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REVIEW ON *MOMORDICA CHARANTIA* LINN.

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ABSTRACT

Momordica charantia Linn., is also known as bitter gourd and bitter melon belonging to Cucurbitaceae family. This plant cultivated throughout the India as vegetable crop and used in folk medicine. Plant has a important role as source of carbohydrates, fats, proteins, minerals, vitamins and the leaves are nutritious source of calcium, magnesium, potassium, phosphorus and iron. The fruits and leaves of this plant contain a variety of biologically active compounds such as alkaloids, glycosides, saponin, flavonoids, phenolic compounds and tannins. In traditional medicine, it used as antidiabetic, anticancer, anthelmintic, antimalarial, analgesic, antipyretic, antifertility and antimicrobial. This article aims to provide a comprehensive review on pharmacological aspects of *Momordica charantia*.

KEYWORDS: *Momordica charantia*, bitter gourd, vitamins, flavonoids, antidiabetic, antimalarial.

INTRODUCTION[4,6,19,24]

The plant *Momordica charantia* L., family Cucurbitaceae, is also known as bitter gourd, bitter melon, balsam pear, bitter cucumber and African cucumber. The word *Momordica* is derived form the Latin word *Mordeo* which means to bite and the species name is derived from Greek word and it means beautiful flower. This is a monoecious climber found throughout India upto an altidude of 1500 m. The plant is cultivated in India as vegetable crop, it also grown as ornamental and is used extensively in folk medicine. Two types are commonly found, “Jethua” which comes in a hot summer, and “Barmasiya” which bears fruits throughout the year. *Momordica charantia*, known in India as karela is used in the form

of extracts and health drinks as an antidiabetic agent. It also contains a variety of active ingredients, and the active components in anticancer mechanism mainly includes antibacterial, reduction of blood sugar, reduced fat, resistance mutations, anti-oxidation, cancer cell proliferation, metastasis and the role of inducing cancer cell apoptosis.

TAXONOMY

Kingdom : Plantae
Subkingdom : Viridiplantae
Division : Tracheophyta
Subdivision : Spermatophytina
Class : Mangnoliopsida
Suborder : Rosanae
Order : Cucurbitales
Family : Cucurbitaceae
Genus : Momordica
Species : Momordica charantia L.

HABITAT[4]

This climbing plant is cultivated in gardens everywhere in India for its fruit. It is the major weed in tropical pastures and vegetable crops. It also occurs as a ruderal in disturbed, uncultivated habitats such as roadsides, gardens, fencelines and around houses and farm buildings.

VARIETIES[4]

There are two varieties, one which a small roundish or ovoid fruit (uchche) and the other longer and more cucumber-like (Kerula in Bengali).

DESCRIPTION[3,4]

The plant have a slender, pubescent stem and suborticular, 5-7 lobed, subglabrous leaves. Stems are slender and pubescent. Flowers are yellow coloured and solitary. Fruits are green and whitish, 5.0 to 25.0 cm long, oblong, fusiform, pendulous, beaked or pointed and ribbed with numerous triangular tubercules, 3 valved at the apex when mature, surface rough. Seeds are yellowish-brown, 13-16 mm long and compressed.

PHYTOCHEMICAL PROPERTIES

Momordica charantia primary metabolite are common sugars, proteins and chlorophyll while secondary metabolites are alkaloids, flavonoids, tannins. Phenolic compounds, flavonoids are one of the widespread groups also acting as chemotaxonomic markers. Bitter gourd has important role as a source of carbohydrates, fats, proteins, minerals, vitamins such as ascorbic acid, thiamine, riboflavin and nicotinic acid.[24] Seeds yield about 26.5% of reddish brown semidrying oil.[4] *Momordica charantia* fruits and leaves contain charantin, a steroidal saponin, sitosterol which shows blood sugar lowering activity. Karela fruits also contain a cathartic principle called momordicin. The drug also contains carbohydrates (10%), mineral matter (1.5%), and ascorbic acid (88-188 mg/100gm). The fruit pulp has soluble pectin but no free pectic acid. Research has found that the leaves are nutritious source of calcium, magnesium, potassium, phosphorus and iron. Both edible fruit and leaves are great source of the B vitamins. The protein content, higher concentration of calcium and copper was reported in bitter gourd.

Momordica charantia contains number of tetracyclic and pentacyclic triterpenoids glycosides.[57] The tetracyclic triterpene glycosides are named as Momordicosides A, B, C, D, E, F, G, I, K and L. The pentacyclic triterpene glycosides are oleanolic acid derivatives named as Momordicine I, II and III. It also contains tetracyclic triterpenes glycosides momordica saponin I and II. Momordicine I and II isolated form the leaves of *M.charantia* and characterized as 3β,7β,23ξ-trihydroxy-cucurbita-5,24-dien-19-al and its 23-O-β-glycopyranoside respectively; Momordicine III isolated as its acetate and characterized as 23-O-β-glycopyranoside of 3β,7β,23ξ-trihydroxy-24-oxocucurbita-5,25-dien-19-al.[1,4]

Goyaglycosides A,B,C,D,E,F,G and H, Goyasaponins A,C,F,I and K are cucurbitance type compounds which isolated from methanolic extract of fruits of *Momordica charantia.* Cucurbitane type triterpenoids such as β-19-epoxy-3β,25-dihydroxycucurbita-6,23(E) diene, 3β,7β,25-dihydrocucurbita-6,23(E)-dien-19-al which are isolated from methanolic extract of dried gourds of *Momordica charantia.* New cucurbitane type triterpenoids such as Cucurbita-5,23(E)-diene-3β,7β,25-triol, 3β-acetoxy-7β-methoxycucurbita-5-23(E)-dien-25-ol, cucurbita -5(10),6,23(E)-triene-3β,25-diol, Cucurbita-5,24-diene-3,7,23-trione and those compounds are isolated from methanolic extract of stems of *Momordica charantia*.

PHARMACOLOGICAL PROPERTIES

Antidiabetic

The alcoholic extract of karela pulp demonstrates a significant hypoglycemic activity in various experimental models of diabetes. The extract also increases the rate of glycogen synthesis from 14C-glucose by 4-5 folds in the liver of experimental animals. Momordica's antidiabetic activity could be partly attributed to increased glucose utilization in the liver rather than an insulin secretion effect. The new cucurbitane-type triterpenoids have potential for prevention and management of diabetes by improving insulin sensitivity and glucose homeostasis. Four compounds (C1-C4) isolated from the ethanol extract of M. charantia enhance glucose uptake. The most potent, compound 2 (C2), significantly increases the activation of insulin receptor substrate-1 (IRS-1). These effects appear to be mediated by the IRS-1 signaling pathway in skeletal muscle, not in adipose and liver tissues, suggesting that C2 improves hyperglycemia by increasing glucose uptake into skeletal muscle[7].

The polar molecules of M. charantia also depolarize the L-cell through elevation of intracellular Ca2+ concentration and which in turn releases GLP-1. GLP-1 in turn elevates beta-cell proliferation and insulin secretion. The findings tend to provide a possible explanation for the hypoglycemic action of M. charantia fruit extracts as alternative nutritional therapy in the management and treatment of diabetes.[9] 21 cucurbitane-type triterpenoids are isolated from the extract of M. Charantia L. Three anti diabetes target assays of all triterpenoids were carried out, with all compounds exhibiting aglucosidase inhibitory activity. Particularly, compounds 6, 9 and 11 exhibited excellent alpha-glucosidase inhibitory activity[12]. *Momordica charantia* administration can improve insulin secretion and insulin sensitivity in patients with Type2 diabetis melitus, without pharmacological treatment. *M. charantia* administration reduced A1C, 2-h glucose, glucose AUC, weight, BMI, fat percentage, and WC, with an increment of insulin AUC, first phase and total insulin secretion.[25]

Various compounds have been shown to be responsible for this reputed activity, and, in particular, cucurbitane triterpenoids are thought to play a significant role.[27] The different fractions of *Momordica charantia* to the alloxan-induced diabetic rats resulted in the significant elevation of liver glycogen content which was decreased by 50.60% in diabetic control. The various fractions (Petroleum ether, ethyl acetate and chloroform) of the methanolic extract of *Momordica charantia* have favorable effect on enhancing glycogenesis

activity by increasing the cellular uptake of glucose and also improving glucose tolerance activity.[40]

Anticancer

Importantly, gene ontology and pathway analyses revealed an elevated expression of IL23a, IL1 beta, and PDCD1/PD1 of immune system during oral cancer development, which was significantly suppressed by bitter melon extracts. This extract demonstrates the potential clinical benefits on preventing and delaying the progression of oral dysplasia to SCC.[8]

Guo et al., investigated the effects of charantins A on cell growth inhibition compared with charantins B, momordicin I and azadirachtin A. Among them, charantins A showed the most potent activity against SpLi-221 cells with the lowest IC50 values, and in a time- and dose-dependent manner. The cell membrane disruption and increase of intracellular calcium levels were observed following charantin A treatment.[11]

Agrawal R.C et al., studied the tumour incidence, tumour yield, tumour burden and cumulative number of papillomas in leaves and fruits extract of bitter melon, and they were found to be higher in the controls (without either extract) as compared to the extracts treated experimental groups. In a melanoma model, the mice which received fruit and leaf extracts of Momordica at the doses of 500 and 1000 mg/kg body weight for 30 days showed increase in life span of animals and tumour volume was significantly reduced as compared to control values.[43]

Ganguly, C. et al., found the oral administration of the fruit extract have an adverse effect on the general health and lifespan of the animals when used at a high concentration. But when this dose was reduced by half, the test extract afforded protection from the development of skin tumour and increased life expectancy. Carcinogen-induced lipid peroxidation in liver and DNA damage in lymphocytes were found to be reduced by treatment with Momordica. The fruit extract was found to significantly activate the liver enzymes glutathione-S-transferase, glutathione peroxidase and catalase ($P < 0.001$), which showed a depression following exposure to the carcinogen. The results suggest a preventive role of water-soluble constituents of M. charantia fruit during carcinogenesis, which is mediated possibly by their modulatory effect on enzymes of the biotransformation and detoxification system of the host.[54]

Antifertility

Momordica charantia seed extracts caused infertility in male rats. The interruption in their fertility was probably attributed to the direct toxic to seminiferous tubules, epididymis and the lowered testosterone level which might impact on sperm parameters. The extracts demonstrated significant reductions in diameters of seminiferous tubules and epididymides, spermatid density, daily sperm production and caudal epididymal spermatozoa, sperm motility and viability. Pathological changes in seminiferous tubules revealed atrophy, desquamation, pyknosis nucleus and multinucleated giant cell. Plasma cells were evident in three parts of epididymides of rats treated with high dose of the extract. Furthermore, the high dose of the extract suppressed seminal testosterone level and plasma testosterone level.[27] *Momordica charantia* seed extract shows a dose dependent decrease in the mean testicular volume and weight, seminiferous tubular diameter and cross sectional area.

Udoh P. et al. investigated the effect of *Momordica charantia* fruit extract on the gonads and sex accessory glands of male guinea pigs. During the study, they observe the reduction in number of Leydig cell and increase in epithelial cell height. The prostate glands showed shrinkage of the villi and reduction of secretion. M. charantia extract at 2.6 mg/kg inhibit seminal vesicles secretion, whereas at 1.3 mg/kg, antisecretory effect was less pronounced.[53]

Antimicrobial

The *Momordica charantia* L. shows strong antimicrobial potential, with bactericidal and fungicidal profile, there is the prospect to constitute a new therapeutic strategy for the control of infections, particularly in multiresistant strains[20]. *Momordica charantia* fruits have antimicrobial activity against Aspergilus niger. Oil and seeds have antimicrobial activity against Aspergilus niger and Escheichia Coli[21]. Silver nanoparticles (AgNPs) was prepared through green route with the aid of *Momordica charantia* leaf extract as both reductant and stabilizer. AgNPs shows effective antimicrobial activity against pathogens and thus applicable as potent antimicrobial agent.[23] The ethanolic extract of *Momordica charantia* L. used as a source of plant-derived natural products with resistance modifying activity[47]. The essential oil obtained from the seeds of *Momordica charantia* and which is test for its antibacterial and antifungal activities.[14,48]

Antifungal

The alpha- *Momordica charantia* seed proteins and ribosome-inactivating proteins,which are not good for patients, are of great significance used as antifungal agents[16]. An antifungal

protein, designated MCha-Pr, was isolated from the intercellular fluid of bitter gourd leaves during a screen for potent antimicrobial proteins from plants. MCha-Pr had inhibitory effects towards a variety of fungal species and the 50% inhibition of fungal growth (IC50) for *Altemaria brassicae, Cercospora personata, Fusarium oxysporum, Mucor sp.,* and *Rhizoctonia solani*. In addition, this antifungal protein can inhibit the germination of A. brassicae spores at 12.5 mu M. These results suggest that MCha-Pr in bitter gourd leaves plays a protective role against phytopathogens and has a wide antimicrobial spectrum.[22]

Momordica charantia seed extract containing alpha-momorcharin, a typical ribosome-inactivating protein, could be an effective agent in the control of fungal pathogens, and such natural products would represent a sustainable alternative to the use of synthetic fungicides.[38] The plant lysozyme exerted an antifungal action toward Mucorracem osus and Rhizoctonia solani, in addition to an antibacterial action against Escherichia coli and Staphylococcus aureus.[39] The recombinant napin-like protein (rMcnapin) of *Momordica charantia* exhibits antifungal activity against *Trichoderma viride* with an IC50 of similar to 3.7 mu g/ml and trypsin inhibitor activity with an IC50 of 4.2 mu M.[17,50]

Analgesic and anti-inflammatory

The Methanolic extract of *Momordica charantia* (Mc-ME) exerts its anti-inflammatory activity by reducing the action of transforming growth factor beta-activated kinase 1 (TAK1), which also affects the activation of NF-kappa B and AP-1. This extract blocks NO production in a dose-dependent manner. It also decreases the mRNA expression levels of inducible NO synthase (iNOS) and cyclooxygenase (COX)-2. It also decreases the levels of p65 [a nuclear factor (NF)-kappa B subunit] and c-Fos [an activator protein (AP)-1 subunit] which is indicate by Luciferase assays and nuclear lysate immunoblotting analyses.[10]

The oral administration of *Momordica charantia* fruit extract significantly inhibits acetic acid induced writhing and tail-immersion test induced pain at dose 500 mg/kg. The extract also produce a moderate anti-inflammatory activity. The ethanolic extract showed 42.10% anti-inflammatory effect at dose 500 mg/kg.[35,42] The methonolic extract of the seeds of *Momordica charantia* exhibits a dose related analgesic activity.[56]

Antimalarial

Momordica charantia is popularly used in herbal medicine to cure malaria. Phytochemicals such as terpenoids from the leave extract of *Momordica charantia* which involve in the

antiprotozal and antiplasmodial potential. Flavonoids exhibits antiparasitic potentials against different strains of malaria.[55]

Hypolipidemic

Momordica charantia fruit extract exhibits hypolipidemic activity. Total cholesterol and triglycerides levels are significantly decreased and HDL level is increased in patients who are all taken the treatment with fruit extract of *Momordica charantia.*[33]

Kolawole.O.T and Ayankunle.A.A investigated the seasonal variation in hypolipidemic effect of *Momordica charantia* fruit extract in rats. They concluded that the highest hypolipidemic activity was observed with methanolic extract of spring sample and followed by summer sample. Autumn and winter samples have more or less similar effects but lesser effects than summer sample.[36]

Hossain. M.S, et al., studied the hypolipidemic effect of different fractions of methanolic extract of *Momordica charantia* (Linn.). The different fractions (Petroleum ether, Ethyl acetate and Chloroform) exhibits corrections of altered biochemical parameters and that indicates the plant have favorable effect in hypolipidemic activity.[37]

Oral administration of seed extract of *Momordica charantia* results in a significant reduction in the cholesterol level, phospholipids, triglycerides and free fatty acids in plasma and this confirms the hypolipidemic effect of *Momordica charantia*.[49]

Senanyake.G.V.K, et al., studied the effect of three different varieties (Koimidori, Powerful-Reishi, Hyakunari) of bitter melon. In that Koimidori variety is the most effective in lowering hepatic triglyceride levels as compared to the other two varieties[52]

Hepatoprotective effect

The aqueous extract of *Momordica charantia* significantly restore the liver weight to near normal in CCl_4 induced liver damaged rats. Also treatment with the extract cause a significant increase in Heamoglobin and Packed Cell Volume, decrease in the activities of Alanine Transaminase (ALT), Aspartate Transaminase (AST), Alkaline Phosphatase (ALP) and level of total bilirubin.[28] The aqueous extract of leaves and fruit juice of *Momordica charantia* shows significant hepatoprotective activity.[28,32,34]

Pereira.B.S, et al., evaluated the hepatoprotective activity of Hexane and Ethanol extracts

from *Momordica charantia* leaves on the acute liver injury model induced by ethanol. Both extracts reduced the activity of hepatic enzymes. Hexane extract had a more relevant effect, characterizing hepatoprotective potential.[41]

Wound healing activity

Olive oil macerate of *Momordica charantia* and seed extracts shows significant wound healing activity both in incision and excision wound models.[29,31] *Momordica charanatia* ointment has a promising potential for use as an alternative topical medication for diabetic wounds. Transforming growth factor beta (TGF-beta) plays an important role in wound healing. Delayed wound healing is a consequence of diabetes. Wound healing is determined by the rate of wound closure, total protein content and TGF-beta expression in the wounds and histological histological observation. The wound closure rate in the *Momordica charanatia* ointment is significantly faster than the untreated groups. The *Momordica charanatia* ointment group also shows intense TGF-beta expression and a high level of total protein content.[30,49]

Larvicidal

Gandhi.P, et al., evaluated the larvicidal, acaricidal and pediculicidal effect of synthesized zinc oxide nanoparticles (ZnO NPs) using *Momordica charantia* leaf extract against the larvae of *Rhipicephalus microplus*, adult of Pediculus humanus capitis, and the larvae of *Anopheles stephensi, Culex quinquefasciatus*. Biosynthesized ZnO NPs showed higher toxicity against the larvaes than the leaves extarcts of *Momordica charantia*.[15] In view of the recently increased interest in developing plant-based insecticides as an alternative to chemical insecticides. The ethanolic extract of leaves of *Momordica charantia* shows larvicidal and ovicidal activity.[44,45]

Maurya, et al., studied the larvicidal potential of the various fruit wall extract of *Momordica charantia* against two species of mosquito vectors, *Anophels stephensi* and *Culex quinquefasciatus*. Petroleum ether extract is more effective than carbon tetrachloride and methanol extarcts. All fruit extracts of *Momordica charantia* are toxic to both the larval species.[51]

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