An overview of bitter gourd: Nutritional and therapeutic benefits

Arun HR, GP Sharma, Nagarathna SB, RC Verma and Arun Kumar Goyal

Abstract
Bitter gourd (Momordica charantia L.) belongs to the family Cucurbitaceae. It has significant prominence in providing basic nutritional and medicinal values. It contains various bioactive components including antioxidants, catechin, gallic acid, genistematic acid, chlorogenic acid, polysaccharides, triterpenoids, alkaloids, flavonoids, quinine etc., also good source of vitamins and minerals. The present review paper has presents the pharmacological effects like anti diabetic, antibacterial, anti HIV, Anti cancer and Anti-tumor properties, and antioxidant activities an insight to understand the mechanism of action.

Keywords: Bitter gourd, nutritional value, bioactive compounds, therapeutic properties

Introduction
Momordica charantia L. generally known as bitter gourd, bitter melon, karela or balsam pear (Satkar et al., 2013) belongs to a family Cucurbitaceae. It is one of the important vegetable because of its rich nutrition and medicinal properties (Islam et al., 2011). The major growing regions of bitter gourd are South, Southeast and East Asia, Caribbean, South America, Middle East and America and East Africa (Cefalu et al., 2008; Counsense et al., 2008) and it is grown for its medicinal values and also for the ornamental purpose (Heiser, 1979). They are rich source of Vitamin A and C, essential amino acids, folic acid, thiamine, riboflavin, carotenoids and minerals (Horax et al., 2010; Sandra et al., 2011) because of its rich source; it plays an vital role in human diet. The intake of bitter gourd is increasing day by day due to its therapeutic value like catechin, gallic acid, genistematic acid, chlorogenic acid (Budrat and Shotipruk, 2009), polysaccharides, triterpenoids, alkaloids, flavonoids, quinine (Grover and Yadav, 2004) and saponin compounds (Tan et al., 2014). The polysaccharides of the bitter gourd contains bioactive constituents like antioxidant, anti diabetic, immune enhancing, neuroprotective, antitumor and antimicrobial (Zhang et al., 2016). It also contains principal component “Momordin” i.e. Momordin I is having tumour protective effects; momordicines I and II also having antimicrobial, acylglycosylerols antimutagenic, and chitinase bacteriostatic effects (Nerurkar et al., 2008).

Botanical Description
Bitter gourd is grown in different varieties in different countries. In India the main varieties are India long green, India long white and Hybrid India baby whereas Japan is famous for Japan Green Spindle, China is for Green lover and Hong Kong for its Hong Kong Green. In Bangladesh mainly two varieties are grown i.e. Uchee (small) and Korolla (long) (Alam et al., 2015). The bitter gourd plant is perennial with climbing and flowering vine grows up to 5 m and fruits are elongated with ridges on surface (Lee et al., 2009). The young fruit is emerald green and later changes to orange-yellow when it is ripened (Kandangath et al., 2015). The shape and size of bitter gourds vary due to varieties, climatic factors, regions but in general bitter gourds are 1.0 to 9.8 inch long and 1.0 to 5.9 inch wide with round, oval, oblong and club in shape and color varies from dark green to white. In India the length of bitter gourd ranges from 2.4 to 3.9 inch and dark green in color with ridges on its surface (Kumar et al., 2016). The bitter gourd fruit gets mature after 45-80 days and harvesting is carried out after 60 days and continues up to 150 days from the planting (Islam et al., 2011). The shelf life of fresh bitter gourd is only 4 days at natural conditions and it can be stored up to 3-4 weeks in cold storage (0 to 7 °C) (Wang et al., 2007).
Nutritional composition of bitter gourd

The bitter gourd is highly nutritious due to presence higher amount of protein, ascorbic acid, calcium, iron and phosphorus (Assubaie and EI-Garawy, 2004, Dandawate et al., 2016) (2, 11), also important source of glucosides, carbohydrate, charantin, steroidal, saponin, momordium, vitamins, protein and minerals. The protein content in bitter gourd is fractioned into albumin (49.3 per cent), globulin (29.3 per cent) and glutelin (3.1 per cent) (Horax et al., 2010) [16]. Nutritional composition of bitter gourd fruit are shown in Table 1 and 2. The seeds of the bitter gourd contain 35 to 40 per cent of oil and fatty acid i.e. 3.33 per cent MUFA (monosaturated fatty acid) and 36.71 per cent SFA (saturated fatty acids) (Grossmann et al., 2009; Liu et al., 2010) [14, 26]. Bitter gourd contains high amount of Vitamin A, Vitamin C and vitamins, B1, B3, B6 and B17 (Joseph and Jini, 2013) [20].

Bitter gourd seeds are good source of minerals such as potassium, magnesium, calcium, sodium and phosphorous being the most abundant and highest among the other minerals in fruits and leaves (Liu et al., 2010) [20]. The total phenolic content in bitter gourd was examined by HPLC method, found that for immature, mature and ripe bitter gourd contains 6.9 to 15.7, 6.4 to 14.8 and 4.3 to 14.9 mg GAE/g ethanol extract, respectively and identified phenolic components are gallic acid, epicatechin, catechin, chlorogenic acid, caffeic acid, hydroxy benzoic acid and pyrogallol (Popovich et al., 2010) [32] along with moromordicin, U. momordicinone I, momordicin II (Pandit et al., 2016; Sabourian et al., 2016) [30, 13]. The presence of galacturonic acid in the pulp is also reported. The bitterness of bitter gourd is due to presence of Momordicine and Charingtine which is responsible for health encouraging effect (Kumar et al., 2010) [24].

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Fruit (mg/g)</th>
<th>Leaf (mg/g)</th>
<th>Seed (mg/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>10.74 ± 2.29</td>
<td>17.95 ± 1.00</td>
<td>20.64 ± 5.85</td>
</tr>
<tr>
<td>Total ash (%)</td>
<td>7.36 ± 0.52</td>
<td>15.42 ± 2.08</td>
<td>9.73 ± 2.34</td>
</tr>
<tr>
<td>Crude fibre (%)</td>
<td>6.11 ± 0.42</td>
<td>3.68 ± 0.68</td>
<td>11.50 ± 1.77</td>
</tr>
<tr>
<td>Fiber (%)</td>
<td>1.7 ± 0.5</td>
<td>3.31 ± 1.25</td>
<td>29.60 ± 1.25</td>
</tr>
<tr>
<td>Crude protein (%)</td>
<td>27.88 ± 3.75</td>
<td>27.46 ± 1.60</td>
<td>19.50 ± 0.73</td>
</tr>
<tr>
<td>Carbohydrate (%)</td>
<td>34.31 ± 0.30</td>
<td>32.34 ± 0.24</td>
<td>9.18 ± 0.86</td>
</tr>
<tr>
<td>Calorific value (kcal/100g)</td>
<td>241</td>
<td>213</td>
<td>176</td>
</tr>
</tbody>
</table>

(Source: Bakare et al., 2010) [3]

Table 2: Mineral composition of bitter gourd

<table>
<thead>
<tr>
<th>Components</th>
<th>Concentration (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>20510 ± 5.77</td>
</tr>
<tr>
<td>Magnesium</td>
<td>255 ± 0.69</td>
</tr>
<tr>
<td>Sodium</td>
<td>2200 ± 1.15</td>
</tr>
<tr>
<td>Potassium</td>
<td>413 ± 1.45</td>
</tr>
<tr>
<td>Iron</td>
<td>98 ± 0.23</td>
</tr>
<tr>
<td>Zinc</td>
<td>1210 ± 1.15</td>
</tr>
<tr>
<td>Manganese</td>
<td>1510 ± 3.30</td>
</tr>
<tr>
<td>Copper</td>
<td>32 ± 1.85</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>66000 ± 141</td>
</tr>
<tr>
<td>Vitamin B12</td>
<td>5355 ± 7.10</td>
</tr>
<tr>
<td>Folic acid</td>
<td>20600 ± 42.43</td>
</tr>
</tbody>
</table>

(Source: Bakare et al., 2010) [3]

Therapeutic aids of bitter gourd

The various researchers studied the therapeutic properties of bitter gourd, they are anti-diabetic, anti-ulcerogenic, anti-mutagenic, anti-leukemic, antioxidant, anti-HIV, anti-bacterial, anti-tumor, immune-modulatory activites etc., (Uebanso et al., 2007; Kandangath et al., 2015) [42, 22]. Some important therapeutic effects are described as follows:

a) Antidiabetic activity

Many research studies proven that the intake of bitter gourd fruit, juice, dried powder and extracts acts as a anti-diabetic medicine by lowering of blood sugar level (Lawrence et al., 2009). Ali et al. (1993) found that after consumption of saponin free methanolic extract of bitter gourd juice by insulin-dependent diabetes mellitus (IDDM) rats and normal rats showed that significant hypoglycemic effect in fasting and post-prandial states than non-insulin-dependent diabetes mellitus (IDDM). The consumption of bitter gourd extracts about 13.33 g pulp per kg body weight/day by diabetic rats they observed reduce in body weight and high level of fasting blood glucose (Chatuvedi et al., 2010; Klamann et al., 2010) [23]. In alloxan diabetic albino rats, the acetone extract of bitter gourd about 50, 25 and 75 mg per 100 g body weight lowered the level of glucose in blood from 13.30 to 50 per cent after treatment for 8 to 30 days (Singh et al., 2007; Jiang et al., 2016) [18, 19]. The anti-hyperglycemic property of bitter gourd is due to presence of compounds like oleanc acid 3-O-glucuronide, charantin, polypeptide-p, oleancic acid 3-O-monodesmoside and momordicin and these compounds enhance the production of insulin and promote the growth and repair of beta cells in pancreatic beta cells (Wang et al., 2010) [44]. The bitter gourd acts as vegetable insulin (Leung et al., 2009) [20] and also increases the use of glucose in liver and muscle (Sarkar et al., 1996) [36].

b) Anti-bacterial activity

Bitter gourd is a basis for natural products which is derived from plant with antifungal-modifying and antiepimastigote activity (Santos et al., 2012) [18] and presence of Alphamomorcharin has ability to inhibit the fungal growth and bacterial growth due its Ribosome Inactivating Protein (RIP) (Zhu et al., 2013) [19]. The extract of whole plant has antiprotozoal action and extracts of bitter gourd leaf viz. methanol, water and ethanol has antibacterial action against Salmonella, Pseudomonas aeruginosa, E. coli, Bacillus and Streptococcus (Brandao et al., 2016). In Colombia and Panama tea from leaves of bitter gourd leaves was used for treatment of malaria and by laboratory studies was confirm that species associated with bitter gourd has anti-microbial activity (Olasehinde et al., 2014).

c) Anti-HIV activity

The fruit, seeds and leaves of bitter gourd has α and β-momorcharin protein and these protein acts as an anti-HIV activity in-vitro (Zheng et al., 1999) and also suppress the HIV-1 integrase (Au et al., 2000). The bitter gourd also contains MRK29 protein which has ability to inhibit the viral reverse transcriptase (Wang and Ng, 2001).

d) Anti-cancer and Anti-tumor properties

The bitter gourd has several components which exhibit anticanic properties they are, moromdirin I, i.e. and Id, Alpha and beta momorcharin, cucurbitacin B and MAP-30 (Fan et al., 2015) [12]. The anti-proliferative action of bitter gourd extract used to inhibits the growth breast cancer by encouraging autophagic cell death (170). The growth of
prostate cancer inhibited by the Kuguacin J which is extracted from bitter gourd (Pitchakarn et al., 2011, Brennan et al., 2012) [31, 4]. From in-vivo and in-vitro studies stated that MAP-30 is efficient and safe against liver cancer (Fang et al., 2012a) [13]. The bioactive components of bitter gourd inhibit the DNA, RNA and cellular protein synthesis and it also suppress the cell cycle G2. It inhibit the uptake of thymidine, uridine and leucine into DNA through M phase (Claflin et al., 1978) [9] and also induction of apoptosis can be observed by treatment of bitter gourd (Sun et al., 2001) [39].

e) Anti-oxidant activity
The anti-oxidant activity of bitter gourd from phenolic extracts has been reported (Horax et al., 2005). The leaf extract has highest value of DPPH radical-scavenging activity and ferric reducing power whereas bitter gourd fruit has highest value of hydroxyl radical-scavenging activity, beta-carotene-linoleate bleaching assay and total anti-oxidant capacity (Yadav et al., 2016) [46]. The anti-oxidants are capable of damaging and contracting free radicals (Kamal et al., 2011; Yehye et al., 2016) [21, 47]. The stress-induces lipid peroxidation is inhibited by bitter gourd by increasing the catalase activity and levels of reduces glutathione (Chaturvedi, 2009, Alam et al., 2015) [6, 1]. So bitter gourd should be used in human diet.

Conclusion
The main reason for the interest in bitter gourd is its medicinal and nutritional properties. Bitter gourd is bitter in taste but not bitter for health. Because the presences of many bioactive components are naturally present in this bitter gourd and have potentially act as therapeutic benefits. This review provides the information about pharmacological effects like antidiabetic, antibacterial, anti-HIV, anti-cancer and anti-tumor properties, and antioxidant activities.

References
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