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ANTI DIABETIC ACTIVITY OF MOMORDICA CHARANTIA

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ABSTRACT

Diabetes mellitus is one of the most prevalent disorders in both developed and developing nations, and its incidence is rising quickly in many regions worldwide. It is estimated that nearly one-third of individuals with diabetes mellitus utilize some type of complementary and alternative medicine. One plant that has gained significant attention for its anti-diabetic effects is bitter melon, scientifically known as Momordica charantia (M. charantia), which is also called bitter gourd, karela, and balsam pear. The fruit of this plant is used to treat diabetes and related ailments among indigenous communities in Asia, South America, India, and East Africa.

Numerous pre-clinical studies have documented the anti-diabetic and hypoglycaemic effects of M. charantia through various proposed mechanisms. However, data from clinical trials involving human participants are scarce and often compromised by poor study design and low statistical power. This review aims to emphasize the antidiabetic properties, as well as the phytochemical and pharmacological findings related to M. charantia, and advocates for better-designed clinical trials to clarify its potential therapeutic benefits for diabetes.

INTRODUCTION

Momordica charantia (M. charantia), commonly referred to as bitter melon, karela, balsam pear, or bitter gourd, is a widely used plant for treating diabetes-related issues among indigenous communities in Asia, South America, India, the Caribbean, and East Africa.

Its fruit has a distinct bitter flavor that becomes stronger as it ripens, which is why it is called bitter melon or bitter gourd. Research using biochemical and animal models has generated a lot of data and theories explaining the anti-diabetic properties of M. charantia. However, there are few clinical studies involving human participants, and those that exist often have poor design.

Diabetes mellitus is a well-recognized clinical condition that can lead to various complications such as retinopathy, neuropathy, and nephropathy. Natural products are known to be significant in pharmaceutical biology. Understanding specific plants can offer insights for strategic use and sustainable practices. The alternative medicine field is gaining traction as more active compounds from plant species are identified. M. charantia exhibits notable anti-diabetic and hypolipidemic effects, making it a potential adjunct to conventional diabetes treatments, helping to manage the condition and mitigate its complications. This review discusses the potential anti-diabetic effects of M. charantia and the medicinal properties that contribute to its ability to lower blood sugar levels.

Diabetes mellitus is recognized as one of the top five leading causes of death globally[1]. It represents a significant global health issue, with an anticipated increase in prevalence from 171 million in 2000 to 366 million by 2030[2]. This condition is characterized by a syndrome of metabolic disorders, typically arising from a mix of genetic and environmental factors, leading to elevated blood sugar levels (hyperglycemia)[3]. As a prominent degenerative disease, diabetes is prevalent across all regions of the world and is rapidly becoming the third most deadly disease affecting humanity[4]. It is the most widespread endocrine disorder, impacting 16 million people in the United States and potentially affecting up to 200 million individuals worldwide. Diabetes has served as a clinical model within general medicine[5]. Complementary and alternative medicine encompasses the use of herbs and various dietary supplements as substitutes for conventional western medical treatments. A recent study has indicated that as many as 30% of patients with diabetes mellitus utilize complementary and alternative medicine.

Plant-based anti-diabetic medicine

Plant-based medicine has been utilized effectively around the globe to manage diabetes. In fact, in numerous regions, particularly in developing countries, this may be the sole therapeutic option available for diabetic patients. Various authors have conducted several reviews on anti-diabetic herbal plants. Ayurveda and other traditional medical systems for diabetes treatment identify a range of plants employed as herbal remedies. Therefore, they hold significant importance as alternative medicine due to their minimal side effects and affordability. The active compounds found in medicinal plants have been shown to regenerate pancreatic β cells, promote insulin release, and combat insulin resistance issues. Hyperglycemia plays a role in the onset of diabetic complications. Hypoglycemic herbs boost

insulin secretion, improve glucose uptake by adipose or muscle tissues, and reduce glucose absorption from the intestine as well as glucose production from the liver. Insulin and oral hypoglycemic agents such as sulphonylureas and biguanides remain the primary treatments, but there is an ongoing search for the development of more effective anti-diabetic agents.

Current literature indicates that M. charantia is the most commonly used and recognized anti-diabetic plant. Consequently, this review will focus primarily on
M. charantia and its anti-diabetic properties.

The profile of M. charantia

Plant description

M. Charantia, commonly known as bitter melon or bitter gourd (Figure 1), is a flowering vine belonging to the Cucurbitaceae family. This tropical plant is extensively cultivated across Asia, India, East Africa, and South America due to its intensely bitter fruits, which are frequently utilized in culinary practices and as a natural treatment for diabetes[20]. It is a perennial climber that typically reaches a height of up to 5 meters and produces elongated fruits characterized by a knobbly surface. This plant serves as both a valuable medicinal resource and a vegetable, contributing significantly to human health, and is regarded as one of the most promising plants for managing diabetes.

Fig: Momordica Charantia

Nutrient profile

Bitter melon is an exceptionally nutrient-rich plant that consists of a diverse range of beneficial compounds. These compounds encompass bioactive chemicals, vitamins, minerals, and antioxidants, all of which enhance its impressive ability to address various health

conditions. The fruits are particularly abundant in vitamin C, vitamin A, vitamin E, as well as vitamins B1, B2, B3, and B9 (folate). The caloric content for the leaf, fruit, and seed is recorded at 213.26, 241.66, and 176.61 Kcal/100 g, respectively.

Additionally, the fruit is abundant in minerals such as potassium, calcium, zinc, magnesium, phosphorus, and iron, and serves as a valuable source of dietary fiber (bitter melon "monograph", 2008). The medicinal properties of bitter melon are largely attributed to its significant antioxidant capabilities, which are partly due to the presence of phenols, flavonoids, isoflavones, terpenes, anthroquinones, and glucosinolates, all of which impart a bitter flavor.

Phytochemistry

The fruits of M. charantia contain glycosides, saponins, alkaloids, reducing sugars, resins, phenolic compounds, fixed oils, and free acids[28]. M. charantia is composed of various chemical constituents, including alkaloids, charantin, charine, cryptoxanthin, cucurbitins, cucurbitacins, cucurbitanes, cycloartenols, diosgenin, elaeostearic acids, erythrodiol,
galacturonic acids, gentisic acid, goyaglycosides, goyasaponins, guanylate cyclase inhibitors, gypsogenin, hydroxytryptamines, karounidiols, lanosterol, lauric acid, linoleic acid, linolenic acid, momorcharasides, momorcharins, momordenol, momordicilin, momordicin, momordicinin, momordicosides, momordin, momordolo, multiflorenol, myristic acid, nerolidol, oleanolic acid, oleic acid, oxalic acid, pentadecans, peptides, petroselinic acid, polypeptides, proteins, ribosome-inactivating proteins, rosmarinic acid, rubixanthin, spinasterol, steroidal glycosides, stigmasta-diols, stigmasterol, taraxerol, trehalose, trypsin inhibitors, uracil, vacine, v-insulin, verbascoside, vicine, zeatin, zeatin riboside, zeaxanthin, zeinoxanthin, and amino acids such as aspartic acid, serine, glutamic acid, thscinne, alanine, g-amino butyric acid, and pipecolic acid, ascorbigen,
b-sitosterol-d-glucoside, citrulline, elasterol, flavochrome, lutein, lycopene, and pipecolic acid. The pulp of the fruit
contains soluble pectin but lacks free pectic acid. Studies have indicated that the leaves serve as nutritious sources of calcium, magnesium, potassium, phosphorus, and iron; both the edible fruit and the leaves are excellent sources of B vitamins.

Bioactive compounds

Due to the wide range of medical conditions that bitter melon is capable of addressing, there is an increasing interest among

scientists in examining its bioactive compounds and their effects on the human body. Nevertheless, as numerous studies indicate, there has been a considerable focus on the anti-diabetic

compounds and their hypoglycemic effects[30],[31]. Several clinical studies have demonstrated that bitter melon extract derived from the fruit, seeds, and leaves contains various bioactive compounds that exhibit hypoglycemic activity in both diabetic animals and humans [32],[33].

Momordicine II and 3-hydroxycucurbita-5, 24-dien-19-al-7, 23-di-O-β-glucopyranoside (4) were identified as saponins extracted from M. charantia. Both of these compounds displayed significant insulin-releasing activity in MIN6 β-cells at concentrations of 10 and 25 µg/mL [34]. The primary compounds that have been isolated from bitter melon and recognized as hypoglycemic agents include charantin, polypeptide-p, and vicine.

Anti-diabetic effect of M. charantia

Numerous traditional herbal remedies have been utilized to manage diabetes in Asia and various developing nations. M. charantia is among the plants that have been extensively researched for diabetes treatment. The traditional applications, bolstered by contemporary scientific findings regarding the advantageous properties of M. charantia, position it as one of the most promising plants for diabetes management today. Research into the traditional applications of M. charantia in India has shown that it is a significant plant for reducing blood glucose levels in individuals with diabetes.

M. charantia and glucose metabolism

Insulin is really important because it helps different cells in our body take in glucose to make energy. Since M. charantia and its different extracts are known to lower blood sugar, we need to find out if M. charantia can directly help reduce blood glucose levels. Past research has shown that both the water and alcohol extracts from M. charantia fruit can stop the actions of certain enzymes like fructose 1, 6-diphosphatase and glucose-6-phosphatase, while also boosting the activity of glucose-6-phosphatase dehydrogenase. It has been reported before that M. charantia and its extracts can help cells take in glucose. Several studies have looked at how the powder and chloroform extract of M. charantia compare to insulin in helping glucose and amino acids get absorbed by skeletal L6 myotubes, as well as how Na+ and K+ help glucose absorption in the jejunum brush border membrane vesicles in both normal and diabetic rats.

The findings show that either the freeze-dried fruit juice or chloroform extract at 5-10 µg/mL can help L6 myotubes take in 3H-deoxyglucose and 14C-Me AIB (N-methyl-amino-α-isobutyric acid). These effects were similar to what we see with 100 nmol/L insulin.

When either insulin or M. charantia juice was mixed with wortmannin (which blocks a certain enzyme), it significantly reduced the uptake of 3H-deoxyglucose by L-6 myotubes.

Overall, the results clearly show that M. charantia has properties like insulin, similar to a specific phytochemical in M. charantia called V-insulin.

CONCLUSION

The idea of utilizing food as a form of medicine is a fundamental aspect of dietetics and nutritional sciences. M. charantia has been utilized as a dietary supplement and inethnomedicine for centuries to alleviate symptoms and conditions associated with what is currently recognized as diabetes. Up to now, M. charantia has been thoroughly researched globally for its therapeutic properties in addressing various diseases[61]. It is regarded as a multifaceted plant capable of treating nearly any ailment that afflicts humanity. This may be attributed to the presence of over 225 distinct medicinal components within the plant[62]. These various compounds may function independently or synergistically to produce their therapeutic effects. Concerning diabetes, only charantin, insulin-like peptides, and alkaloid-like extracts exhibit hypoglycemic properties akin to the plant itself or its crude extracts. These diverse compounds appear to deliver their positive effects through multiple mechanisms aimed at managing and treating diabetes mellitus.

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