REVIEW

Momordica charantia Linn.: A Comprehensive Review on Bitter Remedy

Sonia Sharma1*, Shruti Tandon1, Bhupesh Semwal1, Komal Singh2

1 GLA university, Institute of Pharmaceutical Research, Mathura, U.P.
2 Extol College, Bhopal, M.P.

INTRODUCTION

India is called the botanical garden of the world for its rich natural resources. Over 6000 plants in India are in use in traditional, folklore and herbal medicine. The Indian system of medicine has identified 1500 medicinal plants of which 500 are commonly used. Plants have a long therapeutic history over thousands of years and still considered to be promising source of medicine in the traditional health care system. The efficacy and safety of herbal medicine have turned the major pharmaceutical population towards medicinal plant's research. In view of the widespread interest on using medicinal plants the present review on Momordica charantia is to provide up to date information, in references to botanical, commercial, ethnopharmacological, phytochemical and pharmacological studies.

CULTIVATION AND COLLECTION

The plant is cultivated throughout India as a vegetable crop. Two types are grown in North India, the hot season or Jethuya and the rainy season or Baramasiya; the latter bears fruits nearly throughout the year. They differ in habit of growth, in size and shape of fruits and the period of maturation. The plant is commonly cultivated during the warm season of the year. The hot season or early crop is sown between March and April and is often grown without support; the rainy season crop is grown in June-July and is trained on supports. The seeds are sown in lines 2 ft. apart in well-prepared and manured beds or in small pits. Two or three beds are planted in each pit but only one plant is maintained after germination. The plants are watered once or twice a week during the dry weather. They begin to flower 30-35 days later. The yield of fruits varies from 70 to 150 md. per acre.

SYNONYMS

Sans.- Karavella ; Sushavi, Eng.- Bitter gourd, Hin.- Karela; Kareli, Ben.- Uchchebe;Karala; Kerula, Gujar.- Karela, Mah.- Karla, Tel.- Kakara, Tam.- Pavakka-chedi; Pagal, Mal.- Pavali; Kaipavalli, Arab.- Hagala-kayi, Ger.- Gurkenahnlicher Balsamapfel, Quisaul-barri.
Part used: Fruits, seeds and leaves
Family: Cucurbitaceae
Taxonomy1:
Kingdom : Plantae
Division : Magnoliophyta
Class : Magnoliosida
Order : Violes
Family : Cucurbitaceae
Genus : Momordica
Species : Charantia

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MORPHOLOGY
Herbaceous, slender climber with slightly pubescent stems and leaves; petiole blade; leaves to 10-12 cm long, palmately 5-7-lobed; the lobes "sinuate-dentate"; flowers yellow; peduncle with a reniform bracteole; corolla 1.5-2 cm long; fruit obovoid or oblong-cylindric, coarsely ridged and bumpy-tuberculate, to 20 cm, orange or dark yellow when ripe, splitting open to reveal the seeds, these black but covered with a soft, fleshy red aril, 12-16 mm long. Seeds and pith appear white in unripe fruits, ripening to red. The bitter melon more typical of India has a narrower shape with pointed ends, and a surface covered with jagged, triangular "teeth" and ridges. Coloration is green or white. Some bear miniature fruit of only 6-10 cm in length.

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PHARMACOLOGY

antioxidant activity: extracts from bitter melon (Momordica charantia, Cucurbitaceae) showed a significant difference in the FRS between the extract obtained by using cold maceration and that prepared by boiling the plant in the solvent under reflux suggesting the chemical composition of the plant changed during the heating process, leading to an increase in the amount of antioxidant components.

The n-hexane extract of seeds of Momordica has been reported to contain conjugated octadecatrienoic fatty acids and α-eleostearic acid. These acids have been studied for their anti-oxidant activities and are proven to be successful in an in vitro study. Thus it may help to reduce the risk of coronary heart diseases in non-diabetic as well as diabetic patients.

Anthemelinitic, Antiviral and Antimicrobial Activities: extracts of various plant parts of the bitter melon, including the leaf, fruit and seeds have been investigated and found to be pharmacologically active against microbes, a leaf, and a fruit, in addition to whole plant extracts. The fruit extract was studied in a two-step process, leading to an increase in the amount of antioxidant components.

Antitumor activity: the anti-carcinogenic effect of aqueous extract of the bitter melon fruit was studied in a two-step skin carcinogenesis model in mice. Oral administration of the fruit extract protected the mice from the development of skin tumors and increased life expectancy. The extract also reduced carcinogen-induced lipid peroxidation in liver and DNA damage in lymphocytes. The fruit extract was furthermore 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 bitter melon fruit during carcinogenesis, which is possibly mediated by their modulatory effect on enzymes of the biotransformation and detoxification system of the host.

Anticancer activity: the in vivo anti-cancer activity of a crude extract from the bitter melon (Momordica charantia) was determined. The extract inhibited tumor formation in CBA/H mice which had been given i.p. injections of 1.0x10^5 CBA/Di tumor cells (77% of the untreated mice with tumors versus 33% of the treated mice with tumors after 6 weeks). The extract also inhibited tumor formation in DBA/2 mice which had been given i.p. injections of either 1x10^5 P388 tumor cells (0% of untreated mice survived after 30 days versus 40% survival of the treated mice) or 1x10^5 L1210 tumor cells (0% survival of untreated mice versus 100% of treated mice after 30 days). The in vivo antitumor effect required both the prior exposure of tumor cells to the extract (2 hr) in vitro and i.p., biweekly injections of the extract into the mice. The optimum dose for tumor inhibition (8 µg protein, biweekly, i.p.) was not toxic to mice for at least 45 days of treatment. This same treatment caused a marked enhancement of c3H mouse thymic cell response to concanavalin A in vitro. When compared to the untreated control mice, the bitter-melon-injected animals exhibited a 4-fold higher incorporation of tritiated thymidine into trichloroacetic acid-precipitable material after 48 hr of exposure to 50 µg of concanavalin A. A nylon wool-purified spleen cell from these same bittermelon-treated mice exhibited an enhanced mixed lymphocyte reaction when exposed to irradiated P388 stimulator cells (186% of the untreated control mice). These data indicate that in vivo enhancement of immune functions may contribute to the antitumor effects of the bitter melon extract.

Antibacterial activity: Bacillus subtilis, Escherichia coli, Pseudomonas aeruginosa, and Staphylococcus.
as well as in rabbits, but not in non-pregnant females. Bleeding has been induced in pregnant rats given the juice, momorcharins are capable of producing abortions. Uterine atrophy of spermatogenic aspects. in female mice, the plant activity in male rats. Oral administration of the fruit (1.7 g/day extract) to male dogs caused testicular lesions and atrophy of spermatogenic aspects. in female mice, the plant exhibited similar, but reversible, antifertility effects. Momorcharins are capable of producing abortions. Uterine bleeding has been induced in pregnant rats given the juice, as well as in rabbits, but not in non-pregnant females.

**Hypoglycemic activity:**

Studies done in animal model, mainly streptozotocin induced diabetic rats and mice have shown significant lowering of blood glucose levels. bitter gourd extract improves insulin sensitivity, glucose tolerance and insulin signalling in hfd-induced insulin resistance, which may open new therapeutic targets for the treatment of obesity/dyslipidemia-induced insulin resistance.

**Glucose tolerance:**

The effect of karela (momordica charantia), a fruit indigenous to south america and asia, on glucose and insulin concentrations was studied in nine non-insulindependent diabetics and six non-diabetic laboratory rats. A water-soluble extract of the fruits significantly reduced blood glucose concentrations during a 50 g oral glucose tolerance test in the diabetics and after force-feeding in the rats. Fried karela fruits consumed as a daily supplement to the diet produced a small but significant improvement in glucose tolerance. Improvement in glucose tolerance was not associated with an increase in serum insulin responses. These results show that karela improves glucose tolerance in diabetics.

**Insecticide activity:**

At the concentration of 1.0 ppm extract of petroleum ether shows the insecticidal activity. Water extract of dried leaves does not show insecticidal activity in case of oncopelatus fasciatus and, but in the case of blatella germanica and periplaneta americana it shows the strong activity.

**DNA Synthesis Inhibition:**

At the concentration of 0.1 mg/ml hot water extract of entire plant shows the DNA synthesis inhibition on sea urchin ova. Chromatographic fraction of dried fruit in cell culture was actively show DNA synthesis inhibition on bkh-21 cells and vesicular stomatitis virus. Ethanol (100%) extract of seed in cell culture was actively show DNA synthesis inhibition on sarcoma 180(solid).

**CNS Depressant Activity:**

Extract of ethanol of fresh fruit administered intraperitoneally to mice of both sexes at variable doses and then CNS depressant activity was observed.

**Cytotoxic activity:**

In the cell culture dried fruit extract shows the cytotoxic activity on ca-755 and leuk-cml (human). At the concentration of 0.14 mg/ml fresh fruit juice in cell culture shows the cytotoxic activity on melanoma-b cell-m9. Viable cells decreased from 100% to 5% between 18 and 26 hours. The juice was also shows the cytotoxic activity on human lymphocytes and leukemic lymphocytes. At the concentration of 0.4 mg/ml hot water extract of entire plant shows the cytotoxic activity on hep2 cells. Water extract of dried fruit in cell culture shows this activity on cb1/d1 cells. The activity was highly dose dependent. In cell culture water extract of fresh fruit was actively show this activity on human lymphoblast and lymphocytes.

**Antihyperglycemic activity:**

At the dose of 250.0 mg/kg acetone extract of dried fruit in ration of rats shows the antihyperglycemic activity. fall in sugar of 49% in 30 days. Blood sugar in maintained within normal limits for two weeks after treatment ceased vs alloxan induced hyperglycemia. At the dose of 1.0 mg/kg of benzene extract of dried fruit administered intragastrically to rabbit it shows the antihyperglycemic activity. Alloxan recovered rabbits were tested for glucose tolerance following sample treatment vs glucose induced hyperglycemia. Decoction of dried fruit taken orally by the human adult at dose of 500.0 mg/person it was show the antihyperglycemic activity. Ethanol (95%) extract of dried fruit administered intragastrically to female rats at the dose of 250.0 mg/kg was show the antihyperglycemic activity vs streptozotocin induced hyperglycemia. Dried powder fruit, taken orally once daily for 11 days by ten male patients with mild diabetes (23-28 years of age), at a dose of 2.0 mg/person was shows the antihyperglycemic activity.

**Other uses:**

The ripe fruit has been said to induce menstruation. Other effects of bitter melon include dose-related analgesic activity in rats and mice, anti-inflammatory actions, and treatment for gi ailments, such as gas, ulcer, digestion, constipation, dysentery, or hemorrhoids. The plant has also been used for skin diseases (eg, boils, burns, infections, scabies, psoriasis), and for its lipid effects and hypotensive actions. It exhibits genotoxic effects in aspergillus nidulans.

**Ethnomedical uses:**

Leaves and fruits are used in the treatment of diabetes, hypertension, and hyperlipidemia. The plant is also used in the treatment of various skin diseases, such as eczema, psoriasis, and fungal infections. The leaves are used in the treatment of skin infections, while the roots are used in the treatment of digestive problems such as constipation and diarrhea.

**Cytotoxic activity:**

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<th>S.No</th>
<th>Chemical constituents</th>
<th>Structure</th>
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<tbody>
<tr>
<td>1)</td>
<td>Charantine</td>
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<tr>
<td>2)</td>
<td>Goyaglycoside</td>
<td><img src="image2" alt="Goyaglycoside" /></td>
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<tr>
<td>3)</td>
<td>Mormodicoside</td>
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<tr>
<td>4)</td>
<td>Mormodicoside</td>
<td><img src="image4" alt="Mormodicoside" /></td>
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<td>5)</td>
<td>3β,25-dihydroxy-5β,19-epoxycucurbita-6,(23E)-dienen</td>
<td><img src="image5" alt="3β,25-dihydroxy-5β,19-epoxycucurbita-6,(23E)-dienen" /></td>
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### Table 1: Chemical Constituents along with their structures

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<td><img src="image5" alt="3β,25-dihydroxy-5β,19-epoxycucurbita-6,(23E)-dien" /></td>
</tr>
</tbody>
</table>
6) Momordicine I

7) Karavilagenin

8) Karavilagenin C

10) Karaviloside

Karaviloside I = Me
Glc
Karaviloside II = Me
All
Karaviloside III = H
All
11) Karaviloside

12) 3,7,23-trihydroxy-cucurbita-5,24-diene-19-al


14) 3,7-dihydroxy-25-methoxycucurbita-5,23-diene-19-al

15) Kuguacin
16) Kuguacin A

17) Kuguacin B

18) Kuguacin E
Table 2: Chemical constituents along with category 3-13

<table>
<thead>
<tr>
<th>Category</th>
<th>Chemical Constituents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cucurbitane-type triterpenoid saponin</td>
<td>5β,19-epoxy-cucurbita-6,23-diene-3β,19,25-triol-3-0-β-D-allopyranoside, named momordicoside P; 23-O-β-D- allopyranosyl-5β,19-epoxy-cucurbita-6,24-diene-3β,22(S),23(S)-triol-3-0-β-D- glucopyranoside; 23-O-β-D- allopyranosyl-5β,19-epoxy-cucurbita-6,24-diene-3β,22(S),23(S)-triol-3-0-β-D- allopyranoside and 23-O-β-D- allopyranosyl-5β,19-epoxy-cucurbita-6,24-diene-3β,19(R), 22(S),23(S)-tetaol-3-0-β-D- allopyranoside, named momordicoside M, N, and O, respectively, along with one known saponin momordicoside L, were isolated from the fresh fruits of Momordica charantia, kukaguacins F-S</td>
</tr>
<tr>
<td>Fatty acid</td>
<td>α-Eleostearic acid, Linolenic acid, Palmitic acid, Lauric acid, Linoleic acid, myristic acid, oleanolic acid, oleic acid</td>
</tr>
<tr>
<td>acylglucosylerols</td>
<td>3-O-[6'-O-palmitoyl-β-D-glucosyl]-stigmasta-5,25(27)-diene, 3-O-[6'-O-stearyl-β-D-glucosyl]-stigmasta-5,25(27)-diene</td>
</tr>
<tr>
<td>Other constituents</td>
<td>charine, cryptoxanthin, cucurbitins, cucurbitacins, cucurbitanes, cycloartenols, diosgenin, elaestearic acids, erythrodial, galacturonic acids, gentisic acid, goyasaponins, guaynulate cyclase inhibitors, gypsogenin, hydroxystriptamines, karounidiols, lanosterol, , , momorcharasides, morcharins, momordenol, momordicin, momordicins, momordicin, momordicosides, momordin, multiflenol, oxalic acid, pentadecans, petroselanic acid, ribosominactivating proteins, rosmarinic acid, ruboxanthin, spinasterol, steroideal glycosides, stigmastadiols, stignasterol, taraxerol, trehalose, trypsin inhibitors, uracil, vacine, γ-insulin, verbascoside, vicine, zeatin, zeatin riboside, zeaxanthin, and zeinoxanthin</td>
</tr>
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</table>

Table 3: Chemical constituents with activity 4-13

<table>
<thead>
<tr>
<th>Activity</th>
<th>Phytochemical constituents</th>
</tr>
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<tbody>
<tr>
<td>Antimicrobial activity</td>
<td>Sesquiterpenes (71.7%), phenylpropanoids (11.0%), and monoterpenes (7.6%), transnerolid (61.6%) – A-Pinene (0.4%), B-Pinene Octanal , p-Cymene, Limonene (&lt;0.1%), 1,8-Cineole (0.6%), β-Phellandrene (0.3%), Linalool, 0.1%, cis-Dihydrocarveol (4.9%), trans-Dihydrocarveol (0.8%), Carvone(1.2%), (E)-Anethole (0.5%), Safrole(0.9%), Methyl eugenol(0.3%), Germacrene D(4.4%), β-Selinene(1.5%), α-Selinene (1.3%), Myristecin (0.4%), γ-Cadinene(0.4%), trans-Nerolidol(61.6%), Spathulenol(1.7%), Cedrol(0.3%), β-Bisabolol(0.5%), Apiole</td>
</tr>
<tr>
<td>Antioxidant activity inhibitory effects on Epstein-Barr virus early antigen (EBV-EA)</td>
<td>Thirteen cucurbitane-type triterpenoid glycosides, including eight new compounds named charantosides I (6), II (7), III (10), IV (11), V (12), VI (13), VII (16), and VIII (17), and five known compounds, 8, 9, 14, 15, and 18, were isolated from a methanol extract of the fruits of Japanese Momordica charantia, alpha- and beta-momorcharin, cucurbitacin B</td>
</tr>
<tr>
<td>Anticancerous activity</td>
<td>Phenolic compound - Catechin</td>
</tr>
</tbody>
</table>

REFERENCES


<table>
<thead>
<tr>
<th>Drug</th>
<th>Local name</th>
<th>Chemical constituents</th>
<th>Therapeutic uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>M. balsamina</td>
<td>Mokha</td>
<td>Momordicin, Lycopene, Carotene, Fatty oil</td>
<td>Stomachic, tonic, used in haemorrhoids, burns</td>
</tr>
<tr>
<td>M. cochinchinensis</td>
<td>Gulkakra, gangerua</td>
<td>Triterpenoid saponin, bessisterol, ascorbigen, ascorbic acid</td>
<td>Aperient, used in ulcers, sores, obstructions of liver and spleen, external application for lumbago, ulceration.</td>
</tr>
<tr>
<td>M. dioica</td>
<td>Kaksa, golkandra</td>
<td>Ascorbic acid</td>
<td>Used in bleeding piles, bowel affections and urinary complaints</td>
</tr>
<tr>
<td>M. tuberosa</td>
<td></td>
<td>Bitter glycoside , yellow acid resin</td>
<td>Abortifacient</td>
</tr>
<tr>
<td>M. cymbalaria</td>
<td>Kadavanchi</td>
<td></td>
<td>Abortifacient</td>
</tr>
<tr>
<td>M. mixta</td>
<td></td>
<td></td>
<td>Used as a vegetable food</td>
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