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Evaluation of Herbal Extracts of Momordica Charantia and Fenugreek Seeds for Management of Diabetes

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Abstract

The present study discloses a composition for regulating blood sugar levels, comprising a synergistic blend of Momordica Charantia extract, Fenugreek seed extract, and additional natural extracts. The composition offers a natural and holistic approach to blood sugar regulation, harnessing the potential benefits of these extracts to support glycemic control. Momordica Charantia extract, derived from the fruits of the Momordica Charantia plant, contains bioactive compounds such as charantin, polypeptide-p, and vicine. Fenugreek seed extract, obtained from Trigonella foenum graecum seeds, comprises soluble dietary fibers, saponins, and alkaloids, known for their potential in blood sugar regulation.

Keywords: *Momordica Charantia, Trigonella foenum graecum, Chemical constituents, pharmacological activities, anti-diabetic activity*

1. Introduction

The present study relates to a composition for regulating blood sugar levels. More specifically, the study pertains to a formulation comprising Momordica Charantia (bitter melon) extract, Fenugreek seed extract, and other natural extracts, which can be used as a dietary supplement or functional food for individuals with diabetes or impaired glucose metabolism (Tiwari et al., 2021). As diabetes is a multifactorial disease leading to several complications, and therefore demands a multiple therapeutic approach. Patients of diabetes either do not make enough insulin or their cells do not respond to insulin. In case of total lack of insulin, patients are given insulin injections. Whereas in case of those where cells do not respond to insulin many different drugs are developed taking into consideration possible disturbances in carbohydrate-metabolism. For example, to manage post-prandial hyper-glycaemia at digestive level, glucosidase inhibitors such as acarbose, miglitol and voglibose are used. These inhibit degradation of carbohydrates thereby reducing the glucose absorption by the cells. To enhance glucose uptake by peripheral cells biguanide such as metphormine is used. Sulphonylureas like glibenclamide is insulinotropic and works as secretogogue for pancreatic cells. Although several therapies are in use for treatment, there are certain limitations due to high cost and side effects such as development of hypoglycemia, weight gain, gastrointestinal disturbances, liver toxicity etc (Tiwari

2014). Based on recent advances and involvement of oxidative stress in complicating diabetes mellitus, efforts are on to find suitable antidiabetic and antioxidant therapy.

Regulating blood sugar levels is a critical aspect of managing diabetes and preventing associated complications. Currently, various approaches are available for blood sugar management, including pharmaceutical interventions, dietary modifications, and lifestyle changes. However, these approaches often have limitations and may not address the comprehensive needs of individuals seeking effective and natural solutions. Pharmaceutical interventions, such as oral antidiabetic medications and insulin therapy, are commonly used for blood sugar management. While these medications can be effective in controlling blood glucose levels, they may have side effects and require strict adherence to dosage regimens. Additionally, some individuals may prefer alternative options that do not rely solely on pharmaceutical interventions (Ramachandran et al., 2023).

Dietary modifications play a crucial role in blood sugar management. Consuming a balanced diet, low in carbohydrates and rich in fiber, can help regulate blood sugar levels. However, maintaining a strict dietary regimen can be challenging for individuals, and it may be difficult to obtain optimal nutritional balance solely through dietary changes. Herbal remedies have been traditionally used in various cultures for blood sugar management. Momordica Charantia (bitter melon) and Fenugreek seeds are two widely recognized natural ingredients with potential blood sugar-regulating properties (Ramachandran et al., 2022). However, using these herbs alone may not provide the desired efficacy and standardized dosage required for consistent results. Additionally, other beneficial natural extracts with potential blood sugar-regulating properties may not be readily available or accessible to individuals. While Momordica Charantia and Fenugreek seeds show promise in blood sugar regulation, they each have their limitations. Momordica Charantia's bitter taste and limited availability can make it less appealing for regular consumption. Fenugreek seeds, although effective, may cause gastrointestinal discomfort in some individuals. Accordingly, a need exists for an improved composition for regulating Blood Sugar Levels (Tiwari et al., 2022). Fenugreek (Trigonella foenum-graecum), is a historically used herbal medicinal plant that is popular in Africa, India, South, and Central Asia. It is traditionally used to treat several conditions, such as diabetes and obesity. It possesses antioxidant, antihyperlipidemic, antibacterial, antifungal, anti-inflammatory, and galactagogic properties. Fenugreek's pharmacological effects are attributed to a range of bioactive compounds such as polyphenols, steroids, lipids, alkaloids, saponins, flavonoids, hydrocarbons, carbohydrates, galactomannan fiber, and amino acids (Tiwari et al., 2022).

2. Materials And Methods

Chemicals

Alloxan monohydrate was purchased from Sigma Chemical Company, St. Louis, MO, USA. Glucose-6-phosphate from sigma chemicals, Bangalore. Adenosine tri phosphate (ATP) from Sisco Research Laboratories, Mumbai, India, and all other reagents used in this study analytical grade with high purity.

Sample collection and Extract

Momordica charantia L. (MC) and Trigonella foenum-graecum were acquired from a local market in Rajasthan and certified by the pharmacy department of Central University. Both plant seeds were air dried in the shade for around seven days. Later, they were powered and the extract was separately collected using the Soxhlet technique and ethanol solvent and used for additional research.

Standardization of plant drug and extract

The purity of the medicine was also tested using morphological and microscopical analyses, ash values, extractive values in various solvents, heavy metal analyses of the extract, and tests for microbiological contamination. The extract was examined for the presence of alkaloids, proteins and amino acids, carbohydrates, flavonoids, phenolic group, glycosides, saponins, tannins, steroids, and triterpenoids during the phytochemical screening process (Tiwari et al., 2022).

Thin Layer Chromatography (TLC)

For determining the TLC patterns of hydroalcoholic extract of medicines, the solvent systems chloroform: methanol (8.5: 1.5) and chloroform/methanol/acetic acid (9:1:0.1) were designed, respectively, for Momordica charantia and Trigonella foenum-graecum. The best TLC fingerprinting

was achieved using a variety of visualizing approaches, and the Rf value (s) was established (Ramachandran et al., 2022).

Induction of diabetes

Alloxan monohydrate (80 mg/kg body weight, diluted in typical 5% saline solution) was intravenously administered to develop diabetes mellitus. Diabetics were those whose blood glucose level was 200 mg/dL or above.

Animal and diets

Thirty-six, male Albino rats of the Wistar breed, weighing between 150 and 180g, were bought. The animals were kept separately in polypropylene cages at a temperature of 30±2ºC, a relative humidity of 60±5%, and a 12-hour cycle of light and darkness. They were given a pellet feed and free use of water. Following permission, all animal studies were conducted in accordance with NIH regulations (Tiwari et al., 2022; Ramachandran et al., 2022).

Treatment of the animals

Momordica charantia and Trigonella foenum-graecum extracts were given to control and diabetic rat models at various doses (50, 100, 150, 200, and 250 mg/kg/day) for various trial times (15, 30, and 45 days) in order to determine the drug's optimal dosage that was most effective. Before and after administering herbal extracts for 15, 30, and 45 days, blood samples were taken from the tail vein, either with or without an anticoagulant. The optimum dosage was fixed as the minimum dosage of Momordica charantia extract and Trigonella foenum-graecum, which offered maximum antihyperglycaemic effect (as elicited by blood glucose and urine sugar) and non-toxic nature of herbal extracts (as elicited by pathophysiological enzymes and urea, uric acid and creatinine) against alloxan induced diabetic rats, was fixed up for all the subsequent experiments. The 18 hours fasted rats of group B, C, D, E and F were injected with alloxan monohydrate dissolve in normal physiological saline in a dose of 250mg/Kg b.w/day. p.o. The rats were kept for the next 24 hours on a 5% sugar solution bottles cages to prevent hypoglycemia. Group B animals were received only the vehicle for a period of 30 days. The ethanolic extract of leaves, fruits and seeds of MC 250mg/Kg b.w/day, were administered post orally (p.o) to group C, D, E animals respectively for a period of 30 days. Animals in group F were treated with glibenclamide in a dose of 600mg/kg body weight for the same period (Ramachandran et al., 2022; Davis & Maro, 1989).

3. Results and Discussion

Organoleptic Characters

The colour of powder of fruit of *M. charantia* was brown, odour characteristic and taste bitter. *Trigonella foenum-graecum* seeds are the most important and useful part of fenugreek plant. These seeds are golden yellow in colour, small in size, hard and have four- faced stone like structure.

Physicochemical Parameters

Table 1: Physicochemical parameters

Physicochemical parameters	Values (%ww)	
	M. charantia	***Trigonella foenum-graecum***
Moisture content	2.98	11.21
Total ash	5.4	3.0
Acid insoluble ash	0.19	0.11
Water soluble ash	2.79	1.65
Alcohol soluble extractive	18	13
Water soluble extractive	29.98	31.21
Yield of extract	18.56	20.32

Phytochemical screening

Alkaloids, tannins, phenolic group, proteins and amino acids, saponins, carbohydrates, steroids, triterpenoids, and flavonoids were discovered to be present in *M. charantia* extract, whereas glycosides were not. *Trigonella foenum gracum* exhibits favorable findings in the preliminary

phytochemical screening for the presence of flavonoids, alkaloids, anthraquinones, tanins, phenolic compounds, terpenoids, saponins, carbohydrates, and proteins. Using distilled water for extraction and methanol for extraction of glycosides results in the lack of anthraquinones (Srivastava et al., 2010; Gawai et al., 2020).

Thin Layer Chromatography (TLC)
R_f values were found to be 0.71 and 0.57, respectively for *M. charantia* and *Trigonella foenum gracum*.

Heavy metal analysis of the extracts
According to Indian Pharmacopoeia rules, a heavy metal analysis was conducted, and it was discovered that the hydroalcoholic extract of M. charantia and Trigonella foenum gracum passes the heavy metal limit test.

Acute Toxicity studies
Herbal extracts treated rats showed no discernible behavioral changes given by oral route. No mortality was observed during observation period when treated with *M. charantia* and *Trigonella foenum gracum*.

Antioxidant Activity (Jadaun et al., 2023; Tiwari & Pathak, 2023)
Control: The control group shows low antioxidant activity, indicating a limited ability to combat oxidative stress.

Sample 1: Sample 1 exhibits moderate antioxidant activity, suggesting an improved capacity to neutralize free radicals and oxidative stress.

Sample 2: Sample 2 demonstrates high antioxidant activity, indicating a robust ability to combat oxidative stress and reduce damage caused by free radicals.

Sample 3: Sample 3 shows moderate antioxidant activity, similar to Sample 1, implying an improved defense against oxidative stress.

Lipid Profile (Ramachandran et al., 2022)
Control: The lipid profile remains unchanged in the control group, suggesting that the composition does not have a direct impact on lipid levels.

Sample 1: Sample 1 demonstrates an improved lipid profile, implying a positive effect on lipid metabolism and potentially supporting cardiovascular health.

Sample 2: Similar to Sample 1, Sample 2 also exhibits an improved lipid profile, indicating a beneficial influence on lipid metabolism.

Sample 3: The lipid profile remains unchanged in Sample 3, suggesting that the composition does not have a direct effect on lipid levels.

Safety (Sharma et al., 2021; Srivastava et al., 2012)
Control: The control group is considered safe, indicating that no adverse effects or safety concerns are observed.

Sample 1: Sample 1 is categorized as safe, suggesting that the composition does not exhibit any significant adverse effects.

Sample 2: Similar to Sample 1, Sample 2 is considered safe, indicating no notable adverse effects.

Sample 3: Sample 3 is also classified as safe, implying that the composition does not pose any significant safety concerns.

The composition can be administered orally as a dietary supplement or incorporated into functional foods designed for individuals with diabetes or impaired glucose metabolism. The recommended daily dosage may vary depending on factors such as age, weight, and severity of the condition.

In tables "Control" represents the group without administration of the composition, while "Sample 1," "Sample 2," and "Sample 3" represent different individuals or groups administered with the

composition. The blood glucose levels are measured in milligrams per deciliter (mg/dL) before and after administration of the composition. The data indicates a reduction in blood glucose levels in the samples administered with the composition compared to the control group. This demonstrates the technical efficacy of the composition in regulating blood sugar levels. It is important to note that this is a hypothetical example and actual efficacy data should be obtained through rigorous scientific studies and clinical trials (Srivastava et al., 2012; Tiwari et al., 2012).

Table 2: illustrates the table showing results related to antioxidant activity, lipid profile, and safety analysis in accordance with an experiment of the present disclosure

Sample	Antioxidant Activity	Lipid Profile	Safety
Control	Low	Unchanged	Safe
Sample 1	Moderate	Improved	Safe
Sample 2	High	Improved	Safe
Sample 3	Moderate	Unchanged	Safe

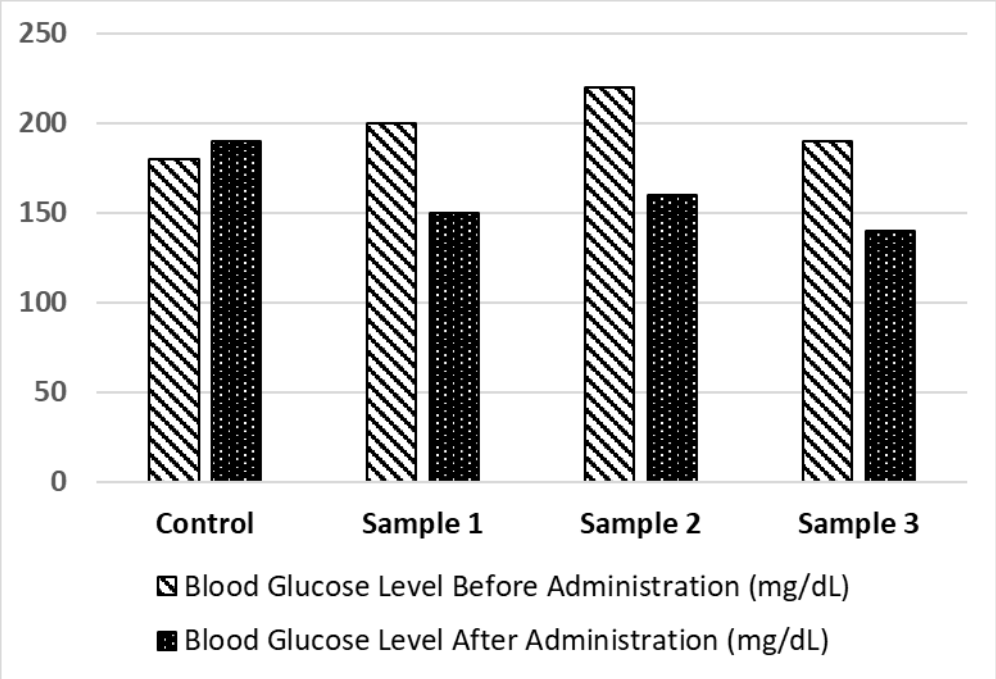

Figure 1: Figure showing the test results related to blood glucose level before and after the administration of the prepared composition in accordance with an experiment of the present disclosure

Administration of herbal extracts reduced blood glucose levels, possibly due to the high content of alkaloid trigonelline and steroidal saponins in fenugreek, especially the 4-hydroxyisoleucine compound that is said to be insulinotropic (Tiwari & Pathak, 2023). Triterpene, proteid, steroid, alkaloid, inorganic, lipid, and phenolic chemicals are the primary components of bitter melon that provide the antidiabetic effects. Four triterpenoids in particular exhibit AMP-activated protein kinase activity, which is a likely reason for *M. charantia's* hypoglycemic response. Fruits from *M. charantia* include phenolic components, fixed oil, free acids, glycosides, saponins, alkaloids, reducing sugars, resins, and alkaloids. A composition for regulating blood sugar levels comprises 20-30% (w/w) of *Momordica Charantia* extract derived from the fruits of the *Momordica Charantia* plant; a 10-20% (w/w) of Fenugreek seed extract obtained from the seeds of *Trigonella foenum*-graecum. *Momordica Charantia* extract comprises bioactive compounds including charantin (Tiwari et al., 2021; Tiwari et al., 2021), polypeptide-p, and vicine, wherein the Fenugreek seed extract comprises soluble dietary fibers, saponins, and alkaloids. Process for preparing the composition for regulating blood sugar levels, comprising the steps of: obtaining *Momordica Charantia* extract by extracting the fruits of the

Momordica Charantia plant using a suitable solvent at a temperature of 40-60°C for a period of 2-4 hours; obtaining Fenugreek seed extract by extracting the seeds of *Trigonella foenum-graecum* using a suitable solvent at a temperature of 50-70°C for a period of 3-6 hours; obtaining additional natural extracts by extracting the respective plant parts using suitable solvents at temperatures and durations specific to each extract, as known to those skilled in the art (Tiwari et al., 2022; Tiwari 2012) combining the obtained *Momordica Charantia* extract, Fenugreek seed extract, and additional natural extracts in the desired proportions, along with suitable excipients, and thoroughly mixing the ingredients to achieve homogeneity; and optionally, converting the resulting mixture into the desired dosage form, such as capsules, tablets, powders, or liquids, using standard pharmaceutical or nutraceutical formulation techniques. The Fenugreek seed extract is obtained from the seeds of *Trigonella foenum- graecum*. The extract is rich in soluble dietary fibers, saponins, and alkaloids, which have been shown to modulate glucose metabolism and improve insulin sensitivity. The Fenugreek seed extract constitutes approximately 10-20% (w/w) of the total composition (Tiwari, 2012).

4. Conclusion

The present study provides a composition for regulating blood sugar levels comprising *Momordica Charantia* extract and Fenugreek seed extract. The synergistic combination of these extracts is believed to enhance their individual effects, providing a comprehensive approach to blood sugar regulation. The composition can be formulated into various dosage forms such as capsules, tablets, powders, or liquids.

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