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Potential effects of *Mudga (Vigna radiata L. Wilczek)* as a dietetic food and medication for diabetes

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ABSTRACT

The green gram *(Vigna radiata L. Wilczek)*, also known as *Mudga* in Sanskrit, is regarded by Ayurvedic science as the best pulse and one of the healthiest foods that may be regularly consumed to maintain health. Diabetes is a chronic lifestyle condition that may be controlled with diet, exercise, and contemporary medications like insulin and oral hypoglycaemic medicines. In Ayurvedic medicine, green grams are advised as both a dietetic food and a medication for diabetes. The phytochemistry of *Vigna radiata*, or mung beans, demonstrates its antidiabetic qualities, and a number of research using green gramme extracts have validated the capacity of mung bean to control insulin resistance and reduce blood glucose levels.

Key words: *Antidiabetic activity, Diabetes, Mudga, Mung bean*

INTRODUCTION

The third most significant pulse crop in India is green gram, (*Vigna radiata L. Wilczek*), which is highly prized as a grain legume. It is also referred to as Mung bean in English. Mung bean is a highly digestible, low-fat, high-protein food that also has a considerable number of minerals and vitamins. Nearly 80% of the total land planted with crops is used for its cultivation, which occurs mostly during India's rainy season (kharif).[1] The green gram's Indian origins are supported by archaeological evidence and the discovery of *Vigna radiata* var. sublobata, a closely related species. It was discovered in the 4500-year-old Harappan culture, in evidence from 3500-year-old Karnataka, and in a portion of 1600-year-old Madhya Pradesh.[2] Green gram, in Sanskrit, is called *Mudga*. One of the first pulses that humans are aware of is the *Mudga*, which is also widely referenced in ancient texts. Green gram is regarded as the best pulse and one of the greatest foods that may be eaten regularly to preserve health, according to traditional Ayurvedic medicine.

Diabetes is a chronic lifestyle disease that is managed with food, exercise, and modern treatments like insulin and oral hypoglycaemic drugs. Most Asian countries, as well as those in Africa and South America, use Mung bean seeds in traditional medicine to treat conditions including diabetes mellitus.

Green gram is recommended as a meal in Ayurvedic science as well as a medicine for diabetes. The antidiabetic properties of *Vigna radiata* (Mung beans) are shown by their phytochemistry.[3] Several studies that have used extracts from green gram have also confirmed the Mung beans' ability to lower blood glucose levels and regulate insulin resistance.

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Prayoga (Utility) of *Mudga* in Ayurveda and *Prameha Roga* (Diabetes)

One of the most significant pulses since the Vedic period is *Mudga*. Nearly every *Purana* mentions *Mudga* and its many uses, including in Homa and Yajna ceremonies, as a food, medicine-both internal and external.[4]

Mudga is considered the finest pulse in Ayurveda and is a member of the *Shami Dhanya Varga* (Pulses) family.[5] Most Ayurvedic writers include *Mudga* as the first of the *Shami Dhanya Varga*. It is listed by Acharya Sushruta as one of the *Sarva Prani Pathya Ahara Varga*, a set of food items regarded as both among the finest and dietary items suitable for all animals.[6] Additionally, according to Acharya Charaka, *Mudga* is *Nityasevaneeya*, or food that should be eaten every day to sustain good health.[7,8] It is the ideal pulse to utilise for soup preparation since it is naturally *Laghu* (light)in digestion.[9] But because the pulse is a recognised *Vatakara* (aggravates *Vata*, the bodily humor), it must be ingested with an eye towards amount.[10]

Ayurvedic lexicons highlight the regular use of *Mudga* in meals as a means of preserving health. According to Ayurvedic literature, it is *Pathya* (Conducive) for diabetes and can be eaten after being prepared into a variety of foods. *Mudgakulmasha* is half baked grains of *Mudga*, which are *Guru* (Heavy for digestion), *Ruchya* (imparts taste), *Vibandhakrut* (constipative), *Vatala* (aggravates *Vata*, the bodily humor) and *Pittashleshmaghna* (Pacifies *Pitta*, one of the regulatory factors of the body that is, responsible for digestion and metabolism and *Kapha*, one of the regulatory factors of the body responsible for body fluids and keeping the body constituents cohesive) in properties and action and it mitigates diabetes.[11] *Mudga-Amalaki Prayoga* (intake of Mung bean and Indian Goosberry) is mentioned as a medicinal preparation for treating diabetes by Ayurveda physicians.[12]

Antidiabetic activities of Mung beans

Mung beans have a lot of study being done on them because of their potential in medicine and food. A variety of experiments are used to identify antidiabetic actions of Mung beans.

Table 1: Antidiabetic activities of Mung beans

SN	Objective of the study	Results and conclusion
1.	To assess Antidiabetic Activity of Mung Bean or *Vigna radiata* (L. Wilczek) Seeds in Alloxan-Induced Diabetic Mice	The plant *Vigna radiata* has considerable antidiabetic properties in its methanolic extract that are comparable to those of the widely used medication Glibenclamide. Therefore, *V. radiata* appears to be a useful natural antidiabetic. In diabetic mice, the methanol extract of *V. radiata* seeds also restored liver glycogen and insulin levels and controlled lipid profiles, AST, ALT, and glycated haemoglobin, indicating its potential benefits in mitigating some of the effects of diabetes.[13]
2.	To assess Antidiabetic, antioxidant and antimicrobial activity of Mung beans extract (natural or sprouted state)	In diabetic rats, the ethanolic extract of Mung beans, whether raw or sprouted, reduced blood glucose levels in a dose-dependent way. By enhancing their lipid profile and markedly reducing their urea levels, the extracts also helped diabetic rats to mitigate complications; the effects were much more noticeable when sprouted Mung beans were used.[14]
3.	To assess Antidiabetic activity of Mung bean extracts in diabetic KK-Ay mice	In type 2 diabetic mice, the antidiabetic effects of Mung bean sprout (MBS) and Mung bean seed coat (MBSC) extracts were studied. For five weeks, KK-Ay mice received oral administrations of MBS and MBSC. MBS (2 g/kg) and MBSC (3 g/kg) were reported to significantly enhance glucose tolerance and raise insulin immunoreactive levels while also lowering blood glucose, plasma C-peptide, glucagon,

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		total cholesterol, triglyceride, and BUN (blood urea nitrogen) levels. These findings imply that in type 2 diabetic mice, MBS and MBSC have anti-diabetic effects.[15]
4.	To assess if polyphenol extracts from germinated Mung Beans can improve type 2 Diabetes in Mice by regulating intestinal microflora and inhibiting inflammation	A certain amount of Mung bean polyphenol extract can help mice with type 2 diabetes by controlling gut microbiota and reducing inflammatory responses.[16]
5.	To assess Anti-diabetic activities of vitexin and isovitexin from Mung bean soup	Mung bean soup containing vitexin and isovitexin has anti-diabetic effects.[17]
6.	To assess if Mung bean seed coat water extract restores insulin sensitivity in insulin-resistant HepG2 cells	In insulin-resistant HepG2 cells, Mung bean seed coat water extract (MSWE) enhanced cellular glucose absorption, decreased intracellular reactive oxygen species (ROS), and restored insulin sensitivity.[18]
7.	To assess anti-diabetic effects of Mung bean sprouts (in vitro study)	Histopathological analyses revealed that exosome-like nanoparticles in Mung bean sprouts (MELNs) increased the area of islet B cells and reduced hepatocyte inflammatory infiltration. Furthermore, MELNs exhibited high biocompatibility and reduced the levels of oxidative stress in liver tissue. MELNs were shown to increase the viability of glucosamine (GlcN)-induced insulin-resistant hepatocytes in vitro tests. Additionally, this study showed that MELNs down-regulated GSK-3β and up-regulated GLUT4 & Nrf2, which encouraged the synthesis of antioxidant enzymes including SOD and HO-1 to lessen oxidative stress. Therefore, Mung bean sprouts' naturally occurring exosome-like nanoparticles have anti-diabetic properties.[19]
8.	To identify hypolipidemic and hypoglycaemic potential of raw, boiled, and sprouted Mung beans *(Vigna radiata l. Walczak*) in rats.	Hypoglycaemic effect was identified in sprouted Mung bean fed rats.[20]
9.	To assess improvement of glucose metabolism via Mung bean protein consumption using Glucodiatm isolated Mung bean protein in Japan	Insulin and fasting plasma glucose levels are suppressed by Mung bean protein. As a result, it could suppress insulin resistance, which is a factor that leads to metabolic syndrome.[21]
10.	To assess the effect of natural and sprouted Mung bean extracts grown in Burkina Faso on the metabolism and overall health status of diabetic Wistar rats	Natural (MBN) and sprouted (MBG) Mung bean extracts showed anti-diabetic activity in Wistar rats by reducing blood glucose levels.[22]
11.	To identify the effect of mixing rice with Mung bean in different food meals on postprandial blood glucose level in healthy adults	Blood glucose levels were shown to be negatively linked with the amount of Mung beans added to rice meals; the levels were highest in volunteers who consumed only rice meals, and they began to decline as the proportion of Mung beans increased. Blood glucose levels were shown to be negatively linked with the amount of Mung beans added to rice meals; the levels were highest in volunteers who consumed only rice meals, and they began to decline as the proportion of Mung beans increased.[23]
12.	To identify the effect of Munghurt Lactobacillus acidophilus from	In alloxan-induced diabetic rats, Munghurt Lactobacillus acidophilus had the impact of lowering blood glucose levels,

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	Green Beans on the blood Glucose levels in Alloxan-induced Diabetic Rats	and there were complementary processes between Glibenclamide and Munghurt Lactobacillus acidophilus in lowering blood glucose level.[24]
13.	To identify if Mung bean peptides promote glucose uptake *via* Jak2 activation in L6 myotubes	By enhancing glucose absorption and activating JAK2 in muscle cells, Mung beans are a potentially beneficial functional diet for preventing hyperglycaemia and type 2 diabetes.[25]
14.	To assess anti-hyperglycaemic effects of fermented and nonfermented Mung bean extracts on Alloxan-induced-diabetic mice	The effects of fermented and nonfermented Mung bean extracts on normoglycemic, glucose-induced, and alloxan-induced hyperglycaemic states have been studied. In both glucose- and alloxan-induced hyperglycaemic rats, the anti-hyperglycaemic activity of nonfermented Mung bean extract was further enhanced by fermented Mung bean extract. Normal mice did not have a hypoglycaemic impact from fermented Mung bean extracts, whereas mice with hyperglycaemia brought on by alloxan and glucose had a considerable drop in blood sugar levels. In the fermented Mung bean-treated group of alloxan-induced hyperglycaemic mice, there was a substantial improvement in insulin secretion and antioxidant level as determined by malonaldehyde (MDA) tests. These findings suggested that in alloxan-treated mice, fermentation using Mardi Rhizopus sp. strain 5351 inoculums might augment the anti-hyperglycaemic and antioxidant benefits of Mung beans.[26]
15.	To investigate the hypoglycaemic and antioxidant effect of Mung bean coat (MBC) in an animal model of type 2 diabetes	An in vitro study using a 95% ethanol extract of Moong bean coat (MBC) showed a 48.6% reduction of yeast α-glucosidase activity. This inhibition was 1.4 times greater than that of acarbose at 0.5 mg/mL. For seven weeks, five-week-old db/db mice were given either the AIN-93G diet or a diet that contained 1% MBC extract. The homeostasis model evaluation for insulin resistance, blood glycated haemoglobin and serum glucose levels, and insulin resistance were all considerably ($p<0.01$) lower in the MBC group mice than in the control group mice. As a result, MBC may be useful in lowering hyperglycaemia and enhancing antioxidant levels in people with type 2 diabetes.[27]

Discussion

Given that diabetes is a chronic lifestyle issue, research into new and alternative treatments for the disease is still gaining a lot of attention. It is advised that diabetes patients engage in physical exercise and individualised dietary management to improve their glycaemic control. Furthermore, improved oral agents have been suggested for complementary and alternative medicine in the form of plant-based foods and spices that are frequently used in traditional medicine to treat diabetes. Because of their low glycaemic indices, whole grains, legumes, and cereals - which provide energy in Asian cuisine - have also been proposed as possible antidiabetic foods in addition to herbs. Because of its high fibre content and low glycaemic index, Mung beans have been suggested as an alternate meal for diabetes people among all other types of seeds.[26] From the Ayurvedic point of view, *Mudga* possesses *Laghu* (light for digestion) *Ruksha* (dry) properties, *Kapha-Pitta Doshahara* in action (pacifies *Kapha*, one of the regulatory factors of the body responsible for body fluids and keeping the body constituents cohesive and *Pitta Doshas*, one of the regulatory factors of the body that is, responsible for digestion and metabolism)[5] and may contribute in the management of diabetes.

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Due to their nutrients and bioactive substances, plain or sprouted Mung beans have a range of pharmacological qualities, such as antibacterial, antioxidant, and antidiabetic effects. By assisting in the maintenance of an equilibrium between oxidants and antioxidants, flavonoids and polyphenols, two types of phytochemicals found in both plain and sprouted seeds, can help the body fight oxidative stress. A healthy diet is essential for maintaining this equilibrium, which helps avoid chronic illnesses like diabetes that are brought on by oxidative damage.[14]

Additional study is required to comprehend the molecular processes of the bioactive substances present in Mung beans. But as several studies have demonstrated, Mung beans may have anti-diabetic properties. A study on mice with type 2 diabetes has demonstrated the preventive effects of germinated Mung bean polyphenol extract. The reason for this was because germinated Mung bean polyphenol (GMP) has the ability to control intestinal flora imbalance and regulate species diversity in diabetic mice, in addition to regulating Firmicutes, Bacteroidetes, and Proteobacteria.[16]

Another research demonstrated the ability of Mung bean soup containing vitexin and isovitexin to suppress the production of advanced glycation end products and the enzymes that metabolise carbohydrates, alpha-amylase and alpha-glucosidase.[17] In another study, rats given sprouted Mung beans were shown to have higher levels of both α-amylase and α-glucosidase inhibitory activity, which evaluated the potential antidiabetic properties of Mung beans.[20] Mung bean protein had an inhibitory impact on insulin resistance,[21] and in healthy people, meals containing Mung beans also shown a drop in postprandial blood sugar levels.[23] Likewise, fermented Mung bean extracts have demonstrated superior antihyperglycemic action, which might be attributed to their higher GABA concentration and free amino acid content.[26]

Additionally, studies have extracted and identified the Mung bean's active peptides, which have been shown to enhance glucose absorption and clarify how they work in L6 myotubes. The active peptides HTL, FLSSTEAQQSY, and TLVNPDGRDSY were separated and identified. The glucose transporter 4 (GLUT4) was encouraged to relocate to the plasma membrane by these peptides. Adenosine monophosphate-activated protein kinase was activated by the tripeptide HTL to enhance glucose absorption, whereas the PI3K/Akt pathway was stimulated by the oligopeptides FLSSTEAQQSY and TLVNPDGRDSY. Furthermore, through their interaction with the leptin receptor, these peptides stimulated the phosphorylation of Jak2.[25] In light of all of these, Mung beans provide a viable functional dietary option for preventing type 2 diabetes and hyperglycaemia.

Conclusion

Mung beans have been suggested as a possible antidiabetic agent, and several scientific studies have supported this claim. It may thus be included into a variety of antidiabetic drugs and is a potential functional food for the prevention of hyperglycaemia and type 2 diabetes.

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