EUROPEAN JOURNAL OF BIOMEDICAL AND PHARMACEUTICAL SCIENCES
http://www.ejbps.com

ISSN 2349-8870
Volume: 9
Issue: 4
109-115
Year: 2022

PHYTOCHEMICAL AND PHARMACOLOGICAL PROFILE OF *MOMORDICA CHARANTIA*: A REVIEW

Dr. Seema Tomar*, Kamalpreet Kaur and Jobanpreet Kaur

G.H.G Khalsa College of Pharmacy, Gurusar Sadhar, Ludhiana, Punjab, India.

***Corresponding Author: Dr. Seema Tomar**

G.H.G Khalsa College of Pharmacy, Gurusar Sadhar, Ludhiana, Punjab, India.

Article Received on 02/02/2022 **Article Revised on 21/02/2022** **Article Accepted on 13/03/2022**

ABSTRACT

Momordica charantia herb belongs to a Cucurbitaceae family that is also known as bitter melon, karela, and pare. It may be found in tropical and subtropical areas all over the world. It has a long history of usage as both food and medicinal. *Momordica charantia* has been used to treat a variety of ailments from ancient times to the present. *M. charantia* has been shown to exhibit antihyperglycemic, antibacterial, antiviral, antitumor, immunomodulation, antioxidant, antidiabetic, anthelmintic, antimutagenic, antiulcer, antilipolytic, antifertility, hepatoprotective, anticancer, and anti-inflammatory effects. Proteins, polysaccharides, flavonoids, triterpenes, saponins, ascorbic acid, and steroids are among the phytochemicals found in this plant. Bitter melon generates p-insulin, a molecule that has a molecular structure similar to insulin. It also contains steroidal saponins like charantin, which help to control blood sugar levels. To completely treat piles, *momordica charantia* leaf juice was utilized. *Momordica charantia* is utilized as a blood purifier due to its bitter tonic properties. In this review, a description of the plant *Momordica charantia*, its chemical constituents as well as its pharmacological activities will be highlighted.

KEYWORDS: *Momordica charantia*, phytochemicals, charantin, p-insulin.

INTRODUCTION

Momordica charantia (M. charantia) is a herb of the Cucurbitaceae family that is also known as bitter gourd, balsam pear, bitter melon, kugua, or karela.[1] The name "Momordica" comes from the Latin word "to bite," and alludes to the serrated ends of the leaf, which appear to have been bitten. The herb, also known as "bitter melon" or "bitter gourd," lives up to its common name by being highly bitter in all parts of the plant, including the fruit.[2,3] *M. charantia* is widely cultivated in the tropical and subtropical regions of the world, such as India, Malaya, China, Thailand, Japan, Singapore, Vietnam, Amazon, East Africa, Brazil, China, Colombia, Cuba, Ghana, Haiti, India, Mexico, Malaya, New Zealand, Nicaragua, Panama, Middle East, Central and South America.[4-6]

M. charantia has also been utilized as a herbal medicine in a variety of nations. The entire plant, particularly the seeds and fruit, has significant pharmacological effects; for example, it has been used in the treatment of diabetes since ancient times and continues to play a major role in diabetes prevention and therapy in many underdeveloped countries.[7,8] *Momordica charantia* contains physiologically active plant compounds such as triterpenes, proteins, hormones, alkaloids, saponins, flavonoids, and acids. It's also been found to aid in the treatment of cancer and diabetes. The most common plant used in anti-diabetic alternative therapies is *Momordica charantia*.[9] This plant is a popular herbal medicine having antidiabetic, abortifacient, anthelmintic, contraceptive, antimalarial, and laxative effects. It is used to treat dysmenorrhea, eczema, gout, jaundice, leprosy, piles, measles, psoriasis, rheumatism, and scabies.[10-12]

SCIENTIFIC IDENTIFICATION

The plant genus *Momordica* is a tiny shrub or perennial climber belonging to the Cucurbitaceae family, with over sixty species found in tropical and subtropical areas.[13]
Kingdom: Plantae;
Subkingdom: Viridiplantae;
Superdivision: Embryophyta;
Division: Tracheophyta;
Subdivision: Spermatophytina;
Class: Magnoliopsida;
Superorder: Rosanae;
Order: Cucurbitales;
Family: Cucurbitaceae;
Genus: Momordica;
Species: M. charantia.[14]

PHYTOCHEMISTRY

Momordica charantia is mostly composed of triterpene, protein, steroid, alkaloid, inorganic, phenolic, and lipid constituents. *Momordica charantia's* charantin, a non-

nitrogenous neutral concept, is hydrolyzed to generate glucose and a sterol. The fruit pulp of *M. charantia* contains soluble pectin but no free pectic acid. Galactouronic acid is also obtained from the pulp. *M.charantia* fruits include glycosides, saponins, alkaloids, reducing carbohydrates, resins, phenolic components, fixed fat, and free acids. There is additional evidence of an unidentified alkaloid as well as 5-hydroxytryptamine. It has been established that 5-HT is present. The hypoglycemic content of the ether extract trace of the alcoholic concentration from *M. charantia* leaves was found to be similar to that of tolbutamide. P-insulin, a pure protein isolated in crystalline form from *M. charantia* fruits, has also been studied.[15,16] *Momordica charantia* consists of the following chemical constituents those are alkaloids, Momordica and charine momorchanins, momordicilin, charantin, momordicius, momordenol, momordin, momordolol, cryptoxanthin, cucuritacins, cucurbitns, cycloartenols, cucuritanes, erythrodiol, elaeostearic acids, galacturonic acid, gentisic acid, goyaglycosides, goyasaponins, and multiflorenol, cucurbitacins, cucurbitanes, diosgenin erythrodiol, guanylate cyclase inhibitors, gypsogenin, lauric acid, karounidiols, hydroxytryptamines, lanosterol, linoleic acid, linolenic acid, momordenol, momordicinin, momordicosides.[17-19]

PHARMACOLOGICAL ACTIVITIES

Anti-microbial Activity: *M. charantia* pulp extract has been shown to have broad-spectrum antimicrobial activity[20], and is similar to the antibacterial activity of hydrophilic leaf extracts against *E. coli, Staphylococcus, Pseudomonas, Salmonella, and Streptobacillus.*[21] When a whole plant extract of Entamoeba histolytica was examined, it was found to exhibit antiprotozoal action. Fruit and fruit juice has antibacterial properties, and a fruit extract was found to be effective against the bacteria that causes stomach ulcers, Helicobacter pylori, in another research.[22] Methanolic extract from *M.charantia* leaves exhibited the highest antibacterial effectiveness of all the organic solvent extracts tested, having a substantial inhibitory impact on *E. coli and S. aureus.*[23]

Anti-oxidant Activity: Apart from diabetes, different portions of the plant *Momordica Charantia* have been used in Indian medicine for a variety of illnesses. Antioxidant activities have been discovered in the bitter melon phenolic extract. In a Streptozotocin induced-diabetic model in rats, the seeds of the plant *Momordica charantia* were found to efficiently correct the altered antioxidant status in streptozotocin induced-diabetes.[24,25] In a study conducted on the bitter gourd and its fractions, total phenolics and total flavonoids were shown to have favorable associations with antioxygenic activities evaluated by the β-carotene-bleaching, ammonium thiocyanate, and DPPH radical-scavenging techniques.[26] In the pulp sample, complete phenolics, β -carotene bleaching, and DPPH radical-scavenging techniques showed significant correlations, whereas total phenolics, ammonium thiocyanate, and DPPH radical-scavenging methods had significant correlations in the seed sample. Because of their different phenolic and flavonoid contents, the pulp of the fruit showed stronger anti-oxygenic action than the seeds.[27]

Anti-viral Activity: A variety of *M. charantia* species, many of which include proteins and steroids, have been shown to have antiviral activity.[28,29] Ethanolic preparations from *M. charantia* leaves and stems effectively suppress HSV-1 and SINV viruses.[30] Bitter gourd protein MAP30 reduces HIV activity, decreases the production of the virus core protein p24 and viral-associated reverse transcriptase (HIV-RT), and has no effect on cellular DNA or protein synthesis in H9 cells, according to researchers.[31] Antiviral effectiveness of bitter gourd compounds in vitro against a range of viruses, including Epstein-Barr, herpes, and HIV. In people and animals, the leaf extract enhanced virus resistance and had an immune stimulant impact, as well as increased interferon production and natural killer cell activation, according to an in-vivo study.[32]

Hypolipidemic Activity: The increased cholesterol and triglyceride levels in diabetic rats were restored to the normal following 21 days of bitter gourd fruit and/or seed administration in an in-vivo investigation.[33] The effects of bitter gourd oil (BGO) on the blood and liver lipids of rats were studied by Noguchi et al. (2001).[34] The presence of (cis) 9, (trans) 11, and (n3)18:3 in the livers of rats fed BGO meals was shown by fatty acid analysis, while this conjugated linoleic acid (CLA) isomer was practically non-existent in the livers of rats fed control diets.

Anti-Inflammatory Activity: *M. charantia* reduced brain oxidative stress produced by a high-fat diet, successfully prevented neuroinflammation, and restored normal levels of neuroinflammatory markers (NF-B1, TNF-, IL-16, IL-22, and IL-17R).[36] Wild *M. charantia* in diets reduced inflammatory stress in septic mice by reducing pro-inflammatory cytokine secretions and pro-inflammatory protein expression (COX-2, iNOS, and NF-B).[37] Total phenolic extracts of *M. charantia* inhibited P. acnes-induced inflammatory reactions in vitro, prevented neutrophil and IL-1 leukocyte infiltration and NF-B activation, decreased MMP-9 levels and IL-8, IL-1, and TNF- activity, and inactivated mitogen-activated protein kinase (MAPK).[38]

Anti-Tumor Activity: Lymphocytic leukaemia, lymphoma, choriocarcinoma, melanoma, breast cancer, skin cancer, and prostate cancer have all been found to be resistant to *M. charantia* extracts and monomer components.[39] Many in-vivo studies have demonstrated the entire bitter gourd plant's anticancer effectiveness. In one sample, a water extract prevented the growth of rat prostate cancer, while in another, a hot water extract of the whole plant decreased the formation of breast tumors in mice. Bitter gourd has also been found to have anti-

cancer and anti-leukemic activities in vitro, including liver cancer, human leukemia, melanoma, and powerful sarcomas.[40] *M. charantia* has been shown to suppress cancer cell growth in the laboratory; its anticancer effects may be attributed in part to MAP30, α -MMC, β -MMC, and other therapeutic proteins.

Immunomodulatory Activity: In in-vivo investigations utilizing carbon clearance assays, *M. charantia* methanolic extracts were demonstrated to dramatically enhance NO secretion and phagocytic activity.[41] Immunomodulatory action has been linked to increased interferon production and natural killer cell activation.[42] Momordicin promotes and encourages B cell proliferation by raising CD86 (cell activation target point) expression and promoting surface membrane immunoglobulin activity in B cell subsets, both of which are required for humoral immunity.[43] Saponins derived from *M. charantia* may increase IL-2 production in vitro by altering the T cell ratio, increasing phagocytic activity, and improving immunological function in aged mice.[44]

Anti-diabetic Activity: A variant of *M.charantia* extract has been proposed for use in the treatment of diabetes in many investigations.[45-51] It has been utilised as an anti-diabetic medication in many nations for thousands of years.[52,53] Several investigations have demonstrated that *M. charantia* has strong antidiabetic effects using cell-based assays, animal models, and human clinical trials.[54-58] Oral treatment of the aqueous extract *M. charantia* fruits at a dose of 250 mg/kg reduced blood glucose levels in diabetic rats induced by streptozotocin (STZ) substantially.[59] The aqueous extract of M. charantia fruits can increase insulin production in β-cells in pancreatic islets isolated from obese-hyperglycemic mice's According to another study, *M. charantia* fruit aqueous extract shows hypoglycemic properties in cyproheptadine-induced diabetic mice.[60] *M. charantia* aqueous extracts decreased glucose levels without altering glucose absorption in the intestine, indicating extrapancreatic actions when orally administered. It also assists in the regeneration of cells and the recovery of destroyed cells in STZ-diabetic rats.[61] After chronic oral administration of *M. charantia* fruit juice at 20 mg/kg to alloxan-induced rats, blood glucose resistance improved considerably from day 7 to day 22.[62] *M. charantia* fruit juice has been found to ameliorate the interrupted estrous cycle in diabetic rats and reduce blood glucose levels in diabetic rats induced by alloxan. The effect of *M. charantia* extracts on diabetes involves both intra- and extra-pancreatic routes.[63] They also enhance insulin release from pancreatic beta cells, as well as repair or promote the formation of insulin-secreting beta cells, according to certain research. P-Insulin, a polypeptide produced from fruits and seeds, was found to immediately lower and stabilize blood sugar levels in rats. Bitter melon also makes lectin, a bioactive molecule that acts similarly to insulin. The capacity of the lectin to bind two insulin receptors together gives it insulin-like bioactivity. This lectin works on peripheral tissues to lower blood glucose levels while also decreasing hunger, similar to how insulin works in the brain. This lectin is primarily responsible for the hypoglycemia impact that occurs after ingesting *Momordica charantia*.[64-68]

Anti-malarial Activity: *Momordica charantia* has traditionally been used by Asians, as well as Panamanians and Colombians, to prevent and treat malaria. According to experimental findings, some species of *Momordica charantia* exhibit anti-malarial properties. Malaria is treated using a tea made from leaves boiled in hot water.[69]

Wound Healing Activity: Treatment with *M. charantia* fruit in the form of ointment (10 percent w/w dry powder in simple ointment base) enhanced wound closure and elevated TGF-expression in wound tissue in diabetic rats.[70] Methanol extracts showed comparable results, dramatically decreasing wound area and epithelisation time.[71]

Anti-fertility Activity: The fruit and leaves of the bitter melon have been found to have an anti-fertility effect in female animals, as well as a negative impact on sperm development in male animals. Bitter melon has historically been used as an abortive and has been associated with poor uterine stimulant function, therefore it is not suggested during pregnancy. This plant should not be taken by individuals who are undergoing fertility treatment or attempting to conceive because it has been found to reduce fertility in both males and females. The active compounds in bitter melon have been proven to be transferred through breast milk in laboratory studies, although it is not suggested for nursing moms. In additional studies, ethanol and water derivatives of the fruit and leaf (ingested orally) were shown to be safe during pregnancy. Various extracts (ether, benzene, and alcohol) of *M. charantia* seeds were given orally and intraperitoneally to male rats for 35 days, according to one of the studies. Pituitary gonadotrophs, which are required for spermatogenesis, were found to be reduced in the tests.[72]

Anti-HIV agent: Alpha- and beta momorcharin, as well as MAP-30 and charantin, are all anti-HIV proteins found in *Momordica charantia*. The HIV has been demonstrated to be suppressed by alpha- and beta-momorcharin proteins present in the seeds, fruit, and leaves. Molecular analogs of MAP-30 are alpha momocharin and beta momocharin. The important protein MAP 30 (Momordica Anti-HIV Antibody) has a size of 30 kDa. It suppresses HIV-1 infection and replication in cell-free cells in a dose-dependent manner.[73] *Momordica charantia* extracts are hypothesized to limit HIV replication by suppressing the syncytial formation and cell-to-cell infection. A preliminary investigation evaluating the effect of *Momordica charantia* extract on CD4/CD8 ratios in three HIV patients revealed that treatment with

Momordica charantia extracts normalized CD4/CD8 ratios.[74]

Larvicidal Activity: *M. charantia* has shown good larvicidal activity against three container breeding mosquitoes— An. stephensi, Cx. quinquefasciatus and Ae. aegypti. *M. charantia* fruit extract's larvicidal potential might be utilised for use against mosquito larvae in drinking water.[75]

Anti-ulcer activity: In rats, 100 mg/kg and 500 mg/kg of methanolic extract from *M. charantia* fruits healed gastric ulcers and prevented the development of duodenal and stomach ulcers. The ulcer index, free acidity, total acidity, and pepsin concentration all dropped substantially in pylorus-ligated rats. Anti-H.pylori antibodies are more common in *M. charantia*.[76]

Anthelmintic activity: The chloroform extract of *M. charantia* seeds (20 mg/ml) exhibited the best anthelmintic activity against Indian adult earthworm Pheretima posthuma when compared to normal Albendazole. Within 3 minutes, the extract produced paralysis, and within 8 minutes, death.[77]

CONCLUSION

M. charantia is a promising plant that has been used to cure a variety of ailments. It has anti-inflammatory properties, antibacterial properties, anti-oxidant properties, anti-diabetic properties, and many more. The chemical constituents present in *M.charantia* such as alkaloids, momordicin, momordicilin, charantin, lauric acid, linoleic acid, and linolenic acid are responsible for these activities. *M.charantia* has a greater therapeutic value used in the management of a various diseases.

REFERENCES

1. Habicht, S.D.; Kind, V.; Rudloff, S.; Borsch, C.; Mueller, A.S.; Pallauf, J.; Yang, R.Y.; Krawinkel, M.B. Quantification of antidiabetic extracts and compounds in bitter gourd varieties. Food Chem., 2011; 126: 172–176.
2. Subratty, A.H.; Gurib-Fakim, A.; Mahomoodally, F. Bitter melon: An exotic vegetable with medicinal values. Nutr. Food Sci., 2005; 35: 143–147.
3. Aminah, A.; Anna, P.K. Influence of ripening stages on physicochemical characteristics and antioxidant properties of bitter gourd (Momordica charantia). Int. Food Res. J., 2011; 18: 895–900.
4. Walters, T.W.; Decker-Walters, D.S. Balsam-pear (Momordicacharantia, Cucurbitaceae). Econ. Bot., 1988; 42: 286–288.
5. Shan, B.; Xie, J.H.; Zhu, J.H.; Peng, Y. Ethanol modified supercritical carbon dioxide extraction of flavonoids from Momordica charantia L. and its antioxidant activity. Food Bioprod. Process, 2012; 90: 579–587.
6. Grover, J.K.; Yadav, S.P. Pharmacological actions and potential uses of Momordica charantia: A review. J. Ethnopharmacol, 2004; 93: 123–132.
7. Raman, A.; Lau, C. Anti-diabetic properties and phytochemistry of Momordica charantia L. (Cucurbitaceae). Phytomedicine, 1996; 2: 349–362.
8. Virdi, J.; Sivakami, S.; Shahani, S.; Suthar, A.C.; Banavalikar, M.M.; Biyani, M.K. Antihyperglycemic effects of three extracts from Momordica charantia. J. Ethnopharmacol, 2003; 88: 107–111.
9. Abdel-Barry JA, Abdel-Hassan IA, Al-Hakiem MH. Hypoglycaemic and antihyperglycaemic effects of Trigonella foenum-graecum leaf in normal and alloxan-induced diabetic rats. J Ethnopharmacol, Nov 1997; 58(3): 149–155.
10. Raman, A.; Lau, C. Anti-diabetic properties and phytochemistry of Momordica charantia L. (Cucurbitaceae). Phytomedicine, 1996; 2: 349–362.
11. Bailey, C.J.; Day, C.; Leatherdale, B.A. Traditional treatments for diabetes from Asia and the West Indies. Pract. Diabetes, 1986; 3: 190–192.
12. Dans, A.M.L.; Villarruz, M.V.C.; Jimeno, C.A.; Javelosa, M.A.U.; Chua, J.; Bautista, R.; Velez, G.G.B.Theeffect of Momordica charantia capsule preparation on glycemic control in type 2 diabetes mellitus needs further studies. J. Clin. Epidemiol, 2007; 60: 554–559.
13. Bharathi L, John K. Momordica Genus in Asia: An Overview. New Delhi: Springer, 2013.
14. Sharma S, Tandon S, Semwal B, Singh K. Momordica charantia Linn.: A comprehensive review on bitter remedy. J Pharm Res Opin, 2011; 1: 42-7.
15. Srivastava Y, Venkatakrishna-Bhatt H, Verma Y, et al. Antidiabetic and adaptogenic properties of Momordica charantia extract: an experimental and clinical evaluation. Phytother Res., 1993; 7: 285289.
16. Welhinda J, Karunanayake EH, Sheriff MH, et al. Effect of Momordica charantia on the glucose tolerance in maturity onset diabetes. J Ethnopharmacol, 1986; 17: 277-282.
17. Ethnopharmacol, 2004; 93(1): 123-132. 26. Bitter melon – Wikipedia, the free encyclopedia. http://wikipedia.org/wiki/Bitter_melon. [Accessed July, 2, 2007.
18. Murakami T, Emoto A, Matsuda H, Yoshikawa M. Medicinal food stuffs. Part XXI. Structures of new cucuritane type triterpene glycosides, goyaglycosides -a,-b,-c,-d,-e,-f,-g, and h, and new oleanane- type triterpene saponins, goyasaponins I, II and III. From the fresh fruit of Japanese momordica charantia L, Chemi Pharma Bull, 2001; 49: 54-63.
19. Prakash A, NG TB, Tso WW. Purification and characterization of charantin, a napin like ribosomeinactivating peptide from bitter gourd (Momordica charantia) seeds, J Peptide Res., 2002; 59: 197-202.

20. Mada, S.B.; Garba, A.; Mohammed, H.A.; Muhammad, A.; Olagunju, A.; Muhammad, A.B. Antimicrobial activity and phytochemical screening of aqueous and ethanol extracts of Momordica charantia L. leaves. J. Med. Plants Res., 2013; 7: 579–586.
21. Saeed, S.; Tariq, P.Antibacterialactivities of Menthapiperita, Pisumsativum and Momordicacharantia. Pak. J. Bot., 2005; 37: 997.
22. Sankaranarayanan J, Jolly CI, Phytochemical, antibacterial, and pharmacological investigations on Momordica charantia Linn., Emblica officinalis Gaertn and curcuma longa Linn. Indian Journal of Pharmaceutical Science, 1993; 55(1): 6.
23. Jagessar, R.C.; Gomes, G. An evaluation of the antibacterial and antifungal activity of leaf extracts of Momordica charantia against Candida albicans, Staphylococcus aureus and Escherichia coli. Nat. Sci., 2008; 6: 1–14.
24. Horax R, Hettiarachchy N and Islam S: Total Phenolic contents and phenolic acid constituents in four varieties of bitter melons (Momordica charantia) and antioxidant activities of their extracts. J Food Sci., 2005; 70.
25. Sathishsekar D and Subramanian S: Antioxidant properties of Momordica Charantia (bitter gourd) seeds on Streptozotocin induced diabetic rats. Asian Pacific J Clin Nutr., 2005; 14(2): 153-158.
26. Padmashree A, Sharma GK, Semwal, AD & Bawa AS. Studies on the antioxygenic activity of bitter gourd (Momordica charantia) and its fractions using various in vitro models. J Science Food Agric., 2011; 91: 776-782.
27. Kubola J & Siriamornpun S. Phenolic contents and antioxidant activities of bitter gourd (Momordica charantia L.) leaf stem and fruit fraction extracts in vitro. Food Chem, 2008; 110: 881-890.
28. Upadhyay, A.; Agrahari, P.; Singh, D.K. A review on salient pharmacological features of Momordica charantia. Int. J. Pharmacol, 2015; 11: 405–413.
29. Basch, E.; Gabardi, S.; Ulbricht, C. Bitter melon (Momordica charantia): A review of efficacy and safety. Am. J. Health-Syst. Pharm, 2003; 60: 356.
30. Beloin, N.; Gbeassor, M.; Akpagana, K.; Hudson, J.; de Soussa, K.; Koumaglo, K.; Arnason, J.T. Ethnomedicinal uses of Momordica charantia (Cucurbitaceae) in Togo and relation to its phytochemistry and biological activity. J. Ethnopharmacol, 2005; 96: 49–55.
31. Leehuang, S.; Huang, P.L.; Chen, H.C.; Huang, P.L.; Bourinbaiar, A.; Huang, H.I. Anti-HIV and Anti-tumor activities of recombinant map30 from bitter melon. Gene, 1995; 161: 151-156.
32. Zhang QC. Preliminary report on the use of Momordica charantia extract by HIV patients. J Naturopath Med., 1992; 3: 65-69.
33. Ahmed I, Adeghate E, Sharma AK, Pallot, DJ, & Singh, J. Effects of Momordica charantia fruit juice on islet morphology in the pancreas of the streptozotocin-diabetic rat. Diabetes Res Clin Pract, 1998; 40: 145-151.
34. Noguchi R, Yasui Y, Suzuki R, Hosokawa M, Fukunaga K, & Miyashita K. Dietary effects of bitter gourd oil on blood and liver lipids of rats. Arch Biochem Biophys, 2001; 396: 207212.
35. Dhar, P., S. Ghosh and D.K. Bhattacharyya, Dietary effects of conjugated octadecatrienoic fatty acid (9 cis, 11 trans, 13 trans) levels on blood lipids and nonenzymatic In vitro lipid peroxidation in rats. Lipids, 1999; 34: 109-114.
36. Nerurkar, P.V.; Johns, L.M.; Buesa, L.M.; Kipyakwai, G.; Volper, E.; Sato, R.Momordicacharantia(bitter melon) attenuates high-fat diet-associated oxidative stress and neuroinflammation. J. Neuroinflamm, 2011; 8: 64.
37. Chao, C.Y.; Sung, P.J.; Wang, W.H.; Kuo, Y.H. Anti-inflammatory effect of Momordica charantia in sepsis mice. Molecules, 2014; 19: 12777–12788.
38. Huang, W.C.; Tsai, T.H.; Huang, C.J.; Li, Y.Y.; Chyuan, J.H.; Chuang, L.T. Inhibitory effects of wild bitter melon leaf extract on propionibacterium acnes-induced skin inflammation in mice and cytokine production in vitro. Food Funct., 2015; 6: 2550.
39. Grover, J.K.; Yadav, S.P. Pharmacological actions and potential uses of Momordica charantia: A review. J. Ethnopharmacol, 2004; 93: 123–132.
40. Fang EF, Zhang CZY, Wong JH, Shen JY, Li CH, Ng TB. The MAP30 protein from bitter gourd Momordica charantia seeds promotes apoptosis in liver cancer cells in vitro and in vivo. Cancer Letters, 2012; 324(1): 66-74.
41. Juvekar, A.R.; Hule, A.K.; Sakat, S.S.; Chaughule, V.A. In vitroandin vivoevaluationofimmunomodulatory activity of methanol extract of Momordica charantia fruits. Drug Invent. Today, 2009; 1: 89–94.
42. Cunnick, J.E., K. Sakamoto, S.K. Chapes, G.W. Fortner and D.J. Takemoio,. Induction of tumor cytotoxic immune cells using a protein from the bitter melon (Momordica charantia). Cell. Immunol, 1990; 126: 278-289.
43. Huang, L.; Adachi, T.; Shimizu, Y.; Goto, Y.; Toyama, J.; Tanaka, H.; Haga, T. Characterization of lectin isolated from Momordica charantia seed as a B cell activator. Immunol. Lett., 2008; 121: 148–156.
44. Wang, X.; Jin, H.; Xu, Z.; Gao, L. Effects of momordica charantia L. saponins on immune system of senile mice. Acta Nutr. Sin., 2001; 263–266.
45. Raman, A.; Lau, C. Anti-diabetic properties and phytochemistry of Momordica charantia L. (Cucurbitaceae). Phytomedicine, 1996; 2: 349–362.
46. Xu, X.; Shan, B.; Liao, C.H.; Xie, J.H.; Wen, P.W.; Shi, J.Y. Anti-diabetic properties of Momordica charantia L. polysaccharide in alloxan-induced diabetic mice. Int. J. Biol. Macromol, 2015; 81: 538–543.

47. Arafat, S.Y.; Nayeem, M.; Jahan, S.; Karim, Z.; Reza, H.M.; Hossain, M.H.; Alam, M.A. Ellagic acid rich Momordica charantia fruit pulp supplementation prevented oxidative stress, fibrosis and inflammation in liver of alloxan induced diabetic rats. Orient. Pharm. Exp. Med., 2016; 16: 267–278.
48. Ahmed, I.; Lakhani, M.S.; Gillett, M.; John, A.; Raza, H.Hypotriglyceridemic and hypocholesterolemic effects of anti-diabetic Momordica charantia (karela) fruit extract in streptozotocin-induced diabetic rats. Diabetes Res. Clin. Pract., 2001; 51: 155–161.
49. Czompa, A.; Gyongyosi, A.; Szoke, K.; Bak, I.; Csepanyi, E.; Haines, D.D.; Lekli, I. Effects of Momordica charantia (Bitter Melon) on Ischemic Diabetic Myocardium. Molecules, 2017; 22: 488.
50. Thent, Z.C.; Das, S.; Zaidun, N.H.Emerging Trends on Drug Delivery Strategy of Momordica charantia against Diabetes and its Complications. Curr. Drug Deliv, 2017; 14.
51. Welihinda, J.; Karunanayake, E.H.; Sheriff, M.H.H.; Jayasinghe, K.S.A. Effect of Momordicacharantia on the glucose tolerance in maturity onset. J. Ethnopharmacol, 1986.
52. Bailey, C.J.; Day, C.; Leatherdale, B.A. Traditional treatments for diabetes from Asia and the West Indies. Pract. Diabetes, 1986; 3: 190–192.
53. Day, C.; Cartwright, T.; Provost, J.; Bailey, C.J. Hypoglycaemic effect of Momordica charantia extracts. Planta Medica, 1990; 56: 426–429.
54. Grover, J.K.; Yadav, S.P. Pharmacological actions and potential uses of Momordica charantia: A review. J. Ethnopharmacol, 2004; 93: 123–132.
55. Chaturvedi, P.; George, S. Momordica charantia maintains normal glucose levels and lipid profiles and prevents oxidative stress in diabetic rats subjected to chronic sucrose load. J. Med. Food, 2010; 13: 520–527.
56. Tripathi, U.N.; Chandra, D. Anti-hyperglycemic and anti-oxidative effect of aqueous extract of Momordica charantia pulp and Trigonella foenum graecum seed in alloxan-induced diabetic rats. Indian J. Biochem. Biophys, 2010; 47: 227–233.
57. Chaturvedi, P. Role of Momordica charantia in maintaining the normal levels of lipids and glucose in diabetic rats fed a high-fat and low-carbohydrate diet. Br. J. Biomed. Sci., 2005; 62: 124–126.
58. Wang, S.; Li, Z.; Yang, G.; Ho, C.T.; Li, S. Momordica charantia: A popular health-promoting vegetable with multifunctionality. Food Funct., 2017; 8: 1749–1762.
59. Mishra, A.; Gautam, S.; Pal, S.; Mishra, A.; Rawat, A.K.; Maurya, R.; Srivastava, A.K. Effect of Momordica charantia fruits on streptozotocin-induced diabetes mellitus and its associated complications. Int. J. Pharm. Pharm. Sci., 2015; 7: 356–363.
60. Çakici, Í.; Hurmo˘glu, C.; Tunçtan, B.; Abacio˘glu, N.; Kanzik, Í.; Sener, B. Hypoglycaemic effect of Momordica charantia extracts in normoglycaemic or cyproheptadine-induced hyperglycaemic mice. J. Ethnopharmacol, 1994; 44: 117–121.
61. Ahmed, I.; Adeghate, E.; Sharma, A.K.; Pallot, D.J.; Singh, J. Effects of Momordica charantia fruit juice on islet morphology in the pancreas of the streptozotocin-diabetic rat. Diabetes Res. Clin. Pract., 1998; 40: 145–151.
62. Chaturvedi, P.; George, S.; Milinganyo, M.; Tripathi, Y.B. Effect of Momordica charantia on lipid profile and oral glucose tolerance in diabetic rats. Phytother. Res., 2004; 18: 954–956.
63. Reyes, B.A.S.; Bautista, N.D.; Tanquilut, N.C.; Anunciado, R.V.; Leung, A.B.; Sanchez, G.C.; Maeda, K.I. Anti-diabetic potentials of Momordica charantia and Andrographis paniculata and their effects on estrous cyclicity of alloxan-induced diabetic rats. J. Ethnopharmacol, 2006; 105: 196–200.
64. Kumar DS, Sharathnath KV, Yogeswaran P, Harani A, Sudhakar K, Sudha P and Banji D. A medicinal potency of Momordica charantia. Int J Pharmaceu Sci Rev Res., 2010; 1(2): 95.13.
65. Virdia J, Sivakamia S, Shahanib S, Sutharc AC, Banavalikar MM and Biyanic MK. Antihyperglycemic effects of three extracts from Momordica charantia." J Ethnopharmacol, 2003; 88(1): 107-11.
66. Khan BB, Flier JS. Obesity and insulin resistance, J Clin Investigation, 2000; 106: 473-481.
67. Shetty AK, Kumar GS, Sambaiah K and Salimath PV. Effect of bitter gourd (Momordica charantia) on glycaemic status in streptozotocin induced diabetic rats." Plant Foods Human Nutr., 2005; 60: 109-12.
68. Lotlikar MM, Rao MRR. Pharmacology of a hypoglycaemic principle isolated from the fruits of Momordica charantia Linn. Ind J Pharmacol, 1966; 28: 129.
69. http://www.gmanews.tv/story/35962/Ampalaya-tablets- outsoon-for-diabetics.
70. Hussan, F.; Lin Teoh, S.; Muhamad, N.; Mazlan, M.; Latiff, A.A. Momordica charantia ointment accelerates diabetic wound healing and enhances transforming growth factor-β expression. J. Wound Care, 2014; 23.
71. Sharma, S.; Sharma, M.C.; Kohli, D.V. Wound healing activity of the ether-chloroform extract of Momordica charantia fruits in rats. Dig. J. Nanomater. Biostruct, 2010; 5: 123–126.
72. Naseem M, Patil S, Patil S, et al. Antispermatogenic and androgenic activities of Momordica charantia (Karela) in albino rats. J Ethnopharmacology, 1998; 61: 9-16.
73. Lee-Huang S., Huang P.L., Bourinbaiar A.S., Chen H.C. and Kung H.F., Proc Natl Acad Sci U S A, 1995; 92: 8818-22.
74. Zhang QC. Preliminary report on the use of Momordica charantia extract by HIV patients. J Naturopath Med., 1992; 3: 65-69.

75. R.K. Singh, R.C. Dhiman & P.K. Mittal; Mosquito larvicidal properties of Momordica charantia Linn (Family: Cucurbitaceae) J Vect Borne Dis., 2006; 43: 88–91.
76. Alam, S., Asad, M., Asdaq, S.M. and Prasad, V.S. (2009). Antiulcer activity of methanolic extract of Momordica charantia L. in rats. J Ethnopharmacol, 123(3): 464-9.
77. Vedamurthy, A.B., Rampurawala, J., Paarekh, P.M., Jogaiah, S. and Hoskeri, J. (2015). Evaluation of anthelmintic activity of Momordica charantia L. seeds. Ind J Nat Prod & Res., 6(2): 153-155.