Introduction

Over 1000 plants had been recognized to possess antioxidant and anti-diabetic potential including Momordica charantia (Ee Shian et al., 2015) (Charantia; 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), Peri (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 plant seedlings 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 alloxaan-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:

- a) Bitter melon is composed of various chemicals that have hypoglycemic activity, i.e., they reduce the amount of sugar in the blood.
- b) Bitter melon stimulates appetite.
- c) Bitter melon helps in the entire digestion process. Hence it is used in the treatment of digestive problems.
- d) Bitter melon has emetic, purgative and anthelmintic properties. It is also anti-flatulent.
- e) Bitter melon is used in the dissolution of fats from the body. It is known to have anti-lipolytic properties.
- f) Bitter melon possesses all the essential vitamins in reasonable amounts, such as vitamin A, thiamine, riboflavin, vitamin C and also minerals like iron.
- g) 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.

1. Bitter melon stimulates a sluggish digestive system and treats dyspepsia.
2. Scientific studies show that fresh juice of bitter melon can lower blood sugar values and keep Insulin under check.
3. 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.
4. Bitter melon is as an Immuno modulator. It might improve immune cell function in people with cancer.
5. 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.
6. 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.**

<table>
<thead>
<tr>
<th></th>
<th><em>M. charantia</em></th>
<th><em>M. dioica</em></th>
<th><em>M. balsamina</em></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stem</strong></td>
<td>Angled, grooved, young parts densely hairy, older branches more or less pubescent.</td>
<td>Slender, glabrous to rarely sparsely pubescent, angled and sulcate.</td>
<td>slender, glabrous</td>
</tr>
<tr>
<td><strong>Leaves</strong></td>
<td>Almost orbicular or reniform in outline, lobes ovate-oblong, acute or subacute, apiculate.</td>
<td>Many variables, membranous, ovate, obtuse or acute and mucronate, lobes triangular.</td>
<td>Herbaceous or slightly hairy particularly on nerves beneath, lobes rhomboid or obovate to eliptic-romboid</td>
</tr>
<tr>
<td><strong>Flowers</strong></td>
<td>Monoeocious, 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.</td>
<td>Male flowers solitary, glabrous peduncles which are hairy, Corolla yellow, Female flowers bracteate or ebracteate.</td>
<td>Monoeocious, 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</td>
</tr>
<tr>
<td><strong>Fruit</strong></td>
<td>Bright orange colored, 5-15 cm long, fusiform, ribbed, with numerous triangular tubercles giving it the appearance of crocodile skin.</td>
<td>Ellipsoid, shortly beaked, denselyechinate with soft spines, apex shortly prostrate and annular, base usually rounded.</td>
<td>Sub-globe to ovoid, with a broad, conical rostrum, abruptly and shortly attenuate at base, bright orange-red to scarlet when ripe</td>
</tr>
<tr>
<td><strong>Seeds</strong></td>
<td>Compressed, oblong, sub bi-dentate at base and apex, sculptured on sides, cream or grey colored.</td>
<td>Many, many variables in size and shape, turgid, more or less pyriform quite smooth.</td>
<td>with a carmine red arillus, grey, ovate or oblong in outline, compressed</td>
</tr>
</tbody>
</table>

(Sampath Kumar et al., 2010) [12]
Pharmacological and medicinal uses

Anti-tumor properties
Some researchers have found that Thai bitter gourd fruit contains anti-carcinogens or chemo-preventive agent (Yasui et al., 2005) [16]. Viral in vivo studies have demonstrated the anti-tumour 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) [40]. 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 (Sathishsekhar 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 charantinin 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. Virdi 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., lecin that has insulin-like activity. The insulin-like bioactivity of lecin is due to its linking together two insulin receptors. This lecin lowers blood glucose concentrations by acting on peripheral tissues and, similar to insulin's effects in the brain, suppressing appetite. This lecin 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

### Table 2: Phytochemical constituents of the Bitter gourd.

<table>
<thead>
<tr>
<th>Source</th>
<th>Phytochemicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant body</td>
<td>Momorcharins, momordenol, momordicillin, momordincins, momordincinin, momordin, momordolol, charantin, chlorine, cryptoxanthin, curcurbitis, cucurbititas, cucurbitanes, cycloartenols, diosgenin, elaeostearic acids, erythrodial, galacturonic acids, gentisic acid, goyaglycosides, goyasaponins, multiflorolens. Glycosides, saponins, alkaloids, fixed oils, cucurbitane-type triterpenes, proteins and steroids. Momordicine, charantin, polypeptide-p insulin, ascorbigen.</td>
</tr>
<tr>
<td>Fruits</td>
<td>Amino acids – aspartic acid, serine, glutamic acid, threonine, glutamic acid, threonine, alanine, a-gaminobutyricacid and pivecolic acid, tuteolin. Fatty acids – Lauric, myristic, palmatic, palmitoleic, stearic, oleic, linoleic, linolenic acid. Enzyme-Urease</td>
</tr>
<tr>
<td>Seeds</td>
<td>Amino acids – valine, threonine, methionine, isoleucine, leucine, phenylalanine and glutamic acid</td>
</tr>
</tbody>
</table>

(Anil kumar et al., 2015) [2]

### Table 3: Proximate composition of M. charantia leaf, fruit, and seed

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

*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]
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 immune 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.

References


