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Medicinal and nutritional importance of bitter melon (*Momordica charantia* L): A review article

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Abstract

Momordica charantia (bitter gourd; family Cucurbitaceae) is an important medicinal vegetable crop, mostly found in tropical and subtropical regions of Asia, tropical Africa, Middle East and America. Bitter melon has been used as a folk remedy for tumors, asthma, skin infections and hypertension. The plant has been used as a traditional medicine in China, India, Africa, and the south-eastern US. It has a non-nitrogenous neutral principle charantin, and on hydrolysis gives glucose and a sterol. The fruit pulp has soluble pectin but no free pectic acid. Galacturonic acid is also obtained from the flesh. Bitter gourd is rich in nutrients like thiamine, beta-carotene, folate, riboflavin, and minerals like calcium, iron, phosphorus, manganese, potassium, magnesium, zinc and dietary fiber. Regular use of bitter gourd juice boosts body stamina and prevents chronic fatigue. The beta-carotene content in bitter gourd helps in controlling eye disorders and enhances eyesight. Bitter melon has Anti-Tumor, Anti-Inflammatory, Anti-oxidant, Ant diabetic, Hypo-lipidemic and Hypo-glycaemic properties.

Keywords: bitter melon, nutritional contents, medicinal properties, human health

Introduction

Over 1000 plants had been recognized to possess antioxidant and anti-diabetic potential including *Momordica charantia* (Ee Shian *et al.*, 2015) [3] *charantia* (bitter gourd; family Cucurbitaceae) is an essential medicinal vegetable crop, mostly found in tropical and subtropical regions of Asia, tropical Africa, Middle East and America. Depending on location, bitter gourd is also known as bitter melon, balsam pear, Kugua (China), Kerala (India), Nigeria URI (Japan), Ampalaya (Philippines), Mara (Thailand) and Peria (Malaysia).

Bitter gourd has received growing attention among all vegetable crops nowadays because it contains an abundance of hydrophilic and lipophilic compounds includes glucosides, saponins, alkaloids, fixed oils, triterpenes, proteins, steroids and polyphenolics that are associated with antioxidants, anti-diabetes, antimicrobial, anti-cancer, hypertensive properties and others. As a source of natural antioxidants, bitter gourd can delay or inhibit the oxidation of lipids or other molecules by inhibiting the initiation or propagation of oxidative chain reaction, in turn, prevent or repair the damage done to the body's cells by oxygen. It works excellently as either reducing agent, free radical scavenger, potential complexes of pro-oxidant metal and/or quencher of singlet oxygen against the free radicals that are known to harm healthy cells, create harmful molecules and contribute to the degenerative processes related to aging and cancer, cardiovascular disease and hypertension.

Bitter melon has been used as a folk remedy for tumors, asthma, skin infections, GI problems, and hypertension. The plant has been used as a traditional medicine in China, India, Africa, and the southeastern US. The plant has been used in the treatment of diabetes symptoms. In the 1980s, the seeds were investigated in China as a potential contraceptive. Morphologically, the bitter melon is an herbaceous vine which bears tendrils, and it creeps along supports. Leaves are simple and alternate, and flowers are yellow. Male and female flowers grow on separate plants. The fruit of the plant, which is known as the bitter melon, has an oblong shape with a warty exterior and is dark green. At least three different groups of constituents in bitter melon have been reported to have blood-sugar lowering actions of potential benefit in diabetes mellitus. These include a mixture of steroidal saponins known as charantin, insulin-like

peptides, and alkaloids (Gupta *et al.*, 2011) [6].

Origin and Distribution

The Karela is believed to be originated in the tropics of the old world. It is widely grown in India and other parts of the Indian subcontinent, Southeast Asia, China, Africa, and the Caribbean and South America as a food and medicine (Gupta *et al.*, 2011) [6].

Cultivation

Karela is an annual or perennial climber found throughout India and also cultivated up to an altitude of 1500m. It is cultivated during the warm season, i.e., during April to July by sowing seeds in a pit. Seeds are sown at a distance of half a meter and provided with manures. Only one plant is retained, and plant seedlings are watered once or twice a week. Plants begin to flower 30-35 days after sowing and fruits are ready for harvesting after flowering 15-20 days (Gupta *et al.*, 2011) [6].

Chemical composition

Momordica charantia has a non-nitrogenous neutral principle charantin, and on hydrolysis gives glucose and a sterol. The fruit pulp of *M. charantia* has soluble pectin but no free pectic acid. Galacturonic acid is also obtained from the flesh. *M. charantia* fruits glycosides, saponins, alkaloids, reducing sugars, resins, phenolic constituents, fixed oil and free acids. The presence of an unidentified alkaloid and 5-hydroxytryptamine is also reported. The 5HT content is reported to be present. The ether extract residue of the alcoholic concentrate from the leaves of *M. charantia* is reported to reveal hypoglycemia activity comparable to that of tolbutamide. The pure protein termed as P-insulin extracted from *M. charantia* fruits in crystalline form is also tested (Ee Shian *et al.*, 2015) [3].

Pharmacology

Oral administration of fresh fruit juice (dose, six c.c. /kg. body wt.) lowered the blood sugar level in normal and alloxan-diabetic rabbits. Oral administration of alcoholic extracts of the plant to some diabetic patients did not produce any hypoglycemic action. P-Insulin, a polypeptide from the fruits and seeds rapidly decreased and normalized the blood sugar level in rats (Ee Shian *et al.*, 2015) [3].

Properties

Bitter melon is a valuable vegetable. It is useful in most metabolic and physiological processes of the human body. It has the following properties: -

- Bitter melon is composed of various chemicals that have hypoglycemic activity, i.e., they reduce the amount of sugar in the blood.
- Bitter melon stimulates appetite.
- Bitter melon helps in the entire digestion process. Hence it is used in the treatment of digestive problems.
- Bitter melon has emetic, purgative and anthelmintic properties. It is also anti-flatulent.
- Bitter melon is used in the dissolution of fats from the body. It is known to have anti-lipolytic properties.
- Bitter melon possesses all the essential vitamins in reasonable amounts, such as vitamin A, thiamine, riboflavin, vitamin C and also minerals like iron.
- Bitter melon is anti-inflammatory and astringent. It has a specific action on the movement of bowels (Kumar *et al.*, 2010) [9].

Medicinal uses of bitter melon

Bitter gourd is rich in nutrients like thiamine, beta-carotene, folate, riboflavin, and minerals like calcium, iron, phosphorus, manganese, potassium, magnesium, zinc and dietary fiber. Regular use of bitter gourd juice boosts body stamina and prevents chronic fatigue. The beta-carotene content in bitter gourd helps in controlling eye disorders and enhances eyesight.

- Bitter melon stimulates a sluggish digestive system and treats dyspepsia.
- Scientific studies show that fresh juice of bitter melon can lower blood sugar values and keep Insulin under check.
- Bitter gourd juice can also prevent jaundice by strengthening the liver. By detoxifying and nourishing liver, bitter melon juice may be beneficial in the treatment of a hangover.
- Bitter melon is as an Immuno modulator. It might improve immune cell function in people with cancer.
- Piles: A popular folk remedy is to mix three teaspoonfuls of juice from bitter melon leaves with a glassful of buttermilk to be taken every morning for about a month on an empty stomach.
- Cholera: Fresh juice of leaves of bitter gourd is also a useful medicine in early stages of Cholera and other types of diarrhea (Ganesan *et al.*, 2008) [5].

Table 1: Botanical differences among the significant *Momordica* species of India.

	<i>M. charantia</i>	<i>M. dioica</i>	<i>M. balsamina</i>
Plant	A much branched climbing annual.	A dioecious, perennial climber with a tuberous root.	A monoecious, much branched, climbing Perennial form a tuberous root.
Stem	Angled, grooved, young parts densely hairy, older branches more or less pubescent.	Slender, glabrous to rarely sparsely pubescent, angled and sulcate.	slender, glabrous
Leaves	Almost orbicular or reniform in outline, lobes ovate-oblong, acute or subacute, apiculate.	Many variables, membranous, ovate, obtuse or acute and mucronate, lobes triangular.	Herbaceous or slightly hairy particularly on nerves beneath, lobes rhomboid or obovate to elliptic-rhomboid
Flowers	Monoecious, male flowers solitary, peduncles slender, glabrous or somewhat pubescent; Corolla somewhat irregular, lemon yellow; Female flowers on 5-10 cm long slender peduncles, bracteate usually at or near the base.	Male flowers solitary, glabrous peduncles which are hairy, Corolla yellow, Female flowers bracteate or ebracteate.	Monoecious, all solitary; Male flowers on slender, filiform peduncles, glabrous or somewhat hairy towards the apex, corolla pale yellow; Female flowers on ebracteate or bracteates peduncles
Fruit	Bright orange colored, 5-15 cm long, fusiform, ribbed, with numerous triangular tubercles giving it the appearance of crocodile skin.	Ellipsoid, shortly beaked, denselyechinate with soft spines, apex shortly prostrate and annular, base usually rounded.	Sub-globose to ovoid, with a broad, conical rostrum, abruptly and shortly attenuate at base, bright orange-red to scarlet when ripe
Seeds	Compressed, oblong, sub bi-dentate at base and apex, sculptured on sides, cream or grey colored.	Many, many variables in size and shape, turgid, more or less pyriform quite smooth.	with a carmine red arillus, grey, ovate or oblong in outline, compressed

(Sampath Kumar *et al.*, 2010) [12]

Table 2: Phytochemical constituents of the Bitter gourd.

Source	Phytochemicals
Plant body	Momorcharins, momordenol, momordicilin, momordicins, momordicin, momordin, momordolol, charantin, chlorine, cryptoxanthin, cucurbits, cucurbitacins, cucurbitanes, cycloartenols, diosgenin, eleostearic acids, erythrodiol, galacturonic acids, gentisic acid, goyaglycosides, goyasaponins, multiflorenol. Glycosides, saponins, alkaloids, fixed oils, cucurbitane-type triterpenes, proteins and steroids. Momordicine, charantin, polypeptide- p insulin, ascorbigen.
Fruits	Amino acids – aspartic acid, serine, glutamic acid, threonine, glutamic acid, threonine, alanine, g-aminobutyric acid and pipercolic acid, luteolin. Fatty acids – Lauric, myristic, palmitic, palmitoleic, stearic, oleic, linoleic, linolenic acid. Enzyme-Urease
Seeds	Amino acids – valine, threonine, methionine, isoleucine, leucine, phenylalanine and glutamic acid

(Anil kumar *et al.*, 2015) ^[2]**Table 3:** Proximate composition of *M. charantia* leaf, fruit, and seed

Parameter (%)	Leaf	Fruit	Seed	Element in leaf	ppm
Moisture (wet wt)	17.97 ± 1.00	10.74 ± 2.29	20.69 ± 5.85	Calcium	20510.00 ± 5.77
Total ash (dry wt)	15.42 ± 2.08	7.36 ± 0.52	9.73 ± 2.34	Sodium	2200.00 ± 1.15
Crude Fat (DW)	3.68 ± 0.68	6.11 ± 0.42	11.50 ± 1.77	Potassium	413.00 ± 1.45
Crude fiber (DW)	3.31 ± 1.25	13.60 ± 1.13	29.60 ± 1.25	Magnesium	255.00 ± 0.69
Crude protein (DW)	27.46 ± 1.60	27.88 ± 3.75	19.50 ± 0.73	Manganese	156.00 ± 0.33
Carbohydrate (DW)	32.34 ± 0.24	34.31 ± 0.30	9.18 ± 0.86	Zinc	120.00 ± 1.15
Caloric value kcal/100g	213.26	241.66	176.61	Iron	98.00 ± .23
-	-	-	-	Copper	32.00 ± 1.85

*Results are mean of 3 determinations ± SEM. Means with same super script down the row are not significant (P>0.05). DW = Dry weight. (Kumar and Khurana, 2016) ^[8]

Pharmacological and medicinal uses

Anti-tumor properties

Some researchers have found that Thai bitter gourd fruit contained anti-carcinogens or chemo-preventive agent (Yasui *et al.*, 2005) ^[16]. Viral in vivo studies have demonstrated the anti-tumoral activity of the entire plant of bitter gourd. In one study, a water extract blocked the growth of rat prostate carcinoma; another study reported that a hot water extract of the entire plant inhibited the development of mammary tumors in mice. Numerous in vitro studies have also demonstrated the anti-cancerous and anti-leukemic activity of bitter gourd against numerous cell lines, including liver cancer, human leukemia, melanoma and solid sarcomas (Fang *et al.*, 2012) ^[4]. The other realm is showing that bitter gourd is as an active immune modulator. However, one clinical trial found insufficient evidence that bitter gourd might improve immune cell function in people with cancer, but this needs to be verified and amplified in other research (Pongnikorn *et al.*, 2003) ^[11].

Anti-inflammatory properties

Ganesan *et al.* (2008) ^[5] demonstrated that anti-inflammatory activity of dried leaves was comparable to 10 mg/kg of indomethacin. Further, Sharma *et al.* ^[14] reported wound healing capacity of fruit powder were comparable to those of povidone-iodine ointment in an excision, incision and dead space wound model in rats.

Anti-oxidant properties

Different parts of this plant have been used in the Indian medicinal system for some ailments besides diabetes. Antioxidant activity of extracted phenolic compound from bitter melon has been reported (Horax *et al.*, 2005) ^[7]. Antioxidant properties of *Momordica charantia* (Karela) seeds on Streptozotocin induced-diabetic rats has been studied and results clearly suggest that seeds of *Momordica charantia* (Karela) may effectively normalize the impaired antioxidant status in streptozotocin induced-diabetes (Sathishsekar *et al.*, 2005) ^[13].

Hypo-glycaemic activity

Charantin isolated from fruits of *M. charantia* was tested for

its hypoglycemic activity. In fasting rabbits, it gradually lowered blood sugar within one to four hours and recovered slowly to the initial level. Charantin was found to be more potent than tolbutamide. However, both compounds produced the similar pattern of blood sugar change. The hypoglycemic activity of charantin in depancreatized cats was less, but abolished, indicating a pancreatic as well as extra-pancreatic action (Lolithkar *et al.*, 1966) ^[10].

Hypo-lipidemic properties

In an in vivo study (Ahmed *et al.*, 1998) ^[1] the elevated cholesterol and triglyceride levels in diabetic rats were returned to normal value after 21 days of administration of bitter gourd fruit and seeds. Viridi *et al.* (2001) ^[15] evaluated the effects of bitter gourd oil (BGO) on the blood and liver lipids of rats.

Anti-diabetic Activity

Karela contains bitter chemicals like, charantin, vicine, glycosides and arabinosides along with polypeptide-p plant insulin, which is hypoglycemic in action and improves blood sugar levels by increasing glucose uptake and glycogen synthesis in the liver, muscles and fat cells. Reports indicate that they also improve insulin release from pancreatic beta cells, and repair or promote new growth of insulin-secreting beta cells. P-Insulin, a polypeptide from the fruits and seeds rapidly decreased and normalized the blood sugar level in rats. Bitter melon contains another bioactive compound, i.e., lectin that has insulin-like activity. The insulin-like bioactivity of lectin is due to its linking together two insulin receptors. This lectin lowers blood glucose concentrations by acting on peripheral tissues and, similar to insulin's effects in the brain, suppressing appetite. This lectin is a major contributor to the hypoglycemic effect that develops after eating Karela. Charantin extracted by alcohol is a potent hypoglycemic agent composed of mixed steroids which are sometimes used in the treatment of diabetes to lower the blood sugar levels (Kumar *et al.*, 2010) ^[9].

Conclusion

Momordica charantia Linn. (Karela) Is a potential herbal plant which is used as vegetable and medicine. It is a good

source of various medicinally important bio-chemicals like, triterpene, protein, steroid, alkaloid, and phenolic which are responsible for its biological and pharmacological activities including anti-diabetic, antioxidant, anti-cancerous and anti-tumorous, anti-microbial, anti-fertility, anti-viral, anti-helminthic, anti-malarial, anti-ulcerative and immuno modulatory etc. on the basis of all these properties *Momordica charantia* Linn. (Karela) can be utilized as a good source of nutritional, medicinal and pesticidal agent.

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