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(REVIEW ARTICLE)

Momordica charantia: A natural medicinal plant

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Abstract

Natural products play an important role in the treatment of several diseases inflicted on mankind and in drug discovery procedures. Drugs synthesized from naturally available products are usually safe, cheap in cost, easily available and more effective than pure synthetic drugs in the treatment of several diseases. Bitter melon containing numerous bioactive compounds like saponins, alkaloids, polypeptides, minerals, vitamins, with the ability to fight against several disorders, i.e. diabetes mellitus, abdominal pain, tumor proliferation, cancer, kidney (stone), scabies and fever. The key constituent of BM called charantin, which is steroidal saponins, act like peptides and certain alkaloids that control sugar levels in blood. The medicinal properties of *M.charantia* are beneficial in regulating blood cholesterol to minimise cardiovascular disorders like atherosclerosis. There are several classes of secondary metabolites, such as tannins, flavonoids, and alkaloids in the fresh and dried leaves extracts of Bitter melon with antimicrobial activity. This phytochemical composition of both the leaves reported antimicrobial activity against different bacteria, like *Salmonella, E. coli, Pseudomonas aeruginosa, Bacillus and Streptococcus.*

Keywords: *Momordica charantia*, bitter melon, antidiabetic, wound healing, antimicrobial, anticancer …

1. Introduction

Momordica charantia is commonly known as Bitter melon, bitter guard and used as a food and natural medicine. The scientific name, Momordica means "to bite," in Latin which is refers to the jagged edges of the leaves. Including fruits, all parts of the plant, contains a bitter compound, momordicinso and very bitter in taste. The plant grows in tropical regions such as India, China, America Malaya, Bangladesh, tropical Africa, Thailand, Middle East. *Momordica charantia* contains a different biologically active phytochemicals, which includes proteins, triterpens, saponins, flavonoids, steroids, alkaloids, and acids. The plant is beneficial for its anti-tumorous, anti-fungal, anti-parasitic, anti-cancer, anti-viral, anti-fertility, anti-bacterial and hypoglycaemic properties due to the presence of numerous phytochemicals. In traditional medication, fruits and leaves are used to cure several diseases like: gout, rheumatism, colic, worms, illness of liver and spleen. Momordica contains alkaloids and peptides which resemble like insulin and charantin, a collection of steroidal sapogenins due to which it has hypoglycaemic property.

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Figure 1 *Momordica* plant with fruits and flowers

2. Botanical Information

Momordica is slender, climbing monoecious plant with yellow coloured separate male and female flowers, arises in the leaf axils and long-stalked leaves, belongs to family Cucurbitaceae. Leaves are simple/alternate of 4–10 cm with 3–6 deeply separate lobes, tendrils unbranched or 2 branched. Fruit is in ovoidal shape, like small cucumber, ellipsoidal, or spindle in shape, filled with flat seeds in pulp and usually with ridged surface, and dehiscent irregularly as a fleshy capsule or indehiscent. The fruits in young stage are in green colour and changes to orange to yellow colour when ripened. The fruit splits into three irregular valves and curls backwards to release numerous reddish-brown or white seeds which are enveloped in scarlet arils. In unripen fruits seeds and pith are in white colour, and red in ripening fruits.

Flowers: Flowers are solitary with hypanthium shallow, 5 lobed calyx, 5 petals, yellow in colour, 1-3 with incurved scales at base, usually 3 stamens inserted towards the base of hypanthium, broad filaments, anthers are distinct or coherent, and of which 2, are dithecal, the other monothecal, cells curved or flexuous; pistillate flowers usually solitary on a bracteate scape. Hypanthium is ovoidal to spindle in shape, perianth usually smaller than in staminate flowers, ovules numerous, horizontal, stigmas 3, 2 lobed, staminodes absent or 3. Seeds are few to numerous, ovate and usually sculptured.

3. Active Constituents

Bitter melon is an edible vegetable and natural medicinal plant with 91.8% water, 1.4% fiber, 0.20% fat, 4.2% carbohydrates. The proteins composition is, 49.3% albumin, globulin 29.3, and glutelin 3.1% [1]. The seeds contain 3.3% of MUFA (monounsaturated fatty acid) and 36.71% of SFA (saturated fatty acids) which is indicated by fatty acid profile and 35% to 40% of oil from seeds. Bitter guard contains maximum amount (60%) of PUFA (polyunsaturated fatty acids). Main constituents of fruits are Charantin, momordicoside L, momordin, stigmasta-5, momordicin, 25-dien3-β-O-glucoside, momordicoside G, β-sitosterol-β-D-glucoside,momordicoside F1, momordicoside F2, momordicoside I, momordicoside K, [3]; A conjugated linolenic acid, α-eleostearic acid (54%) has remarkable importance in PUFA[4,5]. BM contains minerals like potassium, sodium, calcium, phosphorous and magnesium, in maximum amounts in fruit and leaves. Seeds are naturally the best sources of chromium i.e. 5.65 and zinc 45.45 mg/100g.

A variety of compounds are present in Momordica, which are biologically active and that includes two classes of saponins, oleanane and cucurbitane-type triterpenoids [6]. Nearly 20 – 25 phytochemical constituents which exhibit 91% of the oil administered. Main components present in the oil are trans-nerolidol apiole, germacrene, and cis-dihydrocarveol [7,8]. Alphaeleostearic acid with strong blood fat lowering properties, is abundant in oil, anticancer by suppressing the multiplication of tumour cell and anti-inflammatory in action. Minerals particularly Cr and Zn with strong effect on polysaccharides or proteins, and form an anticipation of hyperglycaemia, cholesterol, and hyperlipidaemia [9]. Leaves, fruits and seeds are rich in variety of phytochemicals like steroidal saponins resins, vitamins, polypeptides, minerals, alkaloids, and aromatic volatile oil which are health promoting. Charantin as steroidal saponin, momordicine alkaloid, and p-insulin which is polypeptides in nature, are standard constituents [10]. Fruit pulp

of bitter melon contains soluble pectin and no free pectic acid. BM comprises charantin, steroidal saponin glucosides, mineral matters, alkaloids, ascorbic acid, carbohydrates and momordium etc. Phenolic components, epicatechin, catechin, gentisic acid, chlorogenic acid and gallic acid are present in Momordica extract [11].

4. Medicinal Uses of *Momordica charantia*

In *Momordica*, nutrients like betacarotene, foliate, thiamine, riboflavin and minerals like potassium, calcium, manganese, magnesium, zinc iron, phosphorus, and dietary fiber are abundant. The high antioxidant properties of Momordica is due to phenols, anthroquinones, flavonoids, terpenes, isoflavones, and glucosinolates, all together are responsible for bitter taste [12]. Regular use of bitter gourd juice prevents chronic fatigue by increasing body stamina and the beta-carotene content reduces eye disorders and enhances eyesight.

- Bitter melon promotes secretion of acid and treats dyspepsia by stimulating digestive system [13].
- Bitter melon juice keeps insulin under check and lower blood sugar levels. The phytochemicals charantin, alkaloids and insulin-like peptides, all together responsible for hypoglycaemic property of bitter guard and enhances glucose tolerance without increasing blood insulin levels. These bioactive constituents activate AMPK protein, regulate fuel metabolism and facilitates glucose uptake and all other activities impaired due to diabetics. Bitter melon increases the beta cell number in the pancreas that secretes insulin. Numerous studies have reported the anticancer, anti-inflammatory and anti-diabetic properties of bitter gourd, and several pharmaceutical companies included them in their formulations [14].
- Bitter gourd juice strengthen liver and prevent jaundice. Bitter melon juice detoxifies and nourishes liver and helpful in the hangover treatment [15].
- Hypothetically bitter melon is an immune modulator, can enhance immune cell function in cancer patient. It is also used in the treatment for malaria, cold and flu, fever, tumors, high cholesterol, psoriasis and cancer [16].
- Fresh juice of bitter guard leaves was an effective medicine for diarrhoea and used in early stages of cholera.

4.1. Antidiabetic Activity

Momordica charantia contains phytochemicals like, charantin, polypeptide-p, the plant insulin, vicine, karavilosides and glycosides. These compounds increase glucose uptake and synthesis of glycogen in the liver, muscles and fat cells by which regulates blood sugar and act as hypoglycaemic agents [17]. Fruits and seeds, has a polypeptide, TP-Insulin is which lowers and normalizes the blood sugar level in treated rats. Lectin with insulin like activity is a bioactive compound present in bitter melon. It links the two insulin receptors together and acts like insulin. Lectin act with insulin like activity, on peripheral tissues and lowers blood glucose concentrations. Lectin plays important role in hypoglycaemic effect which generates after consuming bitter guard. Alcoholic extract of charantin, composed of mixed steroids, is a potent hypoglycaemic agent which is used to lower the sugar levels in blood and in the diabetic treatment. The bitter melon fruit increases the glucose uptake of cells by promoting insulin release to enhance the insulin effect. In diabetic rats, extract of fresh and dried fruit lowered the blood sugar. In alloxan-induced diabetic rats, bitter gourd extracts have hypoglycaemic, anti-diabetic, hypolipidemic and hepato-renal protective effects. Bitter melon regulates microvascular dysfunction, a common diabetic complication by reducing capillary permeability at arteriolar and capillary level. One of the hypoglycaemic compounds, charantin, belongs to steroidal saponins consisting of a mixture of (1:1) sitosteryl glucoside and stigmasteryl glucoside, Charantin produces hypoglycaemic effects in rabbits when administered orally or intravenously [18]. P- insulin is a polypeptide consists of 166 amino acids with molecular weight of about 11,000 Da is another hypoglycaemic agent of bitter guard. Clinical studies revealed that blood sugar lowering effect is produced by polypeptide-pZnCl2. Pyrimidine nucleoside, vicine present in seeds and fruits, can induce hypoglycaemia in rats, when treated intraperitonially. In type-2 diabetic patients, Momordica extracts rich in charantin increases insulin-sensitivity [19].

4.2. Anti-Microbial Activity

The chemical composition of fresh leaf extracts *M. charantia* has various secondary metabolites with different therapeutic applications.The secondary metabolites like, tannins (antiviral, antimicrobial, antitumoral and moluscicidal); flavonoids (anticarcinogenic, antioxidant antiviral, and antihemorrhagic). BM leaves with antibacterial action against *Escherichia coli, Pseudomonas aeruginosa, Salmonella, Streptococcus, Bacillus* [20]. Different extractions of fresh leaves were effective against different strains of Escherichia coli, S. aureus, B. cereus. Many secondary metabolites of various classes occur in both the fresh and dried leaves extracts, i.e. tannins, alkaloids and flavonoids, with many biological actions, including antimicrobial. The seed extracts of bitter melon possess antimicrobial activity and controls growth and infection of several viruses and gram- positive and gram- negative bacteria, including *Shigella, Staphylococcus, Pseudomonas, Salmonella, H. pylori Escherichia coli, Streptococcus, Streptobacillus*, and parasitic

organisms *Plasmodium falciparum & Entamoeba histolytica*. The bioactive molecules of bitter melon are potential candidates as chemotherapeutics against leishmaniasis [21].

4.3. Anti-Malarial Activity

Momordica charantia is a natural medicinal plant for preventing against and used in treatment of malaria. Bitter guard is traditionally regarded as anti-malarial by Asians, Colombians and Panamanians. Tea prepared with leaves boiled in water used in malaria treatment. Laboratory studies also confirmed the antimalarial activity of various species of Momordica [22].

4.4. Antioxidant Activity

Antioxidants are substances which can reduce or prevent the damage to cells caused by free radicals. The ethanolic extracts of bitter melon contain high antioxidant activities. like phenolic compounds [23,24]. Bitter guard increases the catalase activity and reduce the glutathione level by which inhibits stress-induced lipid peroxidation. The phenolic compounds extracted from bitter melon have antioxidant activity. *Momordica charantia* seeds having antioxidant properties effectively normalize the impaired antioxidant status in diabetic rats induced with Streptozotocin [25].

4.5. Anti-Tumor Properties

Bitter gourd is anti-carcinogenic and prevents tumor cell proliferation. BM contains anti-carcinogens or chemo preventive agent. Water extract of bitter guard can block the prostate carcinoma growth in rat model study. Hot water extract of entire plant in mice inhibited tumor cell development in mammary glands. Various in vitro studies in numerous cell lines reported the anti-leukemic and anti-cancerous activity of bitter melon including human leukaemia, liver cancer or hepatic carcinoma, solid sarcomas, melanoma [26,27]. Bitter gourd is an effective immunomodulator, improves immune cell function in cancer patients. Fruit and seed extracts of bitter melon inhibit the proliferation of numerous cancer cell lines, including human colon cancer, prostate adenocarcinoma, and metastatic breast cancer cell line MDAMB 23140-41 in In vitro studies.

4.6. Hypo-cholesterolemic activity

Momordica charantia has hypo-cholesterolemic effects when studied in normal and diabetic animals. Octadecatrienoic fatty acid isolated from *Momordica charantia* seeds fed to rats which were fed with sunflower for 4 weeks. After 4 weeks, these rats showed lowering of the plasma lipid peroxidation and erythrocyte membrane lipid peroxidation as well as nonenzymatic liver tissue lipid peroxidation. The levels of triglyceride and cholesterol were normalized after treating with bitter gourd fruit and/or seeds for about 21 days in diabetic rats. The bitter gourd oil (BGO) has its effects on the blood and liver lipids of rats [28].

4.7. Anti-Viral Properties

In-vitro studies on anti-viral activity of Bitter gourd have reported against numerous viruses, including Epstein-Barr, herpes and HIV viruses [29]. The leaf extract of Bitter melon has immunostimulant effect in animals, increase natural killer cell activity interferon production and increases resistance to viral infections. The anti-viral constituents of bitter gourd are of protein or glycoprotein in nature. Bitter gourd may not reduce the multiplication of virus in people infected HIV due to the poor absorption by oral administration. However oral administration of Momordica offset the negative effects of anti-HIV drugs. Various leaf extracts of Bitter guard have anti-bacterial activities against *Pseudomonas, Escherichia coli, Staphylococcus, Streptobacillus, Streptococcus and Salmonella*. Antiprotozoal activity against *Entamoeba histolytica* can be seen in entire plant extract [31]. The fruit and fruit juice have antibacterial properties and activity against *Helicobacter pylori*, the stomach ulcer-causing bacteria.

4.8. Larvicidal Activity

The Phytochemicals present in bitter guard has larvicidal potential. Numerous studies had been conducted against two mosquito vectors such as C. quinquefasciatus and Anopheles stephens [32]

4.9. Anti-genotoxic activity

Momordica charantia has antigenotoxic activity decreases chromosome breakage by decreasing genotoxic effects of methanesulfonate tetracycline and methylnitrosamine [33].

4.10. Anti-helmintic activity

Extracts of *M. charantia* leaf, fruit, and seeds found to be pharmacologically active against helminths. The treatment of Ascaridia galli than piperazine is more effective with aqueous extracts of Momordica. Saponins are anthelmintic agents and inhibit the enzyme acetylcholinesterase activity, hence the worm paralysis, and lead to death.

4.11. Wound healing activity

Fruit powder ointment of *Momordica charantia* is more effective in wound contracting, wound closure time, epithelisation period, tensile strength of the wound and tissue regeneration at wound site when compared to the control group, and also comparable with a reference drug povidone iodine ointment in rat model [34].

Bitter melon has high capacity for wound healing property. Charnatin and other phytochemicals present in the bitter melon stimulates the production of growth factors, induces the proliferation of fibroblasts, and accelerates the oxygenation and capillary circulation of the wound. The antioxidant and antimicrobial effects of phytochemical substances such as flavonoids and glycosides increase the process of healing. Momordica effects the rate of wound healing positively, increases the wound to contract, reduces the time for the wound to close, accelerates the epithelisation process, and the tension of the wound.

5. Conclusion

M. charantia is naturally available dietary supplements and used as ethnomedicine throughout centuries for different health issues like diabetes, cancer, inflammation etc. *M. charantia* studied worldwide for its natural medicinal properties like antidiabetic, anticancer, antimicrobial, antimalarial, antioxidant etc. Bitter guard is a versatile plant with medicinal properties to treat almost many diseases. The plant possesses various medicinal constituents, which act all together or separately to exert their medicinal properties. The phytochemicals i.e. charantin, insulin-like peptide and alkaloid-like extracts possess hypoglycaemic properties in relation to diabetes, similar to the plant itself or its crude extracts. The different compounds present in different plant extracts are beneficial in regulating several mechanisms to control and treat diabetes mellitus. *M. charantia* is a naturally available and feasible option for those who have a higher chance of diabetes.

Compliance with ethical standards

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Disclosure of conflict of interest

The author states no conflict of interest.

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