# Antidiabetic Effect of Gymnema montanum/Momordica charantia/Moringa oleifera

Subjects: Integrative & Complementary Medicine

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*Gymnema montanum* (*G. montanum*, GM) is a plant belonging to *Apocynaceae* family, an endemic, woody climbing shrub found mainly in Africa and India. *Momordica charantia* (*M. charantia*, MC), a plant belonging to the Cucurbitaceae family, is commonly known as a bitter gourd, balsam pear, bitter melon, or Karela and could be found in India, Japan, Singapore, Vietnam, Cuba, Ghana, Haiti, the Middle East, Central and South America and many other regions. *Moringa oleifera* (*M. oleifera*, MO) Lam is a plant that belongs to the Moringaceae family and naturally occurs widely in many tropical and subtropical areas. The extracts of *Gymnema montanum*, *Momordica charantia* and *Moringa oleifera* represent a promising and attractive source of phytochemicals with proven antidiabetic and antioxidant activity in rat models of diabetes. They increase pancreatic insulin and insulin sensitivity in peripheral tissues, reduce insulin resistance and hepatic gluconeogenesis, and have a modulatory effect on glycolysis, gluconeogenesis and antihyperlipidemic properties. All three extracts reduced oxidative stress and revealed antiperoxidative features to protect β-cells against ROS. They are, therefore, good candidates for the management and treatment of diabetes in mammals, especially humans. Moreover, all three plants have been widely used in traditional medicine.

Gymnema montanum | Momordica charantia | Moringa oleifera | Antidiabetic Effect

## 1. Introduction

According to the WHO, diabetes mellitus (DM) is one of the most widespread chronic diseases, and the number of cases is rising rapidly. The number of affected patients in 2014 reached 422 million, an almost two-fold increase compared to 1980 [1]. Current estimations predict that diabetic patients will reach 578 million by 2030 and 700 million by 2045 [2].

Oxidative stress (OS) is one of the leading causes of the development of diabetes and its complications [3]. Although organisms have an integrated antioxidant defense system to block the negative impact of reactive oxygen species (ROS), diabetes can cause this system to fail. Hence, supplementation with exogenous plant-derived antioxidants might possess capacities to avert oxidative stress-induced diseases.

Recently, there have been numerous studies in which plant extracts were used to treat various diseases with traditional medicines [4]. It is estimated that nearly a quarter of all modern medicines are derived from natural products [5]. Among the renowned antioxidant properties of several plants—including green tea, cinnamon, curcumin, grape seeds, and many berries—several new species used in traditional medicine have been documented. In vitro and animal model studies reflect an interest in selecting new phytochemical resources that possess antioxidative properties as candidates for drugs in antidiabetic approaches.

## 2. *Gymnema montanum* Effect on Diabetes

*Gymnema montanum* (*G. montanum*, GM) is an endemic, woody climbing shrub found mainly in Africa and India. Leaves of GM have medical applications, and they have a long history of use in India's Ayurvedic medicine as an antidiabetic drug, diuretic, and digestive stimulant [6].

Currently, extracts from *Gymnema* leaves have found application in metabolic syndrome, weight loss, and cough.

It is postulated that phytochemicals present in GM extract, particularly gallic acid, resveratrol and quercetin, possess the antioxidative, antidiabetic and antihyperlipidemic properties [7] that play a pivotal role in lowering blood glucose in diabetic patients and in improving the action of insulin.

## 3. *Momordica charantia* Effect on Diabetes

*Momordica charantia* (*M. charantia*, MC), a plant belonging to the Cucurbitaceae family, is commonly known as a bitter gourd, balsam pear, bitter melon, or Karela. All plant parts have a bitter taste, including the fruit. India, Japan, Singapore, Vietnam, Amazon, East Africa, Brazil, Malaya, China, Thailand, Colombia, Cuba, Ghana, Haiti, India, Mexico, New Zealand, Nicaragua, Panama, the Middle East, Central and South America are the regions where MC is cultivated. At maturation, the fruit of *M. charantia* can be used as a dietary food, and because of its multiple beneficial activities, has also been used as a herbal medicine [8].

In ancient history, the seed and fruit were used as medication for diabetes. The other fractions of *M. charantia*—roots, leaves and even vines—have been used in folk medicine to treat other diseases like diarrhea, toothache and furuncle. Therefore, this plant is the subject of many ongoing studies investigating its potential in preventing and treatingseveral diseases. Each year, more and more papers reveal the plausible effects of supplementation with *M. charantia*, thereby strongly indicating that this plant possesses various pharmacological functions: antidiabetic, anthelmintic, abortifacient, antimalarial, antimutagenic, antilipolytic, antifertility, hepatoprotective, anti-inflammatory, contraceptive and laxative, anti-ulcerogenic, antioxidative and immune-modulatory [9].

A more comprehensive application of *M. charantia* in multiple areas of medicine is still restricted due to adverse effects observed in many studies. Some of these are hypoglycemic coma in children, and toxicity or even death in laboratory animals [8].

Based on the abovementioned activities of particular chemical components of *M. charantia* extract and broad literature data, it can be reasserted that, in correlation with its composition, the MC extracts possess the following general activities: antidiabetic, antioxidant, antiviral, antimicrobial, anthelmintic, abortifacient, antimalarial, antimutagenic, antilipolytic, antifertility, hepatoprotective, anti-inflammatory, antitumor, hypolipidemic, immunomodulatory, and wound healing.

## 4. *Moringa oleifera* Effects on Diabetes

*Moringa oleifera* (*M. oleifera*, MO) Lam is a plant that belongs to the *Moringaceae* family and naturally occurs widely in many tropical and subtropical areas [10][11]. This plant originates from the western and sub-Himalayan tracts, India, Pakistan, Asia Minor, Africa and Arabia [12][13]. It is well-known as the “drumstick tree” or “the horseradish tree” based on the taste of ground root preparations and the ben oil tree from seed-derived oils [13]. Diverse parts of *M. oleifera* (leaves, fruits, flowers, and roots) are commonly used as food, nutraceuticals, traditional medicine, water sanitization, and biofuel production due to their rich source of many vital nutrients bioactive compounds [14].

Mounting evidence reports that *M. oleifera* parts, especially the leaves, have nutritional properties or can be used in diet supplementation [10]. Using *M. oleifera* extract in food products has improved overall nutritional quality, sensory properties and shelf life. The use of leaves, seed and flower powder is well known in various food applications, such as in fortifying amala (stiff dough), ogi (maize gruel), bread, biscuits, yoghurt, cheese, and soups [11].

*Moringa* in non-traditional medicine is known for treating many diseases, including diabetes, cancer, cardiovascular, neurological, gastroenterological, and inflammatory disorders. *Moringa oleifera* leaves are the most commonly used part of this plant and contain beta-carotene, vitamins B, C, E, minerals, polyphenols [12][13][14], oxidase, catalase, alkaloids, glucosinolates, isothiocyanates, tannins, and saponins [15][16]. In *Moringa* seeds, niazimicin and niazirin and a rhamnosyl benzyl carbamate, rhamnosyl benzyl isothiocyanate, and various derivatives of β-sitosterol were identified. This plant’s stems, roots, and other morphological parts are not well researched, unlike the leaves and seeds; therefore, the data on the composition is relatively limited [16].

Based on the available literature, about 20 pharmacological properties can be attributed to this plant [17]. It is evident that various *Moringa* extracts can have hypoglycemic effects in different in vitro and in vivo models [18][19][20].

## 5. Conclusions

The categories of the analyzed parameters and observed tendencies of changes are presented in **Table 1** [1].

**Table 1.** Distribution and changes of analyzed parameters in meta-analysis.

| Plant | Physiological Efficacy Parameters | Oxidative Stress Parameters |
|---|---|---|

| | | | | |
|---|---|---|---|---|
| | *vs control* | | | |
| *Momordica charantia* | Glycemia↓ Insulinemia↑ body weight ↔ glucose uptake by diaphragm↑ | | no data analyzed Ø | |
| | *vs control* | *vs drug* | *vs control* | *vs drug* |
| *Gymnema montanum* | Glycemia↓ Insulinemia↑ body weight ↑ food intake↓ | Glycemia↓ Insulinemia↓ body weight ↔ food intake ↓ | TBARS ↓ Hydroperoxides↓ | TBARS ↓ Hydroperoxides↓ |
| | *vs control* | | *vs control* | |
| *Moringa oleifera* | Glycemia↓ Insulinemia↔ body weight ↑ | | SOD↓ CAT↑ | |

Changes of parameters in experimental group: ↓—decrease, ↑—increase, ↔—unchanged, Ø—not analyzed.

*Gymnema montanum*, *Momordica charantia* and *Moringa oleifera* are three plants with experimentally confirmed in vivo and in vitro antidiabetic properties:

The following parameter changes resulted from an investigation of the supplementation: reduced oxidative stress, decreased insulin resistance, increased insulin release, reduced adiposity, and a modulatory effect on glycolysis and gluconeogenesis, as well as attenuation of diabetes-associated weight loss, reduced fasting blood glucose and lowered oxidative status.

A comparison of *Gymnema montanum* versus Glybenclamide revealed the superiority of extracts over drug administration in some aspects.

Extracts of *Gymnema montanum*, *Momordica charantia* and *Moringa oleifera* represent a promising and attractive source of phytochemicals with proven antidiabetic and antioxidant activity in rat models of diabetes. They increase pancreatic insulin and insulin sensitivity in peripheral tissues, reduce insulin resistance and hepatic gluconeogenesis, and have a modulatory effect on glycolysis, gluconeogenesis and antihyperlipidemic properties. All three extracts reduced oxidative stress and revealed antiperoxidative features to protect β-cells against ROS.

They are, therefore, good candidates for the management and treatment of diabetes in mammals, especially humans. Moreover, all three plants have been widely used in traditional medicine.

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