucose levels when compared to the placebo group with mild gastrointestinal disturbances.[12,64]

Implication for Future Research

Despite the promising benefits of these medicinal herbs that have been reviewed there remains additional gaps to be filled. Further research is recommended to fill the knowledge gaps in some aspects of herbal medicine such as identifying the toxic phytochemicals that these beneficial herbs may contain. We suggest that more long-term studies be conducted to further investigate the safety and efficacy of these medicinal herbs especially in different populations. Existing studies, however, strongly support its potential as an adjunct treatment for DM management.

CONCLUSION

Despite these promising findings, challenges regarding standardization and effective dosage determination remains. Well-designed clinical trials would be required to determine potential herb-drug interactions and long-term safety. This review contributes to knowledge on the urgent need for integrative approaches in diabetes management, advocating for evidence-based herbal interventions as adjunctive or alternative strategies to conventional therapies. The healthcare organizations and government agencies should gear

efforts toward interventions to promote and increase awareness on the benefits of the herbal medicine DM care.

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