

## Momordica charantia (Bitter melon)



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### Description

*Momordica charantia* (MC), a member of the Cucurbitaceae family, is known as bitter melon, bitter gourd, balsam pear, karela, and pare. It grows in tropical areas of the Amazon, East Africa, Asia, India, South America, and the Caribbean and is used traditionally as both food and medicine. The plant is a climbing perennial with elongated fruit that resembles a warty gourd or cucumber. The unripe fruit is white or green in color and has a bitter taste that becomes more pronounced as the fruit ripens.<sup>1</sup> The seeds, fruit, leaves, and root of the plant have been used in traditional medicine for microbial infections, sluggish digestion and intestinal gas, menstrual stimulation, wound healing, inflammation, fever reduction, hypertension, and as a laxative and emetic.<sup>2</sup> Clinical conditions for which *M. charantia* extracts (primarily from the fruit) are currently being used include diabetes, dyslipidemia, microbial infections, and potentially as a cytotoxic agent for certain types of cancer.<sup>3-6</sup>

### Active Constituents

Although they have not been definitively determined, research indicates the primary constituents responsible for the hypoglycemic properties of *Momordica* are charantin, insulin-like peptide (plant (p)-insulin), cucurbitanoids, momordicin, and oleanolic acids.<sup>7</sup> P-insulin is structurally and pharmacologically similar to bovine insulin and is composed of two polypeptide chains held together by disulfide bonds.<sup>8</sup> MC also has numerous other constituents including proteins (momordin, which may have anticancer properties), glycosides, saponins, and minerals.<sup>2</sup> It is also rich in vitamins A and C and beta-carotene, as well as the minerals iron, phosphorus, and potassium.<sup>1</sup>

### Mechanisms of Action

The most well researched MC mechanism is its blood sugar lowering effect. Research using a validated animal model of diabetes has demonstrated MC extracts increase glucose utilization by the liver,<sup>9</sup> decrease gluconeogenesis via inhibition of two key enzymes (glucose-6-phosphatase and fructose-1,6-bisphosphatase), and improve glucose oxidation through the shunt pathway by activating glucose-6-phosphate dehydrogenase.<sup>10</sup> Extracts of MC also enhance cellular uptake of glucose, promote insulin release and potentiate its effect,<sup>11,12</sup> and increase the number of insulin-producing beta cells in the pancreas of diabetic animals.<sup>13</sup>

Bitter melon extracts have been shown to inhibit growth and proliferation of various types of cancer cells in animals and *in vitro*. This may be attributed to the identification of a potent inhibitor of guanylate cyclase, an enzyme present in high amounts in many types of tumor cells.<sup>14,15</sup> Other research indicates MC extracts modify the immune response in cancer patients via decreased intestinal secretion of interleukin-7, reduced lymphocyte number, and increased T-helper and natural killer cell populations.<sup>16</sup>



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MC extracts have broad-spectrum antimicrobial activity, having been shown to prevent infection by numerous viruses, bacteria, parasitic organisms, and fungi. Although mechanisms have not been determined for all organisms, in the case of viral infection it is thought that certain bitter melon constituents prevent viral penetration of the cell wall.<sup>8</sup> The immune-stimulating properties of MC extracts may also contribute to decreased rates of microbial infection observed in animal studies.

Animal studies demonstrate MC extracts, particularly the saponin fraction, have lipid-lowering effects resulting from inhibition of pancreatic lipase activity and subsequent decreased lipid absorption.<sup>4</sup> Another study demonstrated MC juice has an inhibitory effect on membrane lipid peroxidation.<sup>6</sup>

## Clinical Indications

### Diabetes

Perhaps the best-researched use of bitter melon is to lower blood sugar levels in diabetics. Alcohol-extracted charantin from *Momordica charantia* consists of mixed steroids, and in an animal model of diabetes it improved glucose tolerance to a degree similar to the oral hypoglycemic agent, tolbutamide.<sup>9</sup> A clinical trial of nine patients with confirmed type 1 diabetes found that subcutaneous injection of an MC extract containing crystallized p-insulin resulted in a statistically significant decrease in blood sugar levels compared with controls. Fasting blood sugar was drawn prior to the administration of p-insulin and plasma glucose levels were used to determine the dosage of p-insulin given to each patient. The onset of p-insulin's effect was noted 30-60 minutes after administration, with peak effect ranging widely from 4-12 hours.<sup>17</sup> This most resembles long acting (NPH) insulin that demonstrates an onset of 1.5-2 hours, with a peak effect from 4-12 hours after administration.

Oral bitter melon preparations have also been shown to be effective in clinical trials of type 2 diabetes. Welihinda et al demonstrated a statistically significant improvement in glucose tolerance in type 2 diabetics. Eighteen diabetic subjects (average age 38 years) were given 100 mL MC juice 30 minutes prior to a glucose load. Improved glucose tolerance was observed in 13 of

18 patients (73%). To serve as a control, a glucose tolerance test was administered to all 18 subjects using 100 mL of water prior to the glucose load.<sup>18</sup>

In another uncontrolled trial, two MC extracts were evaluated. Dried fruit powder was given (5 g three times daily) to five subjects with diabetes (type unspecified), and seven subjects in a second group received an aqueous extract containing 100 g fruit per 100 mL of water. Those in the fruit powder group experienced an average 25-percent drop in blood sugar at the end of the three-week trial, while those in the aqueous extract group experienced an average 54-percent drop in blood sugar after three weeks. Glycosylated hemoglobin (HbA1C) examined in seven subjects decreased an average of 17 percent after the three-week trial.<sup>19</sup>

A randomized, double-blind, placebo-controlled, three-month trial involving 40 diabetic patients (either newly diagnosed or poorly controlled) examined the effect of encapsulated MC extract powder (Charantia<sup>®</sup>) on HbA1C. Secondary outcome measures were fasting blood sugar, total cholesterol, and body weight. MC extract or placebo (two capsules three times daily; exact dosage not disclosed) was administered to 20 patients in each group. While a slight improvement was noted in HbA1C, it was not statistically significant, and no significant improvements were observed in secondary outcomes compared to the control group.<sup>20</sup> Although the amount given may have been insufficient to effect improvement, this remains purely speculative since the dosage was not disclosed.

### Dyslipidemia

Several animal studies using a rodent model of diabetes have examined the effect of bitter melon extracts on abnormal lipid parameters. Significant decreases in triglycerides and LDL cholesterol and increases in HDL cholesterol were noted in all studies.<sup>5,6,21-23</sup> In the longest study (10 weeks) MC extract was given to normal and streptozotocin-induced type-1 diabetic rats. Diabetic rats had elevated total cholesterol, triglycerides, and phospholipids, as well as decreased HDL cholesterol; moderate increases in plasma lipid peroxides and malondialdehyde (signs of increased oxidative stress) were also observed. After 10 weeks, diabetic rats receiving MC extract experienced a normalization of all parameters compared to control rats not given the extract.<sup>6</sup>

## Microbial Infections

*In vitro* studies have shown bitter melon extracts and the MAP30 protein analog, isolated from the seeds of MC extracts, possess broad-spectrum antimicrobial activity. MC extracts inhibit infection and growth of several viruses, including HIV,<sup>24</sup> *Herpes simplex*,<sup>25</sup> and Epstein Barr virus.<sup>2</sup> A preliminary report on the effect of MC extract in three HIV patients showed a normalization of CD4/CD8 ratios with MC treatment. It is believed MC extracts inhibit HIV replication by preventing syncytial formation and cell-to-cell infection.<sup>26</sup> MC extracts also appear to inhibit the growth of numerous gram-negative and gram-positive bacteria, including *E. coli*, Salmonella, Shigella,<sup>27</sup> Staphylococcus, Pseudomonas, Streptobacillus, Streptococcus, and *H. pylori*, and parasitic organisms *E. histolytica* and *Plasmodium falciparum*.<sup>2,28</sup>

## Cancer

Although clinical trials have not been conducted using MC extracts in cancer patients, *in vitro* studies indicate bitter melon fruit and seed extracts inhibit the growth of several cancer cell lines, including prostate adenocarcinoma,<sup>15</sup> human colon cancer (Caco-2 cells),<sup>29</sup> and the highly metastatic breast cancer cell line MDA-MB 231.<sup>30</sup>

## Drug-Botanical Interactions

Due to its hypoglycemic effects, MC extracts may potentiate the effects of insulin and oral hypoglycemic medications. Patients should be advised to closely monitor blood sugar when adding this botanical to a treatment regimen.

## Side Effects and Toxicity

Oral ingestion of bitter melon fruit is safe as demonstrated by long-term consumption of the fruit in Asian cultures. Subcutaneous injection of p-insulin extracted from MC appears to be safe; however, intravenous injection of MC extracts is significantly more toxic and not recommended. Because bitter melon seeds contain momorcharin, shown to have antifertility effects in female mice, bitter melon seed consumption is not recommended in those seeking to become pregnant.<sup>2,31</sup>

## Dosage

Dosage recommendations depend on the form of bitter melon being consumed. The dose of fresh juice is 50-100 mL but it is extremely bitter and difficult to drink. Although encapsulated dry powder is easier to ingest, the standard dose is 3-15 g daily – a large dose in capsule form. A standardized, encapsulated extract dosage ranges from 100-200 mg three times daily.<sup>32</sup>

## Warnings and Contraindications

Because seed extracts have been shown to induce abortion in mice and the root is a documented uterine stimulant, use is not recommended in pregnant women or those seeking pregnancy.<sup>2,31,33</sup> Although the fruit was not found to induce miscarriage, safety in pregnancy has not been established.

## References

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