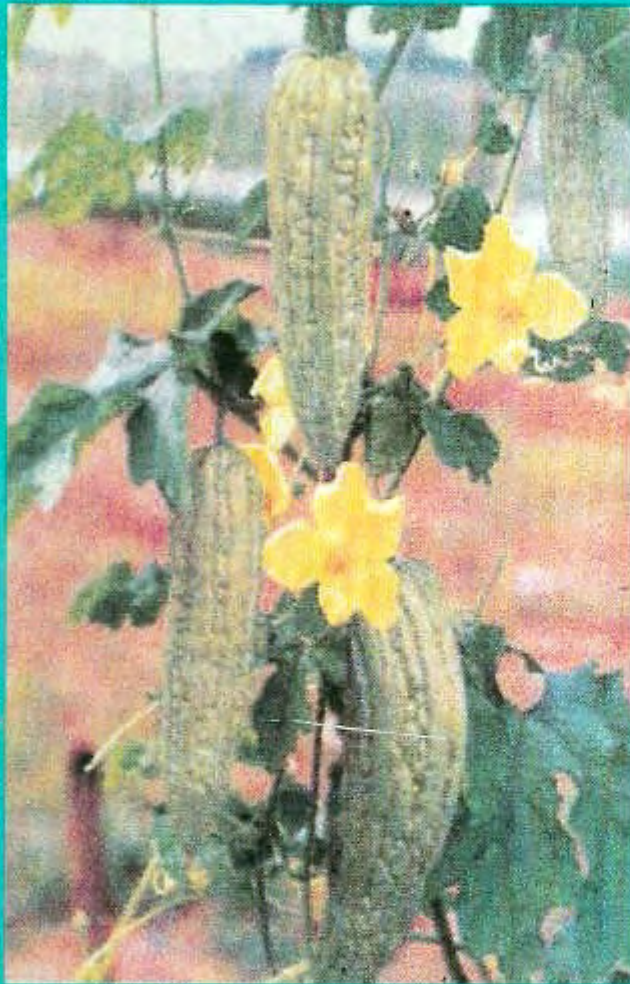


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Medicinal and Aromatic Plant Series, No.3



KARAWILA

(*Momordica charantia*)

Information Services Centre
Industrial Technology Institute
(Successor to CISIR)
Colombo, Sri Lanka

NA 229

Medicinal and Aromatic Plant Series, No. 3



Momordica charantia
- a literature survey -

Compiled by :

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and

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Momordica charantia

1.0 INTRODUCTION

Momordica charantia, also known as balsam pear or bitter gourd is one of the most nutritive and commercially important cucurbit vegetables. The fruits of the plants are used in culinary preparations all over the world. Although there is a bitterness in the fruit, it can be reduced by blanching or soaking in salt water before cooking. Bitter gourd also has great medicinal value and used widely in folk medicine and in ayurveda, especially to treat diabetes. Occasionally, it is planted as an ornamental.

The genus *Momordica* belongs entirely to the Old World. It was possibly domesticated first in Eastern India and Southern China, and now has a pantropical distribution with wild and cultivated populations. It is thought that it came from Africa to Brazil with the slave trade in the seventeenth or eighteenth centuries and that bird dispersal of the seeds, accounted for its spread within continents. Bitter gourd is mainly cultivated in South-East Asia and India. In Sri Lanka, it is cultivated in the low country up to 1000 m altitude.

2.0 BOTANY ^{65,91,111,172,177,201}

2.1 TAXONOMY

Bitter gourd belongs to the family Cucurbitaceae, which consists of 117 genera and 825 species. Of them, 30 species belonging to 9 genera are cultivated and used as vegetables, fruits, oil-seeds, edible seeds, fodder and fibre. *Momordica* is the second largest genus of the family with 60 species.

Family : Cucurbitaceae
Genus : *Momordica*
Species : *charantia*

Botanical names

Momordica charantia Linn.; *Momordica humilis* Wall.; *Momordica muricata* DC.; *Momordica senegalensis* Lamk.; *Momordica balsamina* Blanco; *Momordica cylindrica* Blanco; *Cucumis africanus* Thunb.

Other names

Sinhala	:	Karawila
English	:	Bitter gourd, Balsam pear, African cucumber
Tamil	:	Pakal, Pavakkachedi, Pavakkayi
Sanskrit	:	Ambuvallika, Brihadvalli, Chiripatra, Kandakataka, Karawallilata, Kathilla, Kathillaka, Katilla, Patu, Pitapushpa, Rahavalli, Sukanda, Karavalli,

2.2 PLANT DESCRIPTION

It is an annual, tendril climber with somewhat twining, much branched, 5-angled, roughly pubescent stems. The older stems are often flattened and fluted and young parts hairy. It is about 6m or more long. The leaves are simple, alternate, 6 – 12.5cm long, very deeply cordate at base, palmately cut to beyond the middle into 7 or 9 lobes. Lobes are acute, apiculate coarsely spinous – dentate, pubescent on veins on both sides. Petioles are 2.5 – 5cm long, channeled above and narrowly bordered with decurrent leaf – bases.

The flowers are regular, lemon yellow, unisexual, monoecious, solitary, axillary on slender peduncles 5 – 7.5cm long, usually with a large, sessile, rotunate, entire bract on the lower half and often close to the base; Calyx segments 5, fused at base, oval, subacute, pubescent; Petals 5, slightly connate at base, twice as long as calyx segments, rounded, veiny. The flowering period is from June to August. The fruits are large, 8 – 15cm long, ovoid, narrowed at both ends, pendulous, ribbed with prominent tubercles on the ribs. It becomes orange in colour when ripe. Seeds are about 1.2cm long, ovoid, and compressed. Each enclosed in a red pulpy envelope. Each fruit produces about 20- 40 seeds.

3.0 HABITAT ⁶⁵

It is cultivated throughout India, Sri Lanka, Malaysia, China and tropical Africa. In Sri Lanka, it is cultivated in the low-country up to 1000 m altitude.

4.0 AGRONOMY ^{34,61,113,178,177,201}

4.1 SOIL AND CLIMATE

Bitter gourd grows well in tropical and subtropical climates. It is adapted to a wide range of environments and can be grown year round. The plant is sensitive to water logging. It tolerates a wide range of soils but it thrives in a well drained sandy loam, rich in organic matter. It grows wild in low land rain forest, riverine forest and elephant grass. Humid condition with a rainfall of more than 800 mm is required for a good growth.

4.2 PROPAGATION:

Bitter gourd is propagated through seed. Direct seeding is most common, but transplanting may be done if seeds are scarce.

A study on the effects of various factors on seed germination of bitter gourd showed the best temperature range to be between 25 – 35 °C. When freshly harvested and graded, seeds were soaked in different solutions for 12 hours, and the percentage of germination compared with those of dry seeds showed an increase in treated seeds with the highest percentage being 1% KNO₃ solution.

In another study it was found that with the bitter gourd cv. Fizabadi seeds treated with 250mA electric current for 3 minutes produced plants with a significantly higher number of female flowers, female/male ratio, fruits/plant and fruit yield/plant than the untreated seeds.

Gamma radiation on seeds presoaked in water for 24 hours, decreased the male to female flower ratio, whereas ethyl methane sulfonate, mitomycin and hydroxylamine led to selective suppression of the male phase. In all cases there was an increased yield of the crop.

4.3 CULTIVATION ^{1.177.201}

Seeds are sown on well prepared beds, ridges or in small pits. Four seeds are sown per site, later thinned to two. Usually planting holes are spaced 60 cm apart. The plants are watered once or twice a week during the dry weather. They also require supporting poles or trellis about 120 –150 cm in height.

4.4 FERTILIZER ^{1.12.104.185.200.206}

Bitter gourd is an exhaustive feeder. Satisfactory crops can only be obtained if the creepers are supplied with liberal quantities of organic manure in the form of 5 tons of cattle manure per acre and supplemented with fertilizer. A mixture of 150kg of urea, 250kg of conc. super phosphate and 50kg of muriate potash can be used as fertilizer. 250kg of this is applied as a basal dressing just before or after planting and top dressed with 50kg of the mixture, a month later and again with 50kg two months after planting.

In a growth and yield study with a variety of bitter gourd, it was found that fertilizer treatment with 80kg N/ha, 30kg P₂O₅/ha and a spray of 200ppm maleic hydrazide gave the best results.

The effect of carbofuran application on the yield was investigated in Kerala. It was found that application of carbofuran granules at 1.5kg a.i./ha gave the highest yield.

In a study to find the effect of various chemicals on growth it was found that para-chloro phenoxy acetic acid at 100ppm markedly improved the plant growth and Cycocel at 250 & 500ppm produced female flowers about 12 days earlier in comparison to control plants. Maximum fruit yield per plant was produced by Cycocel 250ppm followed by ascorbic acid 25ppm and Cycocel 500ppm.

External application of GA₃ and Ethrel in lower concentrations promoted female flower production as well as fruit set and fruit development. They also improved the quality of the fruit by increase in length, girth and biomass of the fruits as also the total sugar content of the fruits.

Above 14ppm concentration of lead on fields caused stunted growth, chlorosis and reduction in leaf area.

4.5 HARVESTING ^{1,111}

Bitter gourd begins to flower 30 – 35 days after sowing and fruits become ready for harvesting 15 - 20 days later. It requires much attention at this time. Delaying harvesting for 3 – 4 days leads to loss of fruit lustre and acceptability. Fruits are best harvested by cutting the first stalk with scissors or with a sharp knife.

A yield of 20 – 30t/ha is considered satisfactory for bitter gourd. The number of fruits per plant may reach 20 –25 during cropping period.

4.6 BREEDING ^{1,218}

Breeding work on bitter gourd is geared towards developing cultivars with superior quality, a high female to male ratio, high yield, and resistance to diseases and pests. Resistance to foliar diseases and fruit fly is important. The wild forms of bitter gourd are potential sources for resistance.

In many South – East Asian countries, commercial F₁ hybrids, have been released. They show early maturing, are high yielding and of good quality.

4.7 PLANT PATHOLOGY ^{1,29,52,53,101,106,134,157,175,197,199}

4.7.1 Pests :

Aulacophora beetles, with orange to orange red bodies spotted with black, are serious pests of gourds. They destroy the young leaves by feeding on them. Prompt action should therefore be taken to keep them in check by spraying with any one of the following insecticides: Fenitrothion, Metamidiphos, Mathomyl, Fenthion, Phenthoate or Carbopenothion. It is not enough to spray the leaves only since the beetles drop off on to the ground underneath and continue their life cycle there. More effective control is obtained if both the leaves and the soil underneath the creepers are sprayed with the insecticide.

Dacus cucurbitae, Melon fruit fly, is the most destructive insect pest of the bitter gourd. The adult is a large brown fly, 8 – 10 mm long, with a wingspan of 12 – 15 mm. The eggs are laid in groups under the skin of the young fruit. The larvae are typical dipterous maggots, 10 –12 mm long when fully grown. Granular carbofuran applied to soil at 1.5kg a.i./ha at the time of sowing, vining and flowering afforded 83.35% protection against the fruit fly, in Kerala, India but residues were above the permitted limits. In a study fenitrothion and the standard malathion was sprayed on bitter gourd crop twice, alone or in combination with attractants at 10 day intervals, for the control of the fly. Gur, molasses, dried mango juice, citronella oil and protein hydrolyzate were used with fenitrothion, whereas with malathion, only gur was mixed as attractant. Using fenitrothin with all the attractants except, citronella oil, proved better than recommended bait spray consisting of malathion and gur.

Bitter gourd pest, *Bactrocera cucurbitae* was effectively controlled by spraying Triazophos or by trapping the females in poison bait traps containing Dipterex (Trichlorfon).

Fenvalerate was found to be one of the most effective insecticides against *Epilachna vigintipunctata* and *Amrota biguttula* when it was sprayed at fortnightly intervals between 30 and 100 days after sowing.

4.7.1.1 PESTICIDE RESIDUES^{28.114}

When an insecticide is sprayed, a certain amount of it gets deposited on the fruit. Studies have shown that traces of DDT, BHC, endosulfan remain on the fruits.

Malathion appears to be safe for spraying as the home preparatory methods like washing, open and steam cooking of the fruits bring the deposits below the tolerance limit of 8ppm even on the day after 0.05% spraying.

4.7.2 Diseases :

Powdery Mildew :

Powdery mildew is caused by the fungus *Erysiphe cichoracearum*. The disease is most severe in warm dry areas. Whitish powdery spots appear on the upper and lower surface of leaves, and on petioles and stems. Infection progresses from older to younger leaves, and the leaves will dry up. Fruits ripen prematurely and lack flavour. This can be controlled by using sulphur dust if the cultivars are sulphur tolerant or alternatively dinocap.

Powdery mildew caused by *Sphaerotheca fuliginea* can be controlled by using Nimrod (0.8l/ha) and Benlate (1kg/ha).

Mosaic disease :

The disease was characterized by typical mosaic, upward leaf curling, crinkling, mottling and severe stunting. The inter nodal length of the vines was very much reduced, and early infected seedlings failed to trail on the pandal. The fruits of the diseased plants were small in size and number. They were also rough and corky in texture. This virus is transmitted by white fly. Control is therefore by white fly control, and by removing affected plants.

Leaf spot disease :

This disease occurs mainly in South-east Asia, by *Myrothecium roridum*. This can be effectively controlled by Tri Miltox Forte (mancozeb + copper carbonate dihydroxide + copper sulphate + copper oxychloride), Dithane M-45 (Mancozeb) and Pencozeb [Manganese ethylene bis(dithiocarbamate) + zinc].

Black rot disease :

Black fruit rot caused by *Didymella bryoniae* is a disease started with small, circular water soaked lesions on the green fruits which quickly enlarge into blackish spots in a

week. The infected fruits on close examination reveal small, blackish, pin head like structures. Slit open fruits have mycelial growth inside. The disease is favoured by long cloudy and humid weather, which prevailed for almost one week at a stretch. To minimize the disease, seed production should be planned in dry season so the fruit setting and maturation do not coincide with rainy days.

4.8 Storage ^{1,131,173}

Fruits of bitter gourd do not keep well and should be sent immediately to the market. Shelf life can be enhanced by packing in polyethylene bags. In a study it was found that when vials containing fused CaCl₂ or CaCO₃ at 15g/kg with perforated lids or loose under ambient conditions (25 – 31 °C and 70 – 85% relative humidity) were added to polyethylene bags, the shelf life increased. In another study, when bitter gourd was dipped in an oil emulsion prepared from soyabean or sunflower oil, stearic acid, triethanolamide and thiabendazole, shelf life could be extended up to 5 days from 3 days at 20 °C and 30 – 60% RH.

Bitter gourd can be held in cold storage for four weeks at 0 – 3 °C and 85 – 90% R.H.

5.0 CHEMISTRY OF PLANT ^{16,38,48,87,97,111,125,141,144,150,222}

5.1 CHEMICAL CONSTITUENTS OF FRUITS

Table 1 : Proximate composition of the fruit : (100g of edible portion)

	Normal	Small
Moisture	92.4g	83.2g
Energy	25kCal	60kcal
Proteins	1.6g	2.1g
Fats	0.2g	1.0g
Carbohydrates	4.2g	10.6g
Ca	20mg	23mg
P	70mg	38mg
Iron	1.8mg	2.0mg
Carotene	126mcg	126mcg
Thiamine	70mcg	70mcg
Riboflavin	90mcg	60mcg
Niacin	0.5mg	0.4mg
Vitamin C (Ascorbic acid)	88mg	96mg
Ascorbigen		

Bitter gourd is a good source of ascorbic acid. The ascorbic acid content decreases with ripening of the fruit. It is retained in the green fruit during storage, but if it is stored after

ripening, considerable loss of ascorbic acid occurs. Slices of tender fruit lose about 80% ascorbic acid on drying in the sun. About 40% is lost during the cooking of fresh fruit. Cooking destroys about 40% of thiamine as well.

The fruit contains ascorbigen, a bound form of ascorbic acid released by heating with water in an atmosphere of carbon dioxide or nitrogen. Large sized fruits borne by certain types of *Momordica charantia*, are richer in ascorbigen than small fruit borne by other cultivated types.

Table 2 : Fatty acid composition (percent area) of lipid classes of bitter gourd

Fatty acid	Non polar lipids	glycolipids	phospholipids
	42.65%	39.35%	18.00%
Lauric	0.25	0.58	0.27
Myristic	0.09	0.36	0.32
Palmitic	7.36	29.42	35.01
Palmitoleic	0.21	0.19	0.16
Stearic	27.05	9.56	6.30
Oleic	3.92	4.09	6.34
Linoleic	6.31	14.10	19.67
Linolenic	5.87	34.92	26.26
α - eleosteric	44.92	3.63	4.48
Unknown	4.02	3.56	1.20

In bitter gourd, which mature about 30days after flowering, total lipids as well as α - eleostearic acid accumulates rapidly from 10 –20 days. Also there is a disappearance of linolenate and a reduction in linoleic acid concentration, which is concomitant with formation of conjugated fatty acids. The conjugated fatty acids are absent from monoacylglycerols, phospholipids and diacylglycerols throughout maturation.

Table 3 : Amino acid composition^a

Amino acid ^b	Bitter gourds
Asp	11.42
Thr	2.82
Ser	1.77
Glu	18.37
Pro	5.39
Gly	6.67
Ala	6.11
Val	6.67
$\frac{1}{2}$ -Cry	tr
Met	0.33
Ile	5.14

Leu	9.20
Tyr	2.75
Phe	5.49
His	2.87
Lys	3.35
Amm	3.54
Asn	2.05
Arg	6.17

^a Average of two determinations ^b Grams of amino acid/16g of N

The values obtained for cystine and malthionine is thought to be lower than actual content since a small proportion of these acids could be oxidized during analysis.

Comparison of the content of amino acids in bitter gourd with WHO recommended protein and amino acid requirements of human subjects (WHO, 1973), showed that bitter gourd is a good source of most essential amino acids with exception of lysine, cystine and methionine.

Other constituents

Charine

Chitinase

Daucosterol

Kakara

Kakara Ib

Kakara IIIa₁

KakaraIIIb₁

Momordicin (13-hydroxy-28-methoxyurs-11-en-3- one)

Momordicinin (13 β ,28-epoxyurs-11-en-3-one)

Momordicilin (24-[1'-hydroxy-1'- methyl- 2'- pentenyloxy] ursan-3- one)

Momordenol (3 β -hydroxystigmasta-5,14-diene-16-one)

Momordol (1-hydroxy-1,2-dimethyl-2-[8',10'- dihydroxy- 4'7'- dimethyl-11'-hydroxy methyltrideca]-3- ethyl-cyclohex-5-en-4-one)

Momordin

Momordica agglutinin

Momordicoside F₁ (3-O- β -D-glucopyranoside of 5,19-epoxy-25-methoxy-5 β -cucurbita-6,23-diene-3 β -ol)

Momordicoside F₂ (3-O- β -D-allopyranoside of 5,19-epoxy-5 β - cucurbita-6,23-diene - 3 β ,25-diol)

Momordicoside G (3-O- β -D-allopyranoside of 5,19-epoxy-25-methoxy-5 β -cucurbita-6,23-diene-3 β -ol)

Momordicoside I (3-O- β -D-glucopyranoside of 5,19-epoxy-6 β -cucurbita-6,23-diene -3 β ,25-diol)

Momordicoside K

Momordicoside L

3 - O - [6'-O-palmitoyl- β -D-glycosyl]-stigmasta-5,25(27)-diene

3 - O - [6'-O-stearyl- β -D-glycosyl]-stigmasta-5,25(27)-diene

5.2 VOLATILE COMPONENTS OF BITTERMELONS AND BITTERMELON VINES

	ppm	
	melon	vine
Propan-2-ol	0.02	0.06
Propan-1-ol		0.14
Acetic acid		
Ethyl acetate		
2-Methylpropanol	0.07	0.27
<i>Trans</i> -but-2-enal		0.02
Butanol	0.06	0.07
Benzene	0.01	0.01
Pent-1-en-3-one	0.02	0.08
Pent-1-en-3-ol	0.46	0.91
Pentanal	0.09	0.05
Pentan-3-ol		0.02
Pentan-2-ol	0.01	0.01
3-Methylbut-3-enol	0.01	0.08
3-Methylbutanol	0.06	0.21
<i>Trans</i> -2-methylbut-2-enal		0.01
2-Methylbutanol	0.04	0.07
<i>Trans</i> -pent-2-enal	0.06	0.13
Pentanol	0.05	0.13
<i>Trans</i> -pent-2-en-1-ol	0.06	0.04
<i>Cis</i> -pent-2-en-1-ol	0.70	0.66
Hexanal	0.10	0.06
2-Methylpent-2-enal		0.13
<i>Trans</i> -hex-2-enal	0.17	0.30
<i>Trans</i> -hex-3-enol	0.02	0.05
<i>Cis</i> -hex-3-enol	0.93	4.85
<i>Cis</i> -hex-3-enyl formate		0.01
<i>Trans</i> -hex-2-enol		0.04
Hexanol	0.19	0.13
<i>Trans,trans</i> -hexa-2,4-dienal	0.01	0.01
Benzaldehyde	0.01	0.12
Heptanol	0.02	0.02
<i>Trans,trans</i> -hepta-2,4-dienal	0.06	0.07
<i>Cis</i> -hex-3-enyl acetate		0.04
Benzyl alcohol	0.20	1.10
Phenylacetaldehyde	0.07	0.12
<i>p</i> -Cymene		0.02
Octanol	0.01	0.01
2-Phenylethanol	0.02	0.11
Nonanal		0.02

Linalool		0.01
<i>Cis</i> -verbenol		0.03
<i>Cis</i> -sabinol	0.02	0.20
Terpineol		0.03
Myrtenal	0.04	0.15
Myrtenol	0.81	8.65
Nonadienal isomer	0.03	
<i>Trans,trans</i> -nona-2,4-dieal	0.23	
β -Ionone		0.06
Nerolidol	0.02	

5.3 CHEMICAL COMPOSITION OF SEED ^{13,27,37,38,41,63,79,107,109,126,145}

The seed yields a clear, reddish brown, semi-drying oil with the following characteristics:

D ⁴⁰	0.9958
N ²⁷	1.4984
Acid value	3.4
Sap. Value	184.1
Iodine value (Wijs)	120.4
Diene value (Ellis & Jones)	70.6
Unsap. Matter	0.7%

Fatty acid composition (% of total fatty acid)

Palmitic	1.6 – 1.9
Palmitoleic	0.12 – 0.16
Stearic	21.7 – 26.5
Oleic	2.6 – 4.0
Linoleic	3.1 – 4.6
Linolenic	0.54 – 0.63
Eleostearic	63.4 – 67.9

The major fatty acid is eleostearic acid (ESA). Eleostearic acid is also a major component of oil from tung nuts and is the constituent responsible for the 'drying' characteristic of tung oil which is used extensively in paints, coatings, inks etc. When the two oils were compared, it has been found that bitter gourd oil contained about 20% less ESA than tung oil, but about 20% more stearic acid. The higher stearic acid content of bitter gourd seed oil may provide advantages for this oil over tung oil as the latter, in many formulations, dries too quickly and additional stearic acid could retard drying.

Chemical composition of globulins isolated from seeds of bitter gourd :

Nitrogen (%)*	18.36
Ash (%)#	0.36
Lysine	3.66
Histidine	1.98
Arginine	35.18
Aspartic	5.68
Threonine	1.82
Serine	3.45
Glutamic	9.81
Proline	3.79
Glycine	5.22
Alanine	4.61
Valine	3.63
Isoleucine	2.59
Leucine	4.77
Tyrosine	1.59
Phenylalanine	2.67

• nitrogen content in 100% of ash free dry matter of globulins.

Ash content in 100% of dry matter of globulins.

Amino acid comp. (g N of amino acid/100g N)

Sterol glycosides and other compounds

Momordicoside A

Momordicoside B

Momordicoside C (3-O- β -gentiobioside of cucurbit-5-ene-3 β ,24,24,25-tetraol)

Momordicoside D (3-O- β -gentiobioside of cucurbit-5,24-diene-3 β ,22,23-triol)

Momordicoside E (3-O- β -genetiobioside of 3 β -hydroxy-23,24,25,26,27-pentanor-20(ξ)cucurbit-5-en-22-al)

3-O-(β -D-glucopyranosyl)-24 β -ethyl-5-cholesta-7,trans-22(E),25(27)-trien-3 β -ol

β -Sitosterol- β -D-glucoside

Stearic acid

Vicine

Zeatin riboside

Zeatin

Momorcharin I

Momorcharin II

Vicine has been found to be a glycoside of a non protein nitrogenous base, which has a favism inducing toxin. (favism – an acute haemolytic anaemia)

The seed contains a volatile oil, which on steam distillation gave the following volatile components;

p-Cymene
l-Menthol
 Nerolidol
 Pentadecanol
 Hexadecanol
 Squalene
 Pentanal
 Trans-2-heptenal
 Trans-2-hexenal
 2(E),4(E)-nonadienal
 Valeric acid
 Amyl formate
 Amyl valerate
 2-Butylfuran
 2-Hexanone

The seed also contains ribosome inactivating proteins such as,

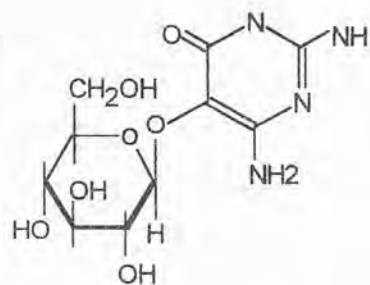
α -Momorcharin
 Momordin a
 Momordin b

5.4 CHEMICAL COMPOSITION OF LEAVES :

Momordicine I
 Momordicine II (20-O- β -glucoside of 3,7,23-trihydroxy cucurbita-5,24-diene-19-al)
 3 β ,7 β ,23-Trihydroxy cucurbita-5,24-diene-7-O- β -D-glucoside
 3 β ,7 β ,25-Trihydroxy cucurbita-5(23E)-dien-19-al
 $n\text{-C}_{28}\text{H}_{58}$
 $\text{CH}_3(\text{CH}_2)_{29}\text{OH}$
 7-Stigmastadien-3 β -ol
 7,25-Stigmastadien-3 β -ol
 5,25-Stigmastadien-3 β -ol-glucoside

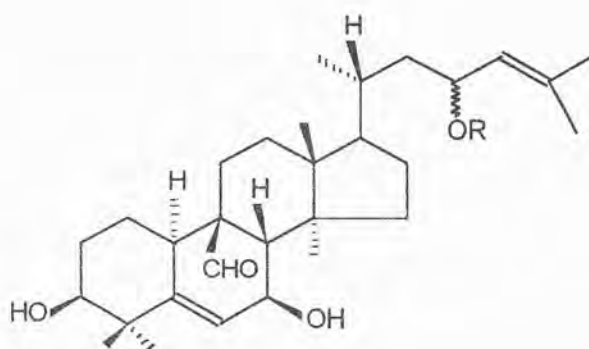
The leaves are a good source of calcium, carotene, riboflavin and ascorbic acid. Analysis of tender leaves from Philippines has given the following:

Moisture	82.5%	Nitrogen	1.042%
Ether ext.	0.47%	Crude fibre	1.8%
Ash	2.61%	Ca	297.0mg/100g
P	53.0mg/100g	Iron	3.27mg/100g
Carotene	5.57mg/100g	Thiamine	0.14mg/100g
Riboflavin	0.55mg/100g	Niacin	1.85mg/100g
Ascorbic acid	210.0mg/100g		



Vicine

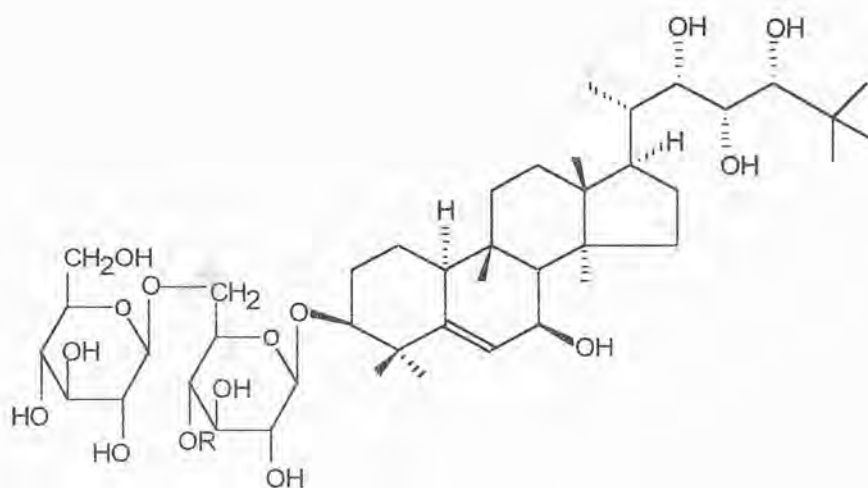
Chemical structure of Vicine



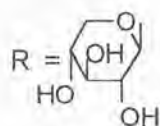
$R = H$: **Momordicine I**

$R = -D - \text{glucopyranosyl}$: **Momordicine II**

Chemical structures of Momordicine I and Momordicine II

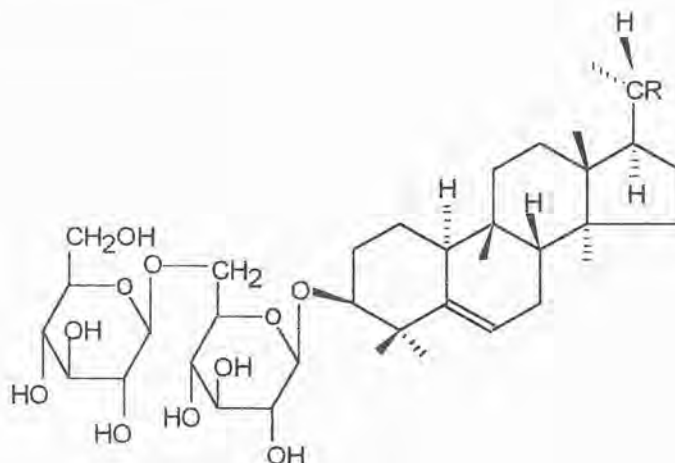


$R = H$: **Momordicoside A**



: **Momordicoside B**

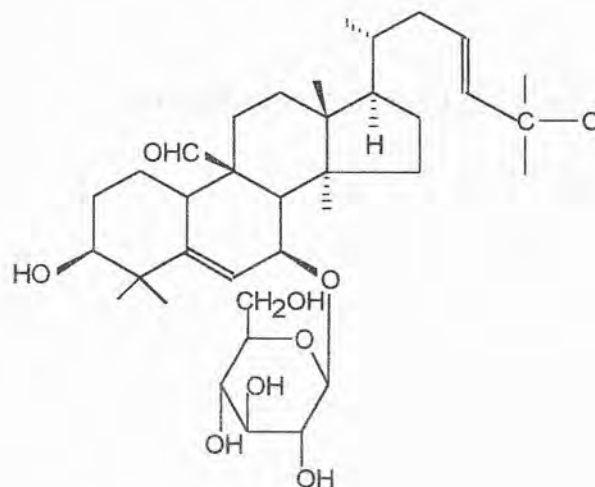
Chemical structures of Momordicoside A and Momordicoside B



$R = CH_2[CH(OH)]_2C(CH_3)_2OH$: **Momordicoside C**

$R = [CH(OH)]_2CH=C(CH_3)_2$: **Momordicoside D**

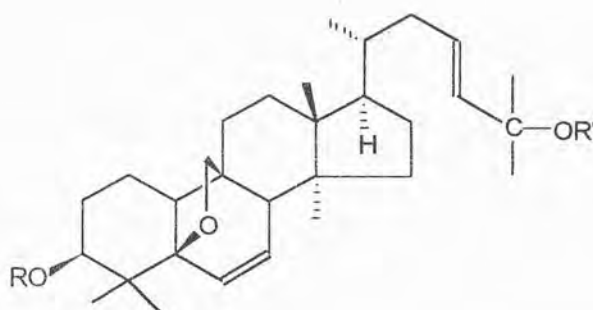
Chemical structures of Momordicoside C and Momordicoside D



R = CH₃ : **Momordicoside K**

R = H : **Momordicoside L**

Chemical structures of Momordicoside K and Momordicoside L



R = -D - glucopyranosyl R' = CH₃ : **Momordicoside F₁**

R' = H : **Momordicoside I**

R = -D - allopyranosyl R' = H : **Momordicoside F₂**

R' = CH₃ : **Momordicoside G**

Chemical structures of Momordicoside F₁, F₂, G, and I

Figure 1. Chemical Constituents of bitter gourd

6.0 BIOLOGY AND HEALTH ASPECTS

6.1 BIOLOGICAL ACTIVITY

Hypoglycaemic activity^{7,17,19,67,74,75,111,149,182,214,,215} :

In the recent years, bitter gourd came into prominence when its hypoglycemic effect and the consequent impact on diabetics mellitus became known. Three groups of polypeptides, of different molecular weights showed elicit hypoglycemia in diabetic and normal fasting mice and inhibit the binding of I-insulin to its antibodies and its hepatic receptors.

A hypoglycaemic peptide, which was termed, 'polypeptide P' has a minimum molecular weight of 11,000. The composition of this amino acid, is substantially different from that of insulin, and it does not cross react in a radioimmuno assay for bovine insulin. However at a dose of 0.5 nits or approximately 20µg per kg body weight, it produces a 60% decline in blood glucose level 4 hours post injection in normal fasting gerbils and langurs and diabetic patients.

Studies have shown that the supernatant obtained on centrifugation of the pressed juice of the fruit without seeds to be most active leading to a significant fall in blood sugar level, in male Sprague – Dawley rats. In a further study it was found that the fruit juice of plant caused an increased glucose uptake by tissue *in vitro* with out concomitant increase of tissue respiration. Oral treatment with the juice prior to a glucose load was found to increase the glycogen content of liver and muscle while it had no effect on the triglyceride content of adipose tissue.

It was found that the activity of the fruit juice was significantly potentiated by giving it in a combination, with fruits of *Embllica officinalis* Gaertn and rhizomes of *Curcuma longa* Linn. Similarly, a significant hypoglycaemic effect was observed when a composition drug, containing compound isolated from different plants including the fruit extract was injected intra peritonally to alloxan diabetic mice.

Charantin, isolated from the fruits of bitter gourd, elicited a 15% fall in blood glucose level 12 hours after intraperitoneal administration to normal fasting rats but it was devoid of hypoglycaemic effect in alloxanized rats. Hypoglycaemic activity of orally administered juice was reported in normal and alloxan induced diabetic rabbits. A maximum fall of 50% in blood glucose concentration was achieved 2 hours post injection when the dose was 12ml/kg. Dried and powdered fruit given orally in the form of a 1% carboxymethyl cellulose solution brought about maximum hypoglycaemia in both normal fasting and diabetic rabbits only at the tenth hour after injection. Pure vicine has been found to possess 32.6% hypoglycaemic activity, and is nonhaemolytic.

The fruit juice of bitter gourd was found to be a potent scavenger of super oxide and hydroxyl radicals. These oxygen radicals are implicated in diabetes and the reported anti-diabetic activity of the fruit juice may be mediated through this mechanism.

Cytostatic and cytotoxic activity^{30,96,101,187,189,186,190,191,204}

Crude aqueous extract of bitter melon has both cytostatic and cytotoxic activities, and is a competitive inhibitor of guanylate cyclase. In a study, a crude extract of *Momordica charantia* was purified and characterized for cytostatic factor, which also exhibits anti-viral activity.

It was found that toxin and non-toxin lectins, momordin and momordica agglutinin are to be single polypeptide chains. The LD₅₀ of momordin was 5mg/kg and it inhibit protein biosynthesis of Ehrlich ascites tumour cells. Momordica agglutinin was able to agglutinate the human O type red blood cells at a concentration of 0.5µg/ml. Galactose or its derivatives were able to inhibit the hemagglutination.

It was also found, that momordin from seeds has an LD₅₀ value of 8.8mg/kg to mice. Also a single dose of momordin 50µg/kg completely inhibited the growth of *Ehrlich ascites* carcinoma.

Anti-viral activity^{89,90}

A inhibitor of human immuno-deficiency virus (HIV) was isolated and purified to homogeneity from seed and fruits. The compound MAP 30 (Momordica Anti-HIV Protein), is a basic protein of about 30kDa. It exhibits dose dependent inhibition of cell-free HIV-1 infection.

MAP 30 at concentration of 1.67µM caused 86% inhibition on syncytium formation in HIV-infected CEM-S5 cell lines, and an LD₅₀ of 0.83M was obtained.

Anti-bacterial activity^{140,219}

High concentrations of the raw fruit aqueous extract (50%) and rind (30 & 50%) showed effective activity against *Escherichia coli* and *Bacillus subtilis* and even lower concentrations against *Proteus vulgaris*. Maximum inhibition was observed with 50% rind extract against *Escherichia coli*.

Ethanollic and methanolic extracts of seeds of *Momordica charantia* when screened for their anti-microbial activity against 8-gram-positive and 3 gram-negative bacteria also have shown considerable *in vitro* anti-microbial activity.

Anti-fungal activity²⁴

Momordicine I and momordicine II have shown activity against *Collectotrichum gloeosporioides* and *Cladosporium cucumerinum*. 33.3% and 58.8% activity against *C. gloeosporioides* with momordicine I at 0.5 and 1.0mg/ml. While 16.7 and 22.9% inhibition for momordicine II at 0.25 and 0.5mg/ml respectively. Momordicine I exhibited activity against *C. cucumerinum* at 0.5mg/ml while momordicine II did not show any activity up to 1mg/ml.

Anti-feedent and insecticidal activity^{44,84,137}

Extracts of *Momordica charantia* have shown activity against *Amsacta moorei* 2nd instar larvae. In another study it was found a seed oil emulsion, resulted in 100% killing of the larvae of *Athalia proxima*, 48h after spraying, both under laboratory and field conditions. Spraying of 1% and 0.5% emulsion also resulted in significant kill of the larvae.

Leaf extract when screened for activity against *Plasmodium falciparum* cultured *in vitro*, inhibited growth in a dose dependent manner. The IC₅₀ value is 68.4µg/ml.

In addition momorcharin I and II isolated from seeds are very potent in the inhibition of protein synthesis in the cell-free system. The i.p. LD₅₀ values for mice were 2.54 and 9-14mg/kg respectively. Due to a lower level of toxicity, momorcharin II is more suitable for manufacture of immunotoxins.

6.2 TOXICOLOGY

The isolated vicine of seeds had shown that it has toxic properties too. Vicine is a favism inducing toxin.

6.3 ETHNOMEDICINE

6.3.1 HOME REMEDIES^{36,44,66,111,114,202,213}

The fruit is used in folk remedies for tumours in Brazil. The seeds are administered as an anthelmintic, the dose being two to three seeds. The anthelmintic action is said to reside in the embryo. In Congo, the leaf is used for colic and the seed for roundworm.

In the Indian peninsula the whole plant, mixed with cinnamon, long pepper, rice and oil of *Hydnocarpus venetaous* is used as an ointment in psoriasis, scabies and other cutaneous diseases. The root is used as an abortifacient. Bahamians used it for colds, flu, and fever. Cubans, for colitis, fever and hepatitis and as litholytic.

In Japan, the plant enters into the composition of a remedy for skin ailments, headache and constipation. In the Philippines, the plant is used in making an arrow poison. In China used as a mono herbal medicine, dried fruit, powdered, and made into pills, 18g/day for diabetes mellitus, effective with mild and moderately chronic cases, reducing glucose in the blood and urine, and the frequency of urination.

Young girls suffering from painful menstruation are given half a cup of a decoction made from leaves. Boiling is for two minutes, and often the mixture includes a piece of *Euphorbia hirta*, a pinch of salt, and a strip of orange peel. Adults take a leaf tea for high blood pressure.

For diabetes mellitus (mild, non-insulin dependent) and fertility regulation, the upper four leaves are steamed and half a cup is drunk twice daily or 1/3 cup thrice a day, 30 minutes before meals. A decoction of 6 tablespoons of finely chopped leaves boiled in

two glasses of water over a low fire for fifteen minutes is also used for diabetes. (Aluminum pots should not be used.)

6.3.2 AYURVEDIC USES ¹¹⁴

The fruit is useful in rheumatism, gout and diseases of liver and spleen. It is also considered as tonic, stomachic carminative and cooling.

Leaf juice ½ tola with a little turmeric powder added is given for the nausea of children, as it acts as an emetic and thus cleanses the stomach.

In liver complaints of children a mixture of the juice of bitter gourd leaves, that of leaves of *Adansonia digitata*, ripe betel leaves and the fresh bark of *Eugenia jambolana*, in which sweet flag root is rubbed is given for seven days. Root is applied externally as a paste for piles.

Powdered whole plant is used for dusting over leprous and other intractable ulcers and in healing wounds. Mixed with cinnamon, long pepper, rice and chaulmugra oil forms a good ointment in psora, scabies, malignant ulcers and other skin diseases.

Externally it is applied to the scalp in pustular eruptions, burns, boils, etc. The plant is also used in snake bite. Leaf juice in which black pepper is ground is applied round the orbit for night blindness. Leaf juice is rubbed to soles in the burning of feet. Nursing mothers are fed with Karavila to increase the flow of milk.

The leaves are crushed and the juice is massaged into the skull. It encourages the growth of hair.

6.4 COMMERCIAL PREPARATIONS

Table 4 : Commercial preparations of bitter gourd

PRODUCT	DESCRIPTION	USES
Karawila Capsules	Each capsule contains the equivalent of 10g Karawila extract	For diabetes

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