IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 3, June 2024

Antidiabetic Compound in Juice of Momordica Charantia

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Abstract: *The present article provides an overview of Diabetic mellitus and its treatment with insulin, oral hypoglycemic drugs, and herbal drugs. Despite significant progress in the treatment of diabetes with oral hypoglycemic agents, the search for newer drugs continues because current synthetic drugs have several limitations.Herbal drugs with antidiabetic activity have yet to be commercially formulated as modern medicines, despite being recognized for their therapeutic properties in traditional medical systems. This study investigated the beneficial effects and mechanism of action of the juice of Momordica charantia on streptozotocin. (STZ)-induced diabetes in rats. Diabetes mellitus was linked to significant ($p < 0.01$) reductions in body weight, plasma insulin, and insulin-positive cells per islet, as well as significant ($p < 0.01$) increases in blood glucose, osmolarity, and systolic blood pressure over time compared to age-matched healthy controls. Oral administration of M. charantia juice to STZ-induced diabetic rats partially reversed all of the diabetes-induced effects observed.*

Keywords: Diabetic mellitus, oral hypoglycemic, M. charantia, antidiabetic, Herbal drugs, Juice

I. INTRODUCTION

Momordica charantia (M. charantia), also known as bitter melon, karela, balsam pear, or bitter gourd, is a popular plant used for the treating of diabetes related conditions amongst the indigenous populations of Asia, South America, India, the Caribbean and East.Its fruit has a distinguishing bitter taste, which is more pronounced as it ripens, hence the name bitter melon or bitter gourd. Biochemical and animal model experiments have produced abundant data and hypotheses accounting for the anti- diabetic effects of M. charantia. In comparison, clinical studies with human subjects are sparse and low quality in design.

Diabetes mellitus is well known clinical entity with various late complications like retinopathy, neuropathy, nephropathy, etc. Natural products are known to play an important role in pharmaceutical biology. Specific plant knowledge may provide insight for strategic consumption and sustainable use. The alternate medicine system is now gaining momentum with the knowledge of active principles identified from plant species. M. charantia has significant antidiabetic as well as hypolipidemic activity so that it can be used as an adjuvant along with allopathic treatment of medicine to treat diabetes as well as to delay the late complications of diabetes. In the present review, we have elucidated the possible antidiabetic activity of M. charantia and its medicinal potency responsible for the hypoglycemic activity.

Diabetes mellitus is considered as one of the five leading causes of death in the world. Diabetes mellitus is a major global health concerning with a projected rise in prevalence from 171 million in 2000 to 366 million in 2030. It is a syndrome of disordered metabolism, usually due to a combination of hereditary and environmental causes, resulting in abnormally high blood sugar levels (hyperglycemia). Being a major degenerative disease, becoming the third most lethal disease of mankind and increasing rapidly141. It is the most common endocrine disorder, affecting 16 million individuals in the United States and as many as 200 million individuals worldwide. Diabetes has been a clinical model for general medicine. Complementary and alternative medicine involves the use of herbs and other dietary supplements as alternatives to mainstream western medical treatment. A recent study has estimated that up to 30% of patients with diabetes mellitus.

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II. PLANT BASED ANTI-DIABETIC MEDICINE

Plant—based medicine has been used cost—effectively worldwide to treat diabetes. In fact, in many parts of the world, especially poor countries, this may be the only form of therapy available to treat diabetic patients. There are several reviews by different authors about anti—diabetic herbal plants. Ayurveda and other traditional medicinal systems for the treatment of diabetes describe a number of plants used as herbal drugs. Hence, they play an important role as alternative medicine due to less side effects and low cost. The active principles present in medicinal plants have been reported to possess pancreatic cells regenerating, insulin releasing and fighting the problem of insulin resistance. Hyperglycemia is involved in the etiology of development of diabetic complications. Hypoglycemic herbs increase insulin secretion, enhance g ucose uptake by adipose or muscle tissues and inhibit glucose absorption from intestine and glucose production from liver1191. Insulin and oral hypoglycemic agents like sulphonylureas and biguanides are still the major players in the management, but there is quest for the development of more effective anti—diabetic agents.From the current literature, it is evident that M. charantia is the most widely used and popular anti—diabetic plant. Thus, this review will concentrate mainly on M. charantia and its anti diabetic properties.

III. THE PROFILE OF M. CHARANTIA

3.1. Plant description:

M. Charantia (bitter melon or bitter gourd) (Figure l) is a flowering vine in the family Cucurbitaceae. It is a tropical plant that is widely cultivated in Asia, India, East Africa, and South America for its intensely bitter fruits that are commonly used in cooking and as a natural remedy for treating diabetes[201. It is a climbing perennial that usually grows up to 5 m, and bears elongated fruits with a knobbly surface. It is a useful medicinal and vegetable plant for human health and one of the most promising plants for diabetes

Figure 1. M. charantia plant.

3.2 Nutrient profile:

Bitter melon is a powerful nutrient—dense plant composed of a complex array of beneficial compounds. These include bioactive chemicals, vitamins, minerals and antioxidants which all contribute to its remarkable versatility in treating a wide range of illnesses. The fruits contain high amounts of vitamin C, vitamin A, vitamin E, vitamins Bl, B2 and B3, as well as vitamin B9 (folate). The caloric values for leaf, fruit and seed were 213.26, 241.66 and 176.61 Kcal/ 100 g respectively1221.

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The fruit is also rich in minerals including potassium, calcium, zinc, magnesium, phosphorus and iron, and is a good source of dietary fiber (bitter melon "monograph", 2008). Medicinal value of bitter melon has been attributed to its high antioxidant properties due in part to phenols, flavonoids, isoflavones, terpenes, anthroquinones, and glucosinolates, all of which confer a bitter taste.

3.3 Phytochemistry:

The main constituents of bitter melon which are responsible for the antidiabetic effects are triterpene, proteid, steroid, alkaloid, inorganic, lipid, and phenolic ds[24,25]. Several glycosides have been isolated from the M. charantia stem and fruit and are grouped under the genera of cucurbitane—type triterpenoids126,271. In particular, four triterpenoids have AMP—activated protein kinase activity which is a plausible hypoglycaemic mechanism of
M. charantia1271.

M. charantia fruits consist glycosides, saponins, alkaloids, reducing sugars, resins, phenolic constituents, fixed oil and free acids[281. M. charantia consists the following 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 amino acids—aspartic acid, serine, glutamic acid, thscinne, alanine, g—amino butyric acid and pipecolic acid, ascorbigen, b—sitosterol—d— glucoside, citrulline, elasterol, flavochrome, lutein, lycopene, pipecolic acid. The fruit pulp has soluble pectin but no free pectic acid. Research has found that the leaves are nutritious sources of calcium, magnesium, potassium, phosphorus and iron; both the edible fruit and the leaves are great sources of the B vitamins.

3.4. Bioactive compounds:

Based on the multitude of medical conditions that bitter melon can treat, scientists are more and more interested in studying its bioactive compounds and their actions on the body. However, as many studies report, there has been substantial emphasis on the anti—diabetic compounds and their hypoglycemic properties130,311. A number of reported clinical studies have shown that bitter melon extract from the fruit, seeds, and leaves contain several bioactive compounds that have hypoglycemic activity in both diabetic animals and humans.

Momordicine Il and 3—hydroxycucurbita—5, 24—dien— 19—al—7, 23— di—o—ß— glucopyranoside (4), were isolated as saponins from M. charantia. Both compounds showed significant insulin releasing activity in MIN6 ß—cells at concentration of 10 and 25 gg/mL1341. The major compounds that have been isolated from bitter melon and identified as hypoglycemic agents include charantin, polypeptide—p and vmcme.

3.4.1. Charantin :

Charantin is a typical cucurbitane type triterpenoid in M. charantia and is a potential substance with antidiabetic properties. Pitiphanpong et al. demonstrated that charantin could be used to treat diabetes and can potentially replace treatment. It is a mixture of two compounds, namely, sitosteryl glucoside and stigmasteryl glucoside. Chen et al. isolated 14 cucurbitane triterpenoids, kuguacins, including two pentanorcucurbitacins, one octanorcucurbitacin, and two trinorcucurbitacins, along with six known.analogues from the vines and leaves of M. charantia. The charantin from bitter melon fruit was extracted and estimated by high performance thin layer chromatographic method.

Studies have reported that the compound is more effective than the oral hypoglycemic agent tolbutamide1121. In a study, two aglycones of charantin were isolated and identified as sitosterol and stigmastadienol glycosides, however, when tested separately for their hypoglycemic effects in vivo, these two constituents did not produce any notable changes in blood glucose levels1401. This is an indication that charantin may contain other specific components, yet to be identified, that are responsible for the hypoglycemic activity observed in diabetics.

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3.4.2. Polypeptide-p:

Bitter melon is one of the most commonly used vegetable that contains polypeptide—p and is used to control diabetes naturally[411. Polypeptide—p or p—insulin is an insulin— like hypoglycemic protein, shown to lower blood glucose levels in gerbils, langurs and humans when injected subcutaneously[421. The p—insulin works by mimicking the action of human insulin in the body and thus may be used as plant—based insulin replacement in patients with type—I diabetes1431. Recently, Wang et al. have cloned and expressed the 498 bp gene sequence coding for the M. charantia polypeptide p gene and have also proved the hypoglycemic effect of the recombinant polypeptide in alloxan induced diabetic mice[441. The oral intake of the extract from bitter melon seeds does produce hypoglycemic effects in streptozotocin (STZ) induced type—I diabetic rats1321. This indicates that compounds in bitter melon seeds other than p—insulin may also be effective in the treatment of type-I diabetes.

3.4.3. Other components:

Many other bitter melon constituents have been identified and isolated by various extraction techniques. The first study to show the in vivo hypoglycemic activity of the major compounds of bitter melon was done by a group of Japanese scientists. They isolated Il compounds by fractionation of a methanol extract from dried bitter melon fruits. The structure of three cucurbitane triterpenoids were determined, as well as two other major compounds that were tested and shown to significantly lower blood glucose levels in diabetic mice1211. Four compounds that may be responsible for the bitter taste of the plant were isolated and identified as momordicosides K and L, and momordicines I and Il. The last two compounds isolated were identified as sitosterol and stigmastadienol, the aglycones of charantin.

IV. MEDICINAL PROPERTIES OF M. CHARANTIA

Bitter melon is traditionally known for its medicinal properties such as antidiabetic, anticancer, anti— inflammation, antivirus, and cholesterol lowering effects. It contains many phenolic compounds that may have the potential as antioxidant and antimutagen125,. The fruit, stems, leaves and roots of bitter melon have all been used in traditional medicine to help treat ailments such as hyperlipidemia, digestive disorders, microbial infections and menstrual problems. Bitter melon has been shown to possess powerful antiviral properties that can stimulate the immune system and activate the body's natural killer cells to help fight off viruses such as white spot syndrome virus and human immunodeficiency virus. Studies have also shown that bitter melon has anti—carcinogenic properties and can be used as a cytotoxic agent against many types of cancefl. Ray et al. showed that the extract of bitter melon modulates signal transduction pathways for inhibition of breast cancer cell growth and can be used as a dietary supplement for prevention of breast cancefl.Bitter melon extract can also be used as a broad spectrum antibacterial agent to fight off infections caused by Escherichia coli, Salmonella, Staphylococcus aureus, Staphylococcus, Pseudomonas, and Streptobaccilus. In addition, the plant possesses anti—helmintic properties, which are effective in the treatment of malaria. Traditionally, bitter melon has also been used as an abortifacient agent used to induce abortions. Therefore, pregnant women are advised to avoid consumption of the plant . The extract of the seed also have antispermatogenic effect .

Anti—diabetic effect of M. Charantia

There are many traditional herbal remedies that have been used to treat diabetes in Asia and other developing coumtries. M. charantia is one of the plants that has been investigated thoroughly for the treatment of diabetes. With the traditional use supported by modern scientific evidence of the beneficial function of M. charantia, it is one of the most promising plants for diabetes today.Investigation of the traditional uses of M. charantia in India revealed that it is one of the most important plant for lowering blood glucose levels in patients with diabetes.

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Sr. no	Ingredients	Quantity
1.	Momordica Charantia	500 gm
2.	Ginger	20 gm
3.	Lemon juice	20 ml
4.	Salt	10 gm
5.	Honey	Q.S.
6.	Water	Q.S.

Table 1. Proximate composition of M. charantia leaf, fruit and seed.

V. FORMULATION FOR THE ANTIDIABETIC JUICE : M.CHARANTIA REQUIRENMENT (APPARATUS):

- Autoclve
- beaker
- measuring cylinder
- centrifuge machine
- refrigerator etc.

Procedure:

- Fresh fruit washed thoroughly
- Juice obtained by using commercial juice extractor.
- Fresh juice was centrifuged at 5000 rpm for 30 min.And the clear suprnatant was considered as 100%.
- Momordica charantia fruit is diluted with autoclaved distilled water.
- Add flavouring and sweetning agents simultaneously
- Collect and store in well closed container at 4 c.
- Product stored at cool temperature

5.1 Possible modes of action of M. charantia and its extract :

M. charantia and its various extracts and components are believed to exert their hypoglycemic effects via different physiological, pharmacological and biochemical modes. The possible modes of the hypoglycemic actions of M. charantia and its various extracts and compounds are its hypoglycemic effect stimulation of peripheral and skeletal muscle glucose inhibition of intestinal glucose uptake inhibition of adipocyte differentiation, suppression of key gluconeogenic stimulation of key enzyme of HMP pathway, and preservation of islet ß cells and their functions. Today, over 140 different studies worldwide have investigated anti—hyperglycemic and hypoglycemic effects of the different extracts and ingredients of M. charantia in both human and animal.

According to Kim and Kim, M. charantia extract suppressed the activation of mitogen— activated protein kinases (MAPKs) including stress—activated protein kinase/ cJun N— terminal kinase (SAPK/JNK), p38, and p44/42, and the activity of NFKB. The findings suggest that M. charantia protects pancreatic ßcells through down regulation of MAPKs and NFKB in MIN6N8 cells. A similar study suggest that M. charantia improves the serum and liver lipid profiles and serum glucose levels by modulating PPARY gene expression. According to Ragasa et al., clerosterol and were isolated as sterols from M. charantia having significant hypoglycemic effects . M. charantia was identified to possess a potent neuroprotective activity against global cerebral ischemia reperfusion induced neuronal injury and consequent neurological deficits in diabetic mice. Protein tyrosine phosphatase 1B (PTPIB), a negative regulator of insulin signaling, has served as a potential drug target for the treatment of type 2 diabetes.

M. charantia, its extracts and isolated components are believed to exert their hypoglycaemic effects via different physiological and biochemical processes. These include insulin secretagogue like effect, stimulation of skeletal muscle and peripheral cell glucose utilization, inhibition of intestinal glucose uptake, inhibition of adipocyte differentiation,

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suppression of key gluconeogenic enzymes, stimulation of key enzymes, HMP pathway and preservation of pancreatic islet cells and their functions.

5.2 Preservation of pancreatic (Beta cells and insulin secretion)

It was previously demonstrated by Jeewathayaparan et al. that oral administration of M. charantia could lead to the secretion of insulin from endocrine pancreatic.This observation was further confirmed by Ahmed et al. who investigated the effect of daily oral administration of M. charantia fruit juice and the distribution of ox, and b cells in the pancreas of STZ—induced diabetic rats using immunohistochemical methods. The feeding of alcoholic extract from M. charantia showed definite improvement in the islets of Langerhans1811.

Physiological experiments have also shown that M. charantia can stimulate insulin secretion from the endocrine pancreas and elicit glucose uptake in the liver1741. Current evidence therefore indicates that the recovery and subsequent increase in the number of insulin producing cells followed by the release of insulin may be part of the several pathways by which M. charantia exerts its hypoglycemic effects. In addition to the properties mentioned above, M. charantia and its extracts may possess cell like proliferation and growth like properties similar to that of insulin1821. Nevertheless, further experiment are required, at least at the molecular level, to determine the precise mechanisms whereby M. charantia can either repair damaged 13 cells or prevent their death.

5.3 M. charantia and glucose metabolism

Insulin plays a major biochemical role in stimulating the uptake of glucose by different cells of the body for the production of energy. Since M. charantia and its various extracts and components have been reported to exert hypoglycemic effects, and then it is important to understand whether M. charantia may have a direct effect in inducing a reduction in blood glucose leve. Previous studies have shown that both the aqueous and alcoholic extracts of the fruit of M. charantia can inhibit the activities of fructose 1, 6—diphosphatase and glucose—6—phosphatase and at the same time stimulating the action of glucose6— phosphatase dehydrogenase. It was previously reported that M. charantia and its various extracts can stimulate peripheral cell glucose uptake. A number of studies have investigated the effect of the powder and chloroform extract of M. charantia in comparison with insulin on glucose and amino acid uptakes by skeletal L6 myotubes and Na+ and K+ glucose uptakes by jejunum brush border membrane vesicles in both age matched control and STZ induced diabetic rats. The results show that either the lyophilized fruit juice or chloroform extract at 5—10 yg/mL can stimulate H—deoxyglucose and C—Me AIB (N—methyl- amino-isobutyric uptakes by L6 myotubes. These effects were similar in magnitude to the effects obtained with 100 nmol/L insulin. Incubation of either insulin or M. charantia juice in the presence of wortmannin (a phosphatidylinositol 3—kinase inhibitor) resulted in a marked inhibition of ^{3}H—deoxyglucose uptake by L—6 myotubes1711. Together, the results have clearly demonstrated that M. charantia contains insulin like properties, similar to one phytochemical component of M. charantia called v-insulin.

In addition to its insulin—like effects on skeletal muscle cells, daily oral intake of M. charantia fruit juice over a period of 10 weeks significantly reduced the amount of Na+ and K+—dependent C-D glucose absorbed by rat jejunum brush border membrane vesicle compared to vesicles obtained from STZ—induced diabetic rats. Taken together, these results clearly

demonstrated that M. charantia and its extracts can directly regulate blood glucose via two mechanisms. Firstly, it can regulate how much glucose is absorbed by the gut into the blood following a meal and secondly, it can stimulate glucose uptake into skeletal muscle cells just like insulin. Moreover, it seems to exert its effect via the same intracellular signaling pathways as insulin in regulating glucose metabolism in the body.

Evaluation of antidiabetic M charantia

VI. PROXIMATE ANALYSIS

The leaf of M. charantia is consumed as a vegetable in some parts of the world, this necessitate the investigation of the proximate composition of the leaves in comparis with the fruits and seeds of the plant. However, other analyses were carried out on the leaves due to its dual usage as vegetable and medicinal purposes. The proximate analysis was carried out according to the procedure of Association of Official Analytical Chemist (AOAC, 2000). The AOAC

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Official methods for analyzing the various parameters are as listed. Crude protein 955.04 (2.4.03), crude fibre 962.09 (4.6.01),
moisture 934.01 (4.1.03), ash 942.05 (4.1.10), crude fat 920.39 (4.5.01), and carbohydrate by difference. The calorific values of the samples were also estimated (Asibey-Berko and Tayie, 1999)

Sr.	Parameter	Leaf	Fruit	Seed
1	Total ash (dry wt)	15.42 ± 2.08b	7.36 ± 0.52a	9.73 ± 2.34a
2	Crude fat (DW)	3.68 ± 0.68a	6.11 ± 0.42b 1	11.50 ± 1.77c
3	Crude fibre (DW)	3.31 ± 1.25a	13.60 ± 1.13b	29.60 ± 1.25c
4	Crude protein (DW)	27.46 ± 1.60a	27.88 ± 3.75a	19.50 ± 0.73b
5	Carbohydrate (DW)	32.34 ± 0.24b	34.31 ± 0.30b	9.18 ± 0.86a
6	Caloric value kcal/100 g	213.26	241.66	176.61

Table 2. Mineral composition of M. charantia leaf

Results are mean of 3 determinations ± SEM. Means with same superscript down the row are not significant (P>0.05), DW = Dry weight.

Digestion of leaves of M. charantia and mineral analysis

The sample of the of M. charantia were washed with the deionised water to remove dust particles. The sample was dried and ground to fine powder. A weighed portion of the ground sample of leaves was placed in a pre-cleaned silica crucible and heated on flame for about 10 min to remove moisture and volatile matter. The crucible was heated in a muffle furnace at 600°C for about 4 h to convert the sample into ash. The ashed sample was dissolved in conc. HNO_3(12 mL). Then the total volume was made to 100 mL with distilled-deionised water. The content was then filtered, and the filtrate was used for the mineral analysis.

Standard solutions of the minerals (sodium, potassium, calcium, magnesium, manganese, iron, zinc and copper) to be analyzed were prepared. The atomic absorption spectrophotometer (Analyst 200, Perkin Elmer Inc., United State) was set with power on for 10 min to stabilize. The standard metal solutions were injected to calibrate the AAS using acetylene as the carrier gas. An aliquot of the mineral solution obtained from the plant digest was injected and the concentration was obtained from the AAS for each mineral element (Okunowo and Ogunkanmi, 2010). The experiments were done in triplicate and the results were averaged.

Sr.	Element	ppm
1	Calcium	20510.00 ± 5.77
2	Magnesium	255.00 ± 0.69
3	Sodium	2200.00 ± 1.15
4	Potassium	413.00 ± 1.45
5	Iron	98.00 ± 0.23
6	Zinc	120.00 ± 1.15
7	Manganese	156.00 ± 0.33
8	Copper	3 32.00 ± 1.85

Table no:3 Results are mean of 3 determinations ± SEM.

Vitamin composition

The vitamin composition of both the dried M. charantia leaves and the leaf extracts (aqueous, methanolic and pet-ether) were determined by chemical methods and high precision analytical method (HPLC), respectively. The concentrations of vitamins A,E,C,B12 in the dried leaves were determined by the procedures of association of

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official analytical chemist (AOAC, 2000) and the folic acid as described by Pearson (1985). While the vitamins present in the leaf extracts were analysed by high performance liquid chromatography (HPLC) (Upchurchill, 2007). The water soluble vitamins were analyzed using APS-1 Reverse Phase C18 (100 x 4.6 mm) and the fat soluble vitamins by Zorbax Eclipse XDB Reverse Phase C18 (150 x 4.6 mm) (Upchurchill, 2007).

Sr.	Vitamin	Ppm
1	A	0.03 ± 0.003
2	E	800.00 ±14.14
3	C	66000.00± 141042
4	B12	5355.00±7.10
5	*Folic acid*	*20600.00±42043*

Table 4. Vitamin content of Momordica charantia dried leaf.

Results are mean of 3 determinations ± SD.

Phytochemical screening :

The dried leaf sample (100 g) of M. charantia was extracted in 300 ml methanol using a Soxhlet apparatus as described by Akueshi etal. (2002). To obtain the aqueo us extract, M. charantia leaves were dried in an oven (SD 93114624, Gallenkamp, United Kingdom) at 40°C and milled to powder. This was extracted in boiling water for 30 min and filtered with a glass wool. The filtrate was concentrated in a lyophilizer. The dried powder was stored at 4°C (Akueshi et al.,2002; Oben et al., 2006). The petroleum ether extract was also obtained using Soxhlet apparatus (Mallikharjuna et al., 2007).

Phytochemical screening of the aqueous and methanolic extracts of M. charantia leaf was carried out. The phytochemical screening for the presence of alkaloids, tannins, flavonoids, saponins, and anthraquinones were carried out according to the methods ofSofowora (2006), Harbone (1991), Trease and Evans (2002) and Edeoga et al. (2005). Also, for glycosides (cyanogenic and cardiac), phylobatannins, reducing compounds, steroids and terpenoids, the methods of Sofowora (2006), Harbone (1991), and Trease and Evans (1996) were used

Sr.	Vitamin	Aq. extract	Methanolic extract	Pet ether extract
1	Vit B3	ND	0.08	ND
2	Vit B6	ND	98.38	ND
3	Vit C	115	ND	0.08
4	Vit E	ND	ND	ND
5	Vit A	ND	ND	11.25
6	Vit K	0.06	ND	5.00
7	Vit D	ND	ND	14.25

Table 5. Vitamin content (ppm) of M. charantia leaf extracts

ND – Not detected.

Statistical analysis

Results are presented as mean ± SEM and the difference between the data sets was analyzed using students T-test, with ($P<0.05$)considered significant.

VII. RESULTS

The result obtained in this study shows the proximate composition, vitamin content and the phytochemicals in M. charantia. The leaf and fruit contain considerable amount of carbohydrate. This was significantly ($P<0.05$) higher than the amount present in the seed (Table 1). The percentages of moisture, total ash, crude fat and crude fibre were also low in the seed. The most abundantmineral present in the leaf of M. charantia was calcium. This was significantly ($P<0.05$) greater than the amount of Bakare et al.sodium, potassium, manganese, zinc, magnesium, iron and copper present (Table 2).The dried leaves of M. charantia contain small amount of vitamin A, E,C,

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B_{12} and folic acid (Table 3). While trace amount of vitamin B3, B6, A, D and K were found present in the methanolic and pet-ether leaf extract of the plant (Table 4). Phytochemical screening of the aqueous and methanolic leaf extracts indicated the presence of alkaloids, tannins, saponins, cardiac glycosides and steroids (Table 5)

VIII. DISCUSSION

Nutrients are necessary for life and good health; these may be found in a number of different foods. The generalfunctions of nutrients include fuel (energy) expressed in kcal building materials for body structures and regulation and control of body processes. The proximate analysis shows that the leaf and fruit of M. charantia are good sources of carbohydrate and protein; these may serve as source of energy and nutrients for the body metabolic activities in addition to its medicinal properties. The carbohydrates and proteins present in the plant may be a conglomerate of bioactive sugars, glycoproteins or proteins which gives the plant its medicinal potency against certain diseases. Some plants are known to contain certain sugars which are biologically active against some diseases (Srivastava et al., 1989; Hokputsa et al., 2004). Also, some plant proteins such as trichosanthin (isolated from tubers of Trichosanthes kirilowii), -trichosanthin (isolated from tubers of Trichosanthes
- and -momorcharins (isolated from seeds of M. charantia), momorcochin (isolated from tubers of Momordica cochinchinensis), luffaculin (isolated from seeds of Luffa acutangula) and luffin-a and luffin-b (isolated from seeds of Luffa cylindrica) have been reported to exhibit abortifacient, antitumor, ribosome inactivating and immunomodulatory properties (Tsao et al., 1990; Ng et al., 1992). Trichosanthin manifests anti-human immunodeficiency virus activity (Ng et al., 1992). The total ash content of the plant materials are low indicating low total mineral elements in the plant materials. However, these values are comparable to values reported for some Nigerian leafy vegetable (Akindahunsi and Salawu, 2005). The elements such as calcium, magnesium, potassium, zinc, iron, manganese and sodium found in reasonable amount in the leaf are nutritionally and biochemically important for proper body function. For instance, calcium is known to play a significant role in muscle contraction, bone and teeth formation and blood clotting (Ahmed and Chaudhary, 2009; Heaney, 2009; Peters and Martini, 2010). Some of these minerals such as magnesium and zinc are needed as cofactor in enzyme catalysis in the body (Ahmed andChaudhary, 2009). Sodium and potassium which are present in the intracellular and extracellular fluid helps to 2192 J. Med. Plant. Res.maintain electrolyte balance and membrane fluidity (Ahmed and Chaudhary, 2009). Iron is known to be a component of some metalloenzymes, myoglobin and heamoglobin (Ahmed and Chaudhary, 2009), which is needed in the transport of oxygen and carbon dioxide during respiration or cellular metabolism. This heamoglobin (containing iron) also serve as buffer to regulate changes in blood pH (Kamshilov and Zaprudnova, 2009). It is known that inorganic mineral elements such as potassium, calcium and zinc play important roles in the maintenance of normal glucose-tolerance and in the release of insulin from beta cells of islets of Langerhans (Choudhary and Bandyopadhyan, 1999). Zinc present in the plant is beneficial to prevention and treatment of diarrhoeal episode, it is also involves in normal functioning of immune system. Iron is an essential trace element for haemoglobin formation and normal functioning of the central nervous system (Adeyeye and Otokiti, 1999). The crude fat content in M. charantia fruit and seed were higher than in the leaf and also higher than the value reported for Amaranthus hybridus (4.65%) (Akubugwo et al., 2007). The crude fat may add to the caloric value extractable from the plant for metabolic activities. The study also shows that the plant contain small amount of fiber, this could be beneficial when consumed. Dietary fibre is important for lowering blood cholesterol and blood sugar. It is known to reduce the risk of diseases such as obesity, diabetes, breast cancer, hypertension and gastrointestinal disorder (Saldanha,1995). vitamins A, B, C, D, B12 and folic acid were found present in the plant. Some of these vitamins such as vitamin B12 found majorly in animal sources function as part of coenzymes methylcobalamin and deoxyadenosylcobalamin used in new cell synthesis (Robert et al., 2003). It helps to maintain nerve cell function and the deficiency leads to pernicious anaemia (Robert et al., 2003). In addition to the antioxidant property of vitamin C and E, vitamin C strengthen the body immunity against infections, helps in collagen and thyroxin synthesis and enhance iron absorption (Robertet al., 2003) while vitamin E play a role in immune function, cell growth, reproduction and DNA repair (Robert et al., 2003; Stryer, 1995, Traber and Packer, 1995). Vitamin A is a component of the visual pigments in the retina; regulates gene expression and cell differentiation. It is an antioxidant. The deficiency may lead to night blindness, xerophthalmia; keratinization of skin (Robert et al., 2003; Stryer, 1995). Folic acid is ahematopoetic vitamin and when deficit in the body leads to anaemia (Robert et al., 2003; Stryer, 1995).

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 3, June 2024

Vitamins are a diverse group of organic molecules required in very small quantities in the diet for health, growth, and survival (Stenesh, 1975). The absence of a vitamin from the diet or an inadequate intake results in characteristic deficiency signs and, ultimately, death (Stenesh, 1975; Smith et al., 1997).

The presence of secondary metabolites such as alkaloids, saponins, tannins, glycosides and cardiac glycosides in the leaf M. charantia may contribute to its medicinal value. Some of these compounds are well documented to exhibit hypoglyceamic activity in animals (Akhtar et al., 1981; Singh, 1986; Ng et al., 1986). Saponins inhibit Na+ efflux leading to higher Na+ concentration in cells, thereby activating a Na+-Ca2+ antiport (Schneider and Wolfing, 2004). This effect produces elevated cytosolic Ca2+ which strengthens the contraction of the heart muscle and thereby reducing congestive heart failure (Schneider and Wolfing, 2004). The protective and metabolic role of alkaloids in animals has been documented (Edeoga and Eriata, 2001). The plant is used by the orthodox doctors in some parts of Nigeria to cure diarrhea, further work will therefore include the investigation of the anti-diarrhoeal effects of the leaf extract of plant in rats.

IX. APPLICATIONS

It is not a original research paper but a review so it can be just said that M. charantia plays a very promising role in controlling blood glucose and there by controlling the risk factor towards CVD.

M. charantia as a medicinal plant in controlling the blood sugar. As such a lot is known by common mass, that M. charantia is beneficial towards controlling diabetes but this review article unveiled so many intricate details of the plant and its applied aspects in medicine.

It is very important plant in case of all cardiac patients. It maintains blood sugar in the body as well as cardiac health of the person specially old peoples which are in the range of 40-60 years.

M. Charantia is also useful for the young generation who is suffering through the problem of obesity. It contains very low calories and it also helps to burn the body fat. It helps them to be in the proper shape.

M. charantia is used in daily food or diet, specially for children as well as teenagers because this fruit contains various multi-vitamins as well as nutrients which helps to boost their immunity and develop their physical and mental health.

X. CONCLUSION

M. charantia has been used as dietary supplements and ethnomedicine throughout centuries for relieving symptoms and conditions related to what we know in modern days as diabetes. To date, M. charantia has been extensively studied worldwide for its medicinal properties to treat a number of diseases1611. It is described as a versatile plant worthy of treating almost any disease inflicted on mankind. This may be due to the fact that the plant possesses over 225 different medicinal constituents. These different compounds may act either separately or together to exert their medicinal effects. In relation to diabetes, only charantin, insulin—like peptide and alkaloid—like extracts possess hypoglycemic properties similar to the plant itself or its crude extracts. These different compounds seem to exert their beneficial effects via several mechanisms to control and treat diabetes mellitus.

Despite the abundant data from biochemical and animal studies, available clinical data as reviewed in the present article are often flawed by small sample size, lack of control and poor study designs. The present review supports the need for better—designed clinical trials with sufficient sample size and statistical power to further indicate the acclaimed efficacy of M. charantia as a natural nutritional treatment for diabetes mellitus. In particular, M. charantia may be a feasible option for ethnic minorities who have a high prevalence of diabetes but prefer treatment based on natural products according to their cultural beliefs.

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IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 3, June 2024

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IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 3, June 2024

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