Charantin: A Neglected Antidiabetic Compound from *Momordica charantia* L.

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**ABSTRACT**

The advancement of active and safe blood glucose lowering agent is yet a significant challenge for present day scientific research. Generally fruit juice of *Momordica charantia* has been utilized for the treatment of diabetes for a considerable length of time. Charantin, a special steroidal glycoside, isolated from *Momordica charantia*, has been identified as a therapeutic agent with blood sugar lowering capacity. However, for treating diabetes, this compound was not clinically investigated. This survey compresses the science, mode of operation and revealed clear strategies for charantin.

**Keywords:** Charantin, *Momordica charantia*, Anti Diabetic, Pharmacology, Extraction, Analysis.

**INTRODUCTION**

*Momordica charantia* L. (Bitter Melon-MC), a tropical vegetable belonging to the family Cucurbitaceae is a typical vegetable in Indian diet, and it is widely consumed as raw juice and as cooked vegetable. It is one such medication which has been utilized since ages for its culinary purposes and additionally for therapeutic properties – mainly as hostile to a person with diabetes. MC is widely known as bittermelon, balsam pear or bitter cucumber in English. Its vernacular names in India are Karela (Hindi) and Karvella (Sanskrit).

The examination of the products of MC expounds a gathering of more than 30 triterpenoids and more than ten steroids which have been discovered from leaves, organic products, seeds, roots, and stems. Various phytoconstituents are isolated from MC, such as, momordicins, momordin, cucurbitins, gentisic acid, erythrodiol, diosgenin, chorine, cryptoxantin, multiflorenol etc.. These are accounted for in every part of the MC plant.

The seeds and fruits of MC are proved to have antioxidant, hepatoprotective, antiviral, anticancer, antiulcer, analgesic, anti-inflammatory, and antifertility activities. Charantin is one of the bioactive compound found in all parts of the plant especially in fruits. Charantin improves blood sugar levels by increasing glucose uptake and glycogen synthesis in the liver, muscles, and fat cells. It also enhances insulin release from pancreatic beta cells, and repair or promotes new growth of insulin-secreting beta cells. Alcoholic extract of charantin was found to be more effective antidiabetic agent than tolbutamide, sometimes used in treating diabetes. Charantin is reported to be an Anti-HIV protein.

**Profile of Nutrients**

The examination of the products of Momordica Charantia portrayed the accompanying dietary certainties.

- Moisture (83.2%), Protein (5.3g), Total Carbohydrate (3.3g), Phosphorous (99mg), Ascorbic acid (85mg), Calcium (84 mg), Iron (2.04 mg), Niacin (1.11 mg), Riboflavin (0.362 mg), Thiamin (0.181 mg), Folate (128 mcg), Nicotinic acid (0.5 mcg), Vitamin A (1734 IU), Total Omega 3 (omg), Total Omega 6 (omg).

**Occurrence and Distribution**

MC is a tropical plant broadly developed in Asia, East Africa, and South America for its effectively unsavory natural items that are commonly used as a piece of cooking and as a characteristic answer for treating diabetes.

**Plant Description**

It is a monoecious annual climber with a slender, branched, angled and grooved stem that grows up to 5 m. Its leaves are alternate, petiolate, orbicular, 5-7 lobed, 5-12 cm in diameter, both surfaces glabrous and prominently nerved. Tendrils are slender and straightforward. Flowers are pale yellow to orange, solitary and unisexual. Fruits are dark green to whitish pepo, 5-25 cm long, oblong, ribbed with many tubercles. Seeds are brownish, compressed, 12-16 mm long, embedded in bright red pulp. It is characteristic in odour and bitter in taste.

**Antidiabetic activity of *M. charantia* extracts**

The reported antidiabetic activity of extracts of *M. charantia* L. have been given in Table 1.
Table 1: Reported Antidiabetic activities corresponding to M. charantia L.

<table>
<thead>
<tr>
<th>Type of extract</th>
<th>Study design</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aqueous extract if fruit</td>
<td>Sprague Dawley rats</td>
<td>Decline in blood sugar level[^14]</td>
</tr>
<tr>
<td>Fruit extract</td>
<td>Wistar rats</td>
<td>150 &amp; 300mg/kg</td>
</tr>
<tr>
<td>Saponins fraction</td>
<td>Male Wistar rats</td>
<td>50 &amp; 100 mg/kg body weight</td>
</tr>
<tr>
<td>Methanolic extract of fruit</td>
<td>Male Sprague Dawley rats</td>
<td>0.21g/kg/day of both fractions</td>
</tr>
<tr>
<td>Alcoholic fruit extract</td>
<td>Female Wistar rats</td>
<td>100mg/kg &amp; 200mg/kg</td>
</tr>
<tr>
<td>Charantin rich extract</td>
<td>T1D Mic e &amp; T2D Mic e</td>
<td>200mg/kg/day</td>
</tr>
<tr>
<td>Polysacc haride</td>
<td>Kumin g mice of both sexes</td>
<td>100, 200 &amp; 300mg/kg body weight</td>
</tr>
<tr>
<td>Alcohol extract</td>
<td>Male Wistar rats</td>
<td>500mg/kg</td>
</tr>
<tr>
<td>Fruit of Seeds</td>
<td>Male Wistar rats</td>
<td>100mg/kg &amp; 200mg/kg</td>
</tr>
<tr>
<td>Fruit juice</td>
<td>Male Wistar rats</td>
<td>10ml/kg body weight/day</td>
</tr>
</tbody>
</table>

[^14]: Ant diagetic activity and amelioration of diabetes-associated complications.  
[^26]: Improved insulin sensitivity.  
[^29]: Inhibited disaccharide activity.  
[^30]: Improved insulin sensitivity.  
[^22]: Improved insulin sensitivity.  
[^21]: Antidiabetic activity.  
[^36]: Hypoglycemic activity.  
[^38]: Improved glucose uptake by diaphragm in the absence and presence of insulin.  

**Charantin**

Charantin is acquired from the Asian bitter melon, responsible for the hypoglycemic activity of these plants. Charantin (Figure 1) is a equal mixture of two steroidal saponins, β-sitosteryl glucoside (C_{25}H_{36}O_{6}) and 5,25-stigmasteryl glucoside (C_{27}H_{46}O_{6}). Physically it is a white crystalline material, neutral and tasteless, melting at 266-
268°C, poorly soluble in water or then again other profoundly polar solvents, and also in apolar solvents like hexane, yet is dissolvable in the ether, ethanol, and methanol, and can be proficiently removed from the plant by pressurized ethanol or acetone at 100°C.

Blood sugar lowering capacity of unripe fruits of bitter melon like that of insulin attributes to its antidiabetic property. The antidiabetic aggravate responsible for the reported activity is charantin, a blend of sitosteryl glucoside and stigmasteryl glucoside. This mixture could be utilized to treat diabetes and can supplant treatment by infusion of insulin which has not been effective in animating the pancreas of the diabetic patients to bring down glucose to the coveted level. At times, the injected subjects hints at symptoms. Ohytoconstituent that show antidiabetic propery, for instance, charantin and others are currently broadly acknowledged as an elective solution for diabetes mellitus, and they are free from adverse events.

Blends of solvents like chloroform, dichloromethane, ethanol or methanol are conventionally used for isolating charantin. Though methods which were found to be successful in isolating charantin has devised, one crucial work in this particular area by J. Pitipanapong et al. was proposed to be a kinder option for the extraction of charantin from MC. Employing pressurized liquid extraction technique as one of the approaches towards separation of charantin, revealed similar yields of charantin but with less extraction time and the dissolvable sum required when compared with conventional soxhlet method. This evidence suggests a fascinating new strategy for quick partition of charantin.

A work by D.M. Cuong et al. reported transcriptome investigation to recognize genes with the triterpenoid biosynthesis pathway in the seedlings of bittermelon. Also, the above said work reported build-up sequences of charantin and their coincidence with the expression pattern of McSE and McCAS1 genes to demonstrate the importance of these genes in the biosynthesis of charantin in bitter melon.

**Extraction techniques**

Extraction techniques for the extraction of Charantin have been given in Table 2.

**Table 2: Reported Extraction Techniques for Charantin.**

<table>
<thead>
<tr>
<th>Method</th>
<th>Solvent</th>
<th>Temperature (°C)</th>
<th>Time</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soxhlet extraction</td>
<td>Petroleum ether and 80% EtOH</td>
<td>40-60</td>
<td>N.M.</td>
<td>N.M.</td>
</tr>
<tr>
<td>Pressurized liquid extraction (PLE)</td>
<td>EtOH 60ml</td>
<td>100</td>
<td>1h</td>
<td>0.126± 0.018 mg/g dried fruit</td>
</tr>
<tr>
<td>Soxhlet extraction</td>
<td>EtOH 200ml</td>
<td>78.5</td>
<td>150m</td>
<td>Comparable with yield obtained by PLE</td>
</tr>
<tr>
<td>Ultrasonication</td>
<td>2ml n-Hexane &amp; 100% MeOH 1ml</td>
<td>RT</td>
<td>1h</td>
<td>40.54 µg/g dry weight</td>
</tr>
<tr>
<td>Soxhlet extraction</td>
<td>MeOH (4 × 50L)</td>
<td>70</td>
<td>N.M.</td>
<td>15 mg/ 35kg dried fruit</td>
</tr>
<tr>
<td>Soxhlet extraction</td>
<td>95% EtOH</td>
<td>60-80</td>
<td>48h</td>
<td>0.091 % of dried fruit</td>
</tr>
<tr>
<td>Soxhlet extraction</td>
<td>50% EtOH</td>
<td>70.24</td>
<td>60h</td>
<td>55.27 mg equiv./g dry fruit</td>
</tr>
<tr>
<td>Soxhlet extraction</td>
<td>70% EtOH</td>
<td>80.34</td>
<td>70h</td>
<td>144.58 mg equiv./g dry leaves</td>
</tr>
<tr>
<td>Soxhlet extraction</td>
<td>EtOH 200ml</td>
<td>B.P.</td>
<td>150m</td>
<td>N.M.</td>
</tr>
<tr>
<td>Hot Reflux</td>
<td>50% EtOH 500ml</td>
<td>150</td>
<td>6h</td>
<td>10.23 mg/50g dried</td>
</tr>
</tbody>
</table>

**Pharmacology of Charantin**

Pharmacological activities specific to charantin are less reported, whereas, most of the reported activities were based on extracts of bitter melon and expected to be charantin as a primary cause for the action.

Patel S et al. reported antibacterial activity of charantin in a specific gram-positive, gram-negative strains of bacteria and a fungal strain using agar diffusion method. Also acknowledged the importance of understanding the mechanism of action and viability of charantin in relation to psoriasis like skin disorders. Another work by T.B. Ng et al., designated charantin, isolated from a bitter gourd, as a peptide having a molecular mass of 9.7kDa. This work confirms the small ribosome inactivating capacity of charantin along with γ-momorcharin and luffin S. This work also reported the inhibitory activity of cell-free translation in a rabbit reticulocyte lysate system.

**Analysis of Charantin**

Analytical methods for the identification and quantification of charantin have been given in Table 3.

**Table 3:** Reported Analytical methods for identification and quantification of Charantin

<table>
<thead>
<tr>
<th>Technique</th>
<th>Stationary Phase</th>
<th>Mobile Phase</th>
<th>Wavelength Or Rf (TLC/HPTLC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLC66</td>
<td>C-18 Waters symmetry column (5μm × 3.9mm × 150mm)</td>
<td>MeOH (100) : H₂O (2) (% v/v)</td>
<td>204 nm</td>
</tr>
<tr>
<td>HPTLC53</td>
<td>20 × 10 cm Aluminium backed plates coated with Silica gel 60F₃₅4</td>
<td>Toluene (68) : Ethyl Acetate (20) : MeOH (10) : Formic Acid (02) % (v/v/v/v)</td>
<td>525 nm 0.71</td>
</tr>
<tr>
<td>HPLC52</td>
<td>C-18 Intersil column (10μm × 3.9 mm × 300mm)</td>
<td>MeOH (100) : H₂O (2) (% v/v)</td>
<td>204 nm</td>
</tr>
<tr>
<td>HPLC48</td>
<td>C-18 Intersil ODS-3-column (5μm × 4.6mm × 250mm)</td>
<td>MeOH (100) : H₂O (2) (% v/v)</td>
<td>204 nm</td>
</tr>
<tr>
<td>HPLC46</td>
<td>C-18 Hypersil column (10μm × 3.9 mm × 300mm)</td>
<td>MeOH (100) : H₂O (2) (% v/v)</td>
<td>204 nm</td>
</tr>
<tr>
<td>HPTLC48</td>
<td>Silica gel</td>
<td>Chloroform (1.5) : MeOH (6) : H₂O (2.5) (% v/v/v)</td>
<td>536 nm 0.40 ± 0.03</td>
</tr>
<tr>
<td>HPLC46</td>
<td>C-18 Hypersil Column (10μm × 3.9mm × 250mm)</td>
<td>MeOH (100) : H₂O (2) (% v/v)</td>
<td>204 nm</td>
</tr>
<tr>
<td>HPLC56</td>
<td>Zorbax SB C-18 column (5μm × 4.6mm × 250mm)</td>
<td>Solvent A - H₂O Solvent B - Acetonitrile</td>
<td>205 nm</td>
</tr>
<tr>
<td>HPLC46</td>
<td>Optimapak (5μm × 4.6mm × 250m)</td>
<td>98% MeOH</td>
<td>204 nm</td>
</tr>
<tr>
<td>HPTLC53</td>
<td>20 × 10 cm Aluminium backed plates coated with Silica gel 60F₃₅4</td>
<td>MeOH (2) : Benzene (8) (v/v)</td>
<td>536 nm 0.31</td>
</tr>
<tr>
<td>HPLC46</td>
<td>Optimapak C-18 Column (5μm × 4.6mm × 250mm)</td>
<td>MeOH (98) : H₂O (2) (% v/v)</td>
<td>204 nm</td>
</tr>
<tr>
<td>HPLC46</td>
<td>Optimapak (5μm × 4.6mm × 250m)</td>
<td>98% MeOH</td>
<td>204 nm</td>
</tr>
</tbody>
</table>

MeOH: Methanol, N.M.: Not mentioned.

**CONCLUSION**

Amidst of all reported activities for *M. Charantia* L., studies specific to charantin are less. Minimal efforts had not been taken to develop charantin as an alternative for treating diabetes. However, the importance of quantification of charantin in MC fruit extracts and formulations containing MC as a primary ingredient is gaining day by day. Problems existing with solvents like chloroform and dichloromethane were chronic to the health of human beings or animals involved and a necessity to create a benign environment by selecting solvents that possess less harm to humans and environment is inevitable. The achievement without bounds utilization of this compound got by pressurized liquid extraction would, consequently, rely on the advancement of a chromatographic procedure that is independent of the utilization of harmful solvents. There is also a dire need in considering wild species of *Momordica* as a potent nutraceutical for the treatment of diabetes. The importances of the antidiabetic property and a profile of unknown saponins and other compounds have to be acknowledged for further research.
LIST OF ABBREVIATIONS
p.o.: per oral
N.M.: not mentioned
N.A.: not applicable
B.P.: boiling point
R.T.: room temperature
EtOH: ethanol
MeOH: methanol

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Guest or honorary authorship based solely on position (e.g. research supervisor, departmental head) is discouraged.

SUPPLEMENTARY MATERIAL
Supportive/Supplementary material intended for publication must be numbered and referred to in the manuscript but should not be a part of the submitted publication. List all Supportive/Supplementary Material and include a brief caption line for each file describing its contents.

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