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REVIEW ARTICLE

A traditional herbal remedy in liver diseases: *Momordica charantia* L. (kudret narı/bitter melon)

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Points to Note

- **Synthesis of Current Evidence:** This review examines whether bitter melon (*Momordica charantia*) has hepatoprotective effects.
- **Major Controversies:** Preclinical studies show *M. charantia* improves fatty liver, alcohol-related liver injury, and hepatocellular damage through antioxidant, anti-inflammatory, and lipid-lowering effects, though clinical evidence is limited.
- **Future Directions:** Bitter melon may support liver health, but it should not be routinely recommended due to insufficient human trials, dosing, and safety data.

ABSTRACT

The liver is the central organ regulating the body's metabolism; therefore, liver diseases negatively affect metabolic activities as well as the immune system. *Momordica charantia* L. is one of the medicinal plants used in folk medicine to prevent or treat liver diseases. *M. charantia* contains compounds with antioxidant and anti-inflammatory properties that protect liver cells from free radical damage and reduce inflammation. In addition, the phytochemicals of *M. charantia* may help regulate blood sugar levels, thereby supporting metabolism and reducing fat accumulation in the liver. Previous studies indicate that *M. charantia* has the potential to enhance liver function while reducing the incidence of fatty liver disease. This study aimed to summarize data from *in vivo* studies investigating the hepatoprotective mechanisms of *M. charantia* at various application doses, highlighting its potential as a future dietary supplement candidate. However, due to insufficient evidence regarding its safety, the possibility of hepatotoxic effects should not be disregarded.

Keywords: Bitter melon, hepatoprotective effect, liver diseases, *Momordica charantia*, non-alcoholic fatty liver disease (NAFLD).

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Introduction

The liver is responsible for several vital functions, including detoxification, protein synthesis, the bile production and secretion, glucose metabolism, bilirubin metabolism, blood clotting, and control of immune function.[1] Several diseases and conditions are frequently associated with liver dysfunction, including hepatitis A, hepatitis B, hepatitis C, hepatitis E, alcohol-related liver diseases, autoimmune hepatitis, non-alcoholic fatty liver disease (NAFLD), drug-induced liver injury, and hepatocellular carcinoma.[2] Given the rising prevalence of liver diseases, there is an increasing need to identify plants and plant-derived compounds that can provide hepatoprotective benefits. Studies indicate that green tea, resveratrol, milk thistle, garlic, and artichoke are among the plants that demonstrate hepatoprotective properties.[3] Although these plants exhibit hepatoprotective effects, they may also become hepatotoxic when consumed in excessive amounts. Green tea, for instance, can induce hepatotoxicity due to its content of epigallocatechin gallate (EGCG). The safe dose of EGCG has been established as less than 338 mg per day. When this threshold is exceeded, EGCG may trigger oxidative damage and potentially lead to mutations.[4] The use of herbs in maintaining human health has a history spanning several centuries. In recent years, there has been a significant increase in interest in the potential of medicinal plants for the protection and enhancement of liver health.

The fruits of *Momordica charantia* L. have been traditionally used for the prevention or treatment of liver diseases, particularly in Asian countries.[5] Therefore, this study focuses on investigating the hepatoprotective effects of *M. charantia*. Due to the limited number of clinical studies evaluating the hepatoprotective effects of *M. charantia*, the present study primarily focuses on evidence from *in vivo* and *in vitro* experiments. Although *M. charantia* has been used medicinally for a long time, recent studies suggest that the alpha-momorcharin compound isolated from its seeds may cause toxicity.[6] In addition, triterpenic compounds, namely 22-hydroxy-23,24,24,25,26,27-pentanorcucurbit-5-en-3-one and 3,7-dioxo-23,24,25,26,27-pentanorcucurbit-5-en-22-oic acid, isolated from *M. charantia* stems, have also been shown to cause toxicity in the HepG2 cell line.[7]

Search Strategy

Electronic literature sources were used to prepare this narrative review. The keywords *Momordica charantia*, bitter gourd, hepatoprotective effect, bitter melon, liver health, preclinical studies, and clinical studies were searched in the PubMed®, Scopus, Web of Science, Google Scholar, and EBSCOhost databases and combined using the search terms "AND," "OR," and "NOT." As the study focused on hepatoprotective effects, other liver diseases were not included. Database searches were updated weekly. Clinical trials and *in vivo* studies were primarily included. As this research is a narrative review, no formal assessment of study quality was performed.

M. charantia

M. charantia, commonly known as "bitter melon" or "bitter gourd," is a species belonging to the Cucurbitaceae family. *M. charantia* has a long history of use in traditional medicine for the treatment of various conditions, including anemia, diabetes, intestinal parasites, digestive system diseases, skin wounds, and liver diseases.[5] In Turkish traditional medicine, an oily macerate prepared by soaking the fruits in olive oil is used to treat gastrointestinal disorders and as a wound-healing agent.[8] In India, the fruits have been traditionally used for various therapeutic purposes, including the treatment of diabetes, psoriasis, and scabies, as well as for their abortifacient and antihelmintic effects.[9] *M. charantia* fruits are also frequently used for the treatment of jaundice in India.[10]

The pharmacological efficacy of *M. charantia* has been demonstrated in scientific studies investigating its diverse chemical composition and traditional medicinal uses. These studies have examined its analgesic effect,[11] antidiabetic activity,[12] anti-inflammatory activity,[13] hepatoprotective activity,[14] hypolipidemic effect,[15] and wound-healing activity.[16] The present study aims to review the literature on hepatoprotection, which is defined as the ability of a substance or treatment to protect the liver from damage or disease (Table 1).

The plant is a rich source of phytochemicals, consisting of various phytochemical groups found in different parts of the plant in varying concentrations. It has been demonstrated that the roots of *M. charantia* contain a variety of phenolic compounds, including flavonoids and triterpene saponins (Fig. 1).[7]

Non-Alcoholic Fatty Liver Disease

Non-alcoholic fatty liver disease has been reclassified under the umbrella term *steatotic liver disease*. Metabolic dysfunction-associated *steatotic liver disease* is the new name for the liver disease formerly known as NAFLD.[34] In recent times, there has been an alarming rise in the prevalence of NAFLD, which in now considered one of the most common forms of liver disease, affecting approximately 25% of the global population. The incidence of this disease is closely associated with the increasing prevalence of obesity.[35] NAFLD is a broad category that encompasses a spectrum of conditions ranging from simple steatosis (hepatic steatosis) to inflammation (steatohepatitis), with or without fibrosis, known as non-alcoholic steatohepatitis (NASH). Additionally, evidence suggests that NAFLD is associated with the development of cirrhosis and hepatocellular carcinoma (HCC).[36]

In a study utilizing a mouse model of NAFLD, the effect of *M. charantia* extract on the progression of NAFLD was examined following the administration of a high-fat diet for five days. When the experimental and control groups were compared, blood glucose, cholesterol, and low-density lipoprotein levels were found to decrease in the experimental group fed a high-fat diet. Histological examinations also revealed improvements in liver structure and function.[37] In

Table 1. Phytochemical constituents identified in different parts of *Momordica charantia* L.

Plant part	Chemical components	Chemical groups
Root	Quercetin[17]	Flavonoid
	Kaempferol[17]	Flavonoid
	Catechin[17]	Flavonoid
	Chlorogenic acid[17]	Flavonoid
	Momordicoside X	Cucurbitane-type triterpene saponin
	3β, 7β, 25-trihydroxycucurbita-5 23(E)-dien-19-al[18]	Cucurbitane-type triterpene saponin
	Momordicin I[18]	Cucurbitane-type triterpene saponin
	Momordicin II[18]	Cucurbitane-type triterpene saponin
	Kuguaglycoside G[18]	Cucurbitane-type triterpene saponin
Leaves	Caffeic acid[19]	Phenolic compounds
	Gallic acid[19]	Phenolic compounds
	Chlorogenic acid[19]	Phenolic compounds
	Karavilagenin F[20]	Cucurbitane-type triterpene saponin
	Karaviloside XII[20]	Cucurbitane-type triterpene saponin
	Karaviloside XIII[20]	Cucurbitane-type triterpene saponin
	Momordicine VI[20]	Cucurbitane-type triterpene saponin
	Momordicine VII[20]	Cucurbitane-type triterpene saponin
	Momordicine VIII[20]	Cucurbitane-type triterpene saponin
	(19R,23E)-5β,19-epoxy-19-methoxycucurbita-6,23,25-trien-3β-ol[20]	Cucurbitane-type triterpene saponin
	Kuguacin R[20]	Cucurbitane-type triterpene saponin
Fruits	Lycopene[21]	Carotenoids
	β-carotene[21]	Carotenoids
	Zeaxanthin[21]	Carotenoids
	Lutein[21]	Carotenoids
	Charantadiol A[22]	Triterpene saponin
	Charantagenin E[22]	Triterpene saponin
	Stigmasterol[22]	Sterols
	7,25-dihydroxycholesterol[22]	Sterols
	Goyaglycoside B[22]	Triterpene saponin
	Charantagenin D[22]	Triterpene saponin
	Kuguaglycoside C[22]	Triterpene saponin
	Momordicoside K[22]	Triterpene saponin
	Quinic acid[23]	Phenolic compounds
	Benzoic acid[23]	Phenolic compounds
	Gallic acid[23]	Phenolic compounds
Seeds	α-eleostearic acid (45.60%)[24]	Fatty acids
	Stearic acid (28%)[24]	Fatty acids
	Oleic acid (12.45%)[24]	Fatty acids
	Linoleic acid (8.90%)[24]	Fatty acids
	trans-Nerolidol (61.6%)[25]	Sesquiterpene
	Apiole (8.9%)[25]	Phenylpropene
	cis-Dihydrocarveol (4.9%)[25]	Monoterpenoids
	Germacrene D (4.4%)[25]	Sesquiterpene

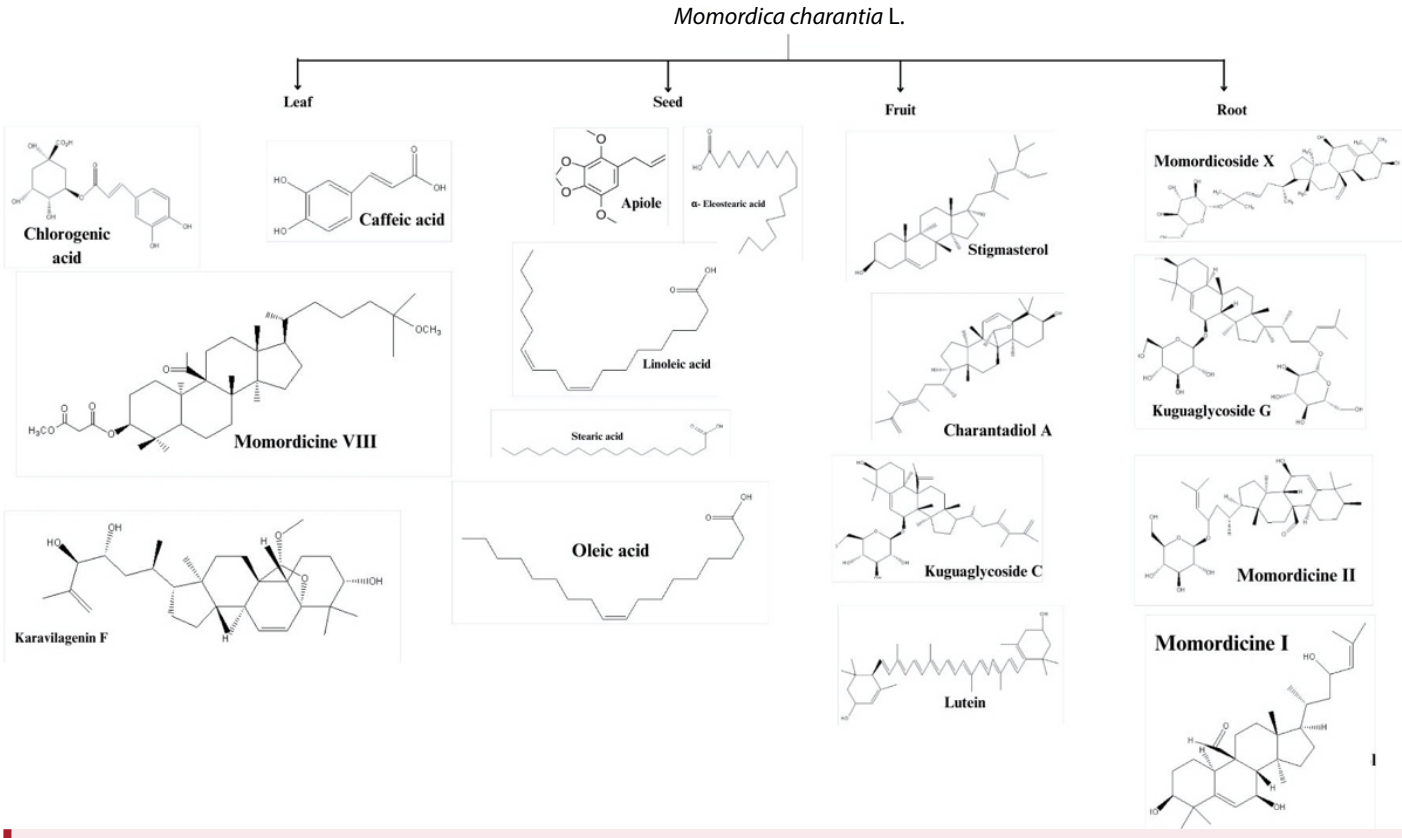


Figure 1. Molecular structure of *M. charantia* components (illustrated by the authors).

a further study, the efficacy of *M. charantia* compounds on the liver was evaluated by isolating the triterpenic saponins 3β, 7β, 25-trihydroxycucurbita-5,23(E)-dien-19-al and momordicine II, which were observed to inhibit lipid accumulation in HepG2 cells.[38]

The impact of protein derived from *M. charantia* fruits on NAFLD was examined in both *in vitro* and *in vivo* assays. It was observed that pretreatment of HepG2 cells with this isolated protein protected them from cellular changes such as steatosis. It was also demonstrated that intracellular triglyceride levels decreased and bile acid production increased. In addition, while findings such as liver discoloration and swelling were observed in rats fed a high-fat diet, lipid accumulation was significantly reduced and no hepatocyte growth was observed in the groups that received *M. charantia* protein at doses of 400 and 800 mg/kg.[39]

The effect of *M. charantia* juice on NAFLD development was investigated in mice at doses of 0.5 and 5 g/kg. In the *M. charantia*-treated group, kidney fat mass and liver weight were significantly lower than those in the fat-only diet group ($p<0.05$).[40]

Alcohol-Related Liver Disease

Chronic alcohol consumption can result in a range of liver damage, from fatty liver with microvesicular steatosis to cirrhosis and HCC. Furthermore, alcohol consumption has been shown to induce mitochondrial DNA damage in hepatocytes.[41] As the duration of alcohol consumption increases, there is a corresponding increase in lipid accumulation in hepatocytes, along with the activation of inflammatory damage, fibrogenesis, and carcinogenesis pathways.[42]

An 80% ethanol extract prepared from *M. Charantia* fruits was investigated for its protective effects against alcohol-induced liver damage in mice. The results of the analyses indicated a statistically significant reduction in liver weight and in the levels of alanine aminotransferase and aspartate aminotransferase, which are biochemical markers of liver damage ($p<0.05$). Histological examinations also demonstrated a reduction in lipid accumulation within hepatocytes.[43]

Hepatocellular Carcinoma

Hepatocellular carcinoma is the most common primary liver cancer and its incidence is increasing. Diseases such as hepatitis B, hepatitis C, and NASH, as well as alcohol consumption, have been implicated in its etiology. Cirrhosis is known to be one of the strongest risk factors for HCC.[44]

A lectin isolated from *M. charantia* was investigated using *in vitro* and *in vivo* methods. In a study conducted using the HepG2 cell line, increased apoptosis was observed at higher doses ($p<0.01$). Histological evaluations in mice also revealed a significant decrease in tumor volume ($p<0.01$).[45]

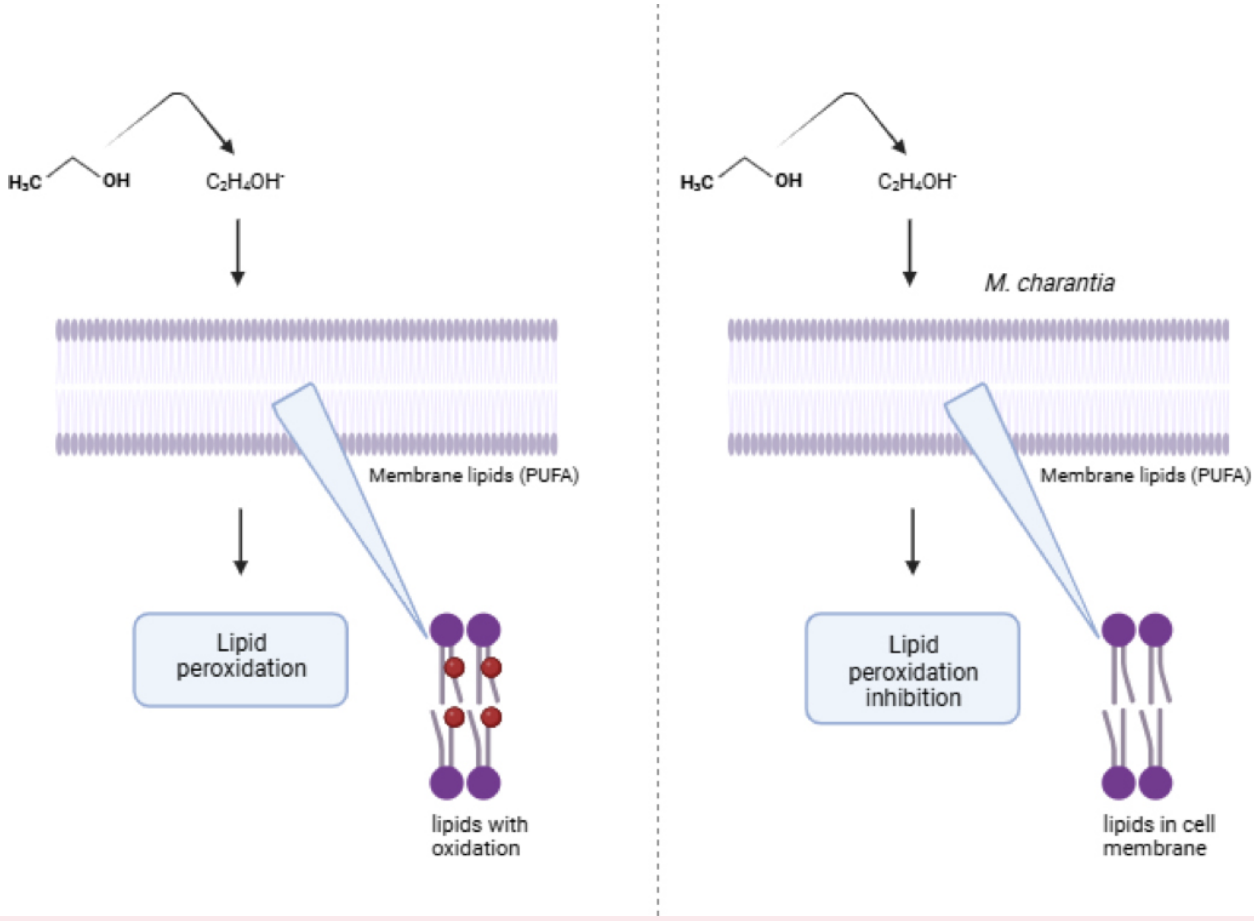


Figure 2. Antioxidant effect mechanism of *M. charantia* (original creations). The effectiveness of *Momordica charantia* in protecting the membrane integrity of liver cells has been demonstrated by its ability to inhibit the alcohol-mediated lipid peroxidation process in the liver (illustrated by the author).

Cucurbitan-type saponosides extracted from *M. charantia* fruits were assessed for their antiproliferative effects on Hep3B and HepG2 liver cell lines. The half maximal inhibitory concentration (IC_{50}) values for caraviloside III were determined to be 16.68 μM for Hep3B and 4.12 μM for HepG2, indicating that it is the most effective saponoside. The IC_{50} values for 5-fluorouracil, which was used as the positive control, were determined to be 15.49 μM for Hep3B and 33.58 μM for HepG2.[46]

The *in vitro* and *in vivo* effects of Momordica anti-HIV protein of 30 kDa (MAP30) protein, isolated from *M. charantia* seeds, were evaluated in cancer cells. *In vitro* studies demonstrated that the compound induced cell cycle arrest at the S phase in the HepG2 cell line. In a mouse model of liver cancer, a dose of 2 mg/kg of MAP30 was administered every two days. Consequently, a notable reduction in tumor volume and size was observed, as confirmed by histological analysis ($p<0.05$).[47]

The oral administration of *M. charantia* seed oil to rats yielded statistically significant outcomes. These included a reduction ($p<0.05$) in the mean number, diameter, and area of dysplastic nodules in the liver, as well as a reduction in the size of neoplastic lesions compared to the control group.[48]

Hepatoprotective Mechanisms of *M. charantia*

The use of plants in natural medical treatments has a long history spanning thousands of years. Advances in science and technology have enabled the efficacy and safety of herbal products to be studied in greater detail, and these products are now available in a variety of formulations. Formulation development is a crucial step in enhancing the efficacy of herbal products while reducing their potential adverse effects on the human body. The components of each herbal product may have different mechanisms of action; therefore, it is necessary to determine how these components can be used most effectively.[49]

Given that herbal extracts contain complex mixtures of phytochemicals, they exhibit a wide range of pharmacological effects through various mechanisms. Hazardous agents such as alcohol can damage hepatocytes and impair the normal functioning of their membranes. Consequently, the activities of transaminases and alkaline phosphatase increase as a result of this damage.[50]

Chronic alcohol consumption can lead to lipid oxidation, resulting in the disruption of membrane permeability. This process involves the formation of hydroxylethyl radicals, which primarily target

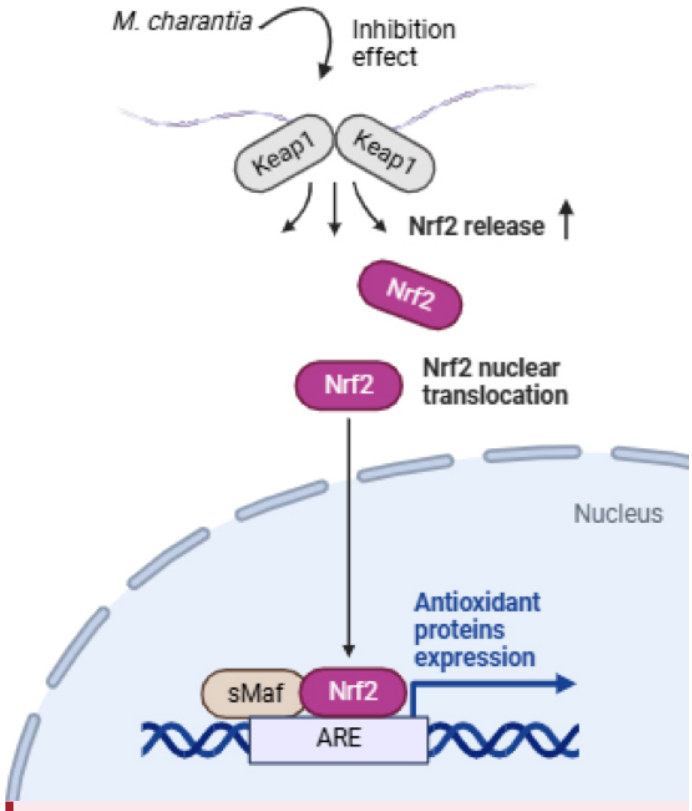


Figure 3. Nrf2-related antioxidant mechanisms (original creations).

polyunsaturated fatty acids. Certain fractions of *M. charantia* have been shown to maintain the membrane integrity of liver cells by inhibiting alcohol-induced lipid peroxidation in the liver.[31] The oxidative mechanism is illustrated in Figure 2.[51]

The use of antioxidants has been shown to inhibit the progression of liver disease and improve the effectiveness of current therapies by reducing oxidative stress. Antioxidants may promote the dissociation of nuclear factor erythroid 2–related factor 2 (Nrf2) from the complex by altering the phosphorylation of Kelch-like ECH-associated protein-1 (Keap1) or Nrf2, leading to Nrf2 activation. Activation of Nrf2 results in its translocation to the nucleus, where it interacts with the antioxidant response element. This process results in increased expression of genes encoding antioxidant enzymes and phase II detoxifying enzymes, which are essential for cellular protection and recovery. Moreover, several studies have shown that certain antioxidants or plant extracts rich in antioxidants protect against hepatotoxin-induced liver injury by enhancing Nrf2 activation.[52] The oxidative mechanism is illustrated in Figure 3.

Under unstressed conditions, the protein Keap1 represses Nrf2. However, in the presence of oxidative stress, Nrf2 is released from repression, thereby activating antioxidant genes and strengthening cellular defense mechanisms. In a study examining the hepatoprotective effects of *M. charantia* on NAFLD, serum concentrations of C-reactive protein and interleukin-6 were significantly reduced following supplementation ($p<0.05$). Similarly, sterol regulatory element-binding protein 1 (SREBP-1), a principal regulator of lipogenesis and a potential contributor to the development of fatty liver, was reduced following *M. charantia* supplementation, accompanied by decreased expression of fatty acid synthase (FAS) and acetyl-CoA carboxylase 1 (ACC-1) proteins, as well as reduced cholesterol and triglyceride (TG) concentrations. Inflammatory processes have been shown to induce the production of tumor necrosis factor-alpha (TNF-α), which may stimulate the maturation of SREBP-1 and contribute to lipid accumulation in hepatocytes. Therefore, it can be suggested that the effects of *M. charantia* on SREBP-1 and its target genes may help reduce inflammation. These findings indicate that *M. charantia* may serve as a promising agent for the prevention and treatment of NAFLD.[40]

The hepatoprotective properties of a formulation containing *Ferula asafoetida*, *M. charantia*, and *Nardostachys jatamansi* were examined in carbon tetrachloride-induced injury in rats. Enzymes including glutamate oxaloacetate transaminase, glutamate pyruvate transaminase, and alkaline phosphatases were selected as markers for the investigation. A statistically significant decrease was observed in the levels of these enzymes ($p<0.01$).[53]

The acute toxicity of *M. charantia* fruits was investigated, and the median lethal dose (LD_{50}) value was calculated to be >5000 mg/kg. Consequently, the fruit is considered relatively safe.[54] Nevertheless, research indicates that bitter melon may potentially interact with hypoglycemic drugs.[55] Furthermore, because *M. charantia* exhibits cytochrome P450 3A4 (CYP3A4) activity, there is a possibility of interaction with drugs metabolized by this enzyme.[56,57] The most frequently observed adverse effects are hypoglycemia and headaches.[55] Its use is not recommended during pregnancy and lactation. Studies in rats demonstrated the occurrence of cardiac hypertrophy in embryos, although no instances of lethality were observed.[58] Therefore, formulations containing *M. charantia* may potentially have adverse effects on the developing fetus.

Bioavailability

Bioavailability is one of the major challenges associated with herbal products.[59] It is important to investigate advanced technologies, such as nanoparticles and phytosomes, for bitter melon. Owing to the unpleasant flavor and limited bioavailability of *M. charantia*, innovative technologies such as nanoparticles and phytosomes may be utilized to enhance stability and bioavailability.[60] Studies involving nanoparticles have shown that herbal extracts may reduce toxicity while increasing activity.[61] The antibacterial efficacy of silver nanoparticles synthesized from *M. charantia* extract has been examined. The nanoparticle-treated group exhibited a notable increase in activity ($p<0.005$).[62] A study using the Huh-7 liver cancer cell line showed that *M. charantia* copper-iron nanoparticles promoted apoptosis. The IC_{50} was determined to be 324 µg/mL, indicating potential effectiveness.[63] Because nanoparticles are extremely small, they may also pose potential safety risks. Nanoparticle safety is a controversial subject due to the lack of evidence regarding both acute and chronic toxicity.[64]

Table 2. *In vivo* studies investigating the hepatoprotective effects of *Momordica charantia* L.

Plant part—solvent used	Research model	Dosage	Results
Leaves—water[26]	CCl_4-induced hepatotoxicity in rats	200 mg/kg and 400 mg/kg	ALT, AST, and ALP ↓ ($p<0.05$) SOD and CAT ↑ ($p<0.05$)
Leaves—50% ethanol[27]	CCl_4-induced hepatotoxicity in rats	100 mg/kg and 200 mg/kg	ALT, AST ↓ ($p<0.05$); histopathological findings showed minimal cellular damage after treatment
Leaves—70% ethanol[28]	CCl_4-induced hepatotoxicity in rats	100 mg/kg and 200 mg/kg	SGOT, SGPT, ALP, and total bilirubin levels improved ($p<0.05$)
Juice[29]	Acetaminophen-induced liver injury in rabbits	5 mL/kg	ALT, AST, and ALP ↓ ($p<0.05$)
Fruit—95% ethanol[30]	Ammonium chloride-induced liver injury in rats	300 mg/kg	AST, ALT, and ALP ↓ ($p<0.05$); decreased blood ammonia and plasma urea levels
Fruit—80% ethanol[31]	Alcohol-induced hepatotoxicity in rats	25, 50, and 100 mg/kg	SOD, GSH, and CAT ↑ ($p<0.05$)
Fruit—water[14]	Restraint-stressed mice	250, 500, and 750 mg/kg	Histopathological findings indicated intact liver cell structure and clearly defined hepatic cords; ALT and AST ↓ ($p<0.05$)
Fruit—Hexane[32]	Rat model of hepatic ischemia-reperfusion injury	200 mg/kg	Prevented increases in SGOT, SGPT, ALP, LDH, and CRP levels ($p<0.01$); prevented increase in MDA levels ($p<0.05$)
Leaves—70% methanol[33]	Cadmium-induced hepatotoxicity in rats	300 mg/kg	Cadmium caused fibrosis around the portal vein and disintegration of hepatocyte nuclei; pretreatment with extracts revealed prominent Kupffer cells

ALP: Alkaline phosphatase; AST: Aspartate aminotransferase; ALT: Alanine aminotransferase; SGOT: Glutamate oxaloacetate transaminase; SGPT: Glutamate pyruvate transaminase; SOD: Superoxide dismutase; CAT: Catalase; GSH: Glutathione; LDH: Lactate dehydrogenase; CRP: C-reactive protein; MDA: Malondialdehyde.

Conclusion

Bitter melon (*M. charantia*) has a long history of use in traditional medicine spanning several centuries. Because the liver performs numerous essential functions in the body, maintaining liver health is of critical importance. Various pathways may contribute to the development of liver disorders; therefore, herbal compounds and extracts that act through multiple mechanisms play an important role. Studies investigating the hepatoprotective effects of *M. charantia* are summarized in Table 2. However, the lack of clinical trials and safety data represents a significant obstacle to the development of *M. charantia* as a therapeutic agent. Its traditional medicinal use provides valuable insight for modern drug development, particularly in elucidating its chemical constituents and determining their mechanisms of action through scientific investigation. *M. charantia* may be used in combination with other herbs, such as milk thistle, and compounds beneficial for liver health, such as curcumin and silymarin. Future studies may investigate potential synergistic effects between these agents. This review aimed to evaluate the hepatoprotective potential of *M. charantia*. However, the current state of clinical research and formulation development is insufficient in several aspects. Moreover, another major limitation is the lack of clinical studies investigating the optimal dosage and duration required to achieve hepatoprotective effects.

Conflict of Interest: The authors have no conflict of interest to declare.

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Use of AI for Writing Assistance: The study did not use artificial intelligence (AI)-supported technologies (such as Large Language Models [LLMs], chatbots or image generators, ChatGPT).

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References

1. Lala V, Zubair M, Minter D. Liver function tests. Indian J Pediatr 2007;74(7):663-671. [CrossRef]
2. Tajiri K, Shimizu Y. Liver physiology and liver diseases in the elderly. World J Gastroenterol 2013;19(46):8459-8467. [CrossRef]
3. Xiao J, So KF, Liong EC, Tipoe GL. Recent advances in the herbal treatment of non-alcoholic fatty liver disease. J Tradit Complement Med 2013;3(2):88-94. [CrossRef]

4. Zhao T, Li C, Wang S, Song X. Green tea (Camellia sinensis): a review of its phytochemistry, pharmacology, and toxicology. Molecules 2022;27(12):1-23. [CrossRef]
5. Ahmad N, Hasan N, Ahmad Z, Zishan M, Zohrameena S. *Momordica charantia*: for traditional uses and pharmacological actions. J Drug Deliv Ther 2016;6(2):40-44. [CrossRef]
6. Meng Y, Liu B, Lei N, Zheng J, He Q, Li D, et al. Alpha-momorcharin possessing high immunogenicity, immunotoxicity and hepatotoxicity in SD rats. J Ethnopharmacol 2012;139(2):590-598. [CrossRef]
7. Chen CR, Liao YW, Wang L, Kuo YH, Liu HJ, Shih WL, et al. Cucurbitane triterpenoids from *Momordica charantia* and their cytoprotective activity in tert-butyl hydroperoxide-induced hepatotoxicity of HepG2 cells. Chem Pharm Bull (Tokyo) 2010;58(12):1639-1642. [CrossRef]
8. Yeşilada E, Gürbüz I, Shibata H. Screening of Turkish anti-ulcerogenic folk remedies for anti-Helicobacter pylori activity. J Ethnopharmacol 1999;66(3):289-293. [CrossRef]
9. Grover JK, Yadav SP. Pharmacological actions and potential uses of *Momordica charantia*: a review. J Ethnopharmacol 2004;93(1):123-132. [CrossRef]
10. Deb D, Datta BK, Debbarma J, Deb S. Ethno-medicinal plants used for herbal medication of jaundice by the indigenous community of Tripura, India. Biodiversitas 2016;17(1):256-269. [CrossRef]
11. Ofuegbe S, Akinrinde A, Oyagbemi A, Omobowale T, Yakubu M, Adedapo A. Phytochemical, acute toxicity, analgesic, *in vitro* antioxidant studies and GC-MS investigation of essential oil of the methanol leaf extract of *Momordica charantia*. J Complement Altern Med Res 2017;4(4):1-18. [CrossRef]
12. Liu Y, Mu S, Chen W, Liu S, Cong Y, Liu J, et al. Saponins of *Momordica charantia* increase insulin secretion in INS-1 pancreatic β-cells via the PI3K/Akt/FoxO1 signaling pathway. Endocrinol Diabetes Nutr (Engl Ed) 2021;68(5):329-337. [CrossRef]
13. Chao CY, Sung PJ, Wang WH, Kuo YH. Anti-inflammatory effect of *Momordica charantia* in sepsis mice. Molecules 2014;19(8):12777-12788. [CrossRef]
14. Deng Y, Tang Q, Zhang Y, Zhang R, Wei Z, Tang X, et al. Protective effect of *Momordica charantia* water extract against liver injury in restraint-stressed mice and the underlying mechanism. Food Nutr Res 2017;61(1):1-11. [CrossRef]
15. Mahwish, Saeed F, Arshad MS, Nisa M, Nadeem MT, Arshad MU. Hypoglycemic and hypolipidemic effects of different parts and formulations of bitter gourd (*Momordica charantia*). Lipids Health Dis 2017;16(1):211. [CrossRef]
16. Pişkin A, Altunkaynak BZ, Tümentemur G, Kaplan S, Yazıcı ÖB, Hökelek M. The beneficial effects of *Momordica charantia* (bitter gourd) on wound healing of rabbit skin. J Dermatolog Treat 2014;25(4):350-357. [CrossRef]
17. Thiruvengadam M, Praveen N, Maria John KM, Yang YS, Kim SH, Chung IM. Establishment of *Momordica charantia* hairy root cultures for the production of phenolic compounds and determination of their biological activities. Plant Cell Tiss Organ Cult 2014;118(3):545-557. [CrossRef]
18. Ma J, Whittaker P, Keller AC, Mazzola EP, Pawar RS, White KD, et al. Cucurbitane-type triterpenoids from *Momordica charantia*. Planta Med 2010;76(17):1758-1761. [CrossRef]
19. Shodehinde SA, Adefegha SA, Oboh G, Oyeleye SI, Olasehinde TA, Nwanna EE, et al. Phenolic composition and evaluation of methanol and aqueous extracts of bitter gourd (*Momordica charantia* L) leaves on angiotensin-I-converting enzyme and some pro-oxidant-induced lipid peroxidation *in vitro*. J Evid Based Complement Alternat Med 2016;21(1):67-76. [CrossRef]
20. Zhao GT, Liu JQ, Deng YY, Li HZ, Chen JC, Zhang ZR, et al. Cucurbitane-type triterpenoids from the stems and leaves of *Momordica charantia*. Fitoterapia 2014;95(1):75-82. [CrossRef]
21. Lee SH, Jeong YS, Song J, Hwang KA, Noh GM, Hwang IG. Phenolic acid, carotenoid composition, and antioxidant activity of bitter melon (*Momordica charantia* L) at different maturation stages. Int J Food Prop 2017;20(3):3078-3087. [CrossRef]
22. Wang X, Sun W, Cao J, Qu H, Bi X, Zhao Y. Structures of new triterpenoids and cytotoxicity activities of the isolated major compounds from the fruit of *Momordica charantia* L. J Agric Food Chem 2012;60(16):3927-3933. [CrossRef]
23. Lopes AP, Petenuci ME, Galuch MB, Schneider VVA, Canesin EA, Visentainer JV. Evaluation of effect of different solvent mixtures on the phenolic compound extraction and antioxidant capacity of bitter melon (*Momordica charantia*). Chem Pap 2018;72(11):2945-2953. [CrossRef]
24. Gölükçü M, Toker R, Ayas F, Çınar N. Some physical and chemical properties of bitter melon (*Momordica charantia* L) seed and fatty acid composition of seed oil. Derim 2014;31(2):17-24. [CrossRef]
25. Braca A, Siciliano T, D'Arrigo M, Germanò MP. Chemical composition and antimicrobial activity of *Momordica charantia* seed essential oil. Fitoterapia 2008;79(2):123-125. [CrossRef]
26. Mada S. Hepatoprotective effect of *Momordica charantia* extract against CCl4 induced liver damage in rats. Br J Pharm Res 2014;4(3):368-380. [CrossRef]
27. Chaudhari BP, Chaware VJ, Joshi YR, Biyani KR. Hepatoprotective activity of hydroalcoholic extract of *Momordica charantia* Linn leaves against carbon tetrachloride induced hepatopathy in rats. Int J ChemTech Res 2009;1(2):355-358.
28. Moharir G, Bharatha A, Ojeh N, Prasad VS. Evaluation of hepatoprotective effect of hydroalcoholic extract of *momordica charantia* leaves in carbon tetrachloride-ınduced liver toxicity in wistar rats. Biomed Pharmacol J 2019;12(3):1555-1560. [CrossRef]
29. Zahra K, Malik MA, Mughal MS, Arshad M, Sohail MI. Hepatoprotective role of extracts of *Momordica charantia* L in acetaminophen-induced toxicity in rabbits. J Anim Plant Sci 2012;22(1):273-277. [CrossRef]
30. Thenmozhi AJ, Subramanian P. Hepatoprotective effect of *Momordica charantia* in ammonium chloride induced hyperammonemic rats. J Pharm Res 2011;4(3):700-702. [CrossRef]
31. Hussain MA. Hepatoprotective activity of ethanolic extract fractions of *Momordica charantia* fruit, against alcohol induced hepatotoxic rats. Adv Pharmacol Toxicol 2014;15(1):43-48.
32. Parikh M, Patel A, Patel K, Tejal G. Protective effect of *Momordica charantia* against hepatic ischemic reperfusion injury model in rats. Austin J Pharmacol Ther 2015;3(1):1-5. [CrossRef]
33. Ajilore BS, Ayannuga OA. Hepatoprotective potentials of methanolic extract of the leaf of *Momordica charantia* Linn on cadmium-induced hepatotoxicity in rats. J Nat Sci Res 2012;2(5):41-47.
34. Rinella ME, Lazarus JV, Ratziu V, Francque SM, Sanyal AJ, Kanwal F, et al. A multisociety Delphi consensus statement on new fatty liver disease nomenclature. Hepatology 2023;78(6):1966-1986. [CrossRef]
35. Younossi ZM, Koenig AB, Abdelatif D, Fazel Y, Henry L, Wymer M. Global epidemiology of nonalcoholic fatty liver disease - Meta-analytic assessment of prevalence, incidence, and outcomes. Hepatology 2016;64(1):73. [CrossRef]
36. Powell EE, Wong VW S, Rinella M. Non-alcoholic fatty liver disease. Lancet 2021;397(10290):2212-2224. [CrossRef]

37. Santos MESM, Lemos BSO, Teixeira KB, Silva LN, Souza GA, Pinto FCH, et al. Effects of the *Momordica charantia* (MC) in the alterations caused by administration of a high fat diet (HL) as a model of non-alcoholic fatty liver disease (NAFLD). FASEB J 2013;27(Suppl 1):1-9. [CrossRef]
38. Yang LC, Lee YT, Kumaran A, Huang SQ, Su CH, Wu DR, et al. Target and non-target analysis with molecular network strategies for identifying potential index compounds from *Momordica charantia* L for alleviating non-alcoholic fatty liver. Ind Crops Prod 2024;219:1-10. [CrossRef]
39. Gao Y, Liu P, Wang D, Liu J, Yang L, Kang Y, et al. Isolation and characterization of a novel protein from *Momordica charantia* L that positively regulates lipid metabolism activity *in vivo* and *in vitro*. J Funct Foods 2022;96:1-10. [CrossRef]
40. Xu J, Cao K, Li Y, Zou X, Chen C, Szeto IM Y, et al. Bitter gourd inhibits the development of obesity-associated fatty liver in C57BL/6 mice fed a high-fat diet. J Nutr 2014;144(3):475-483. [CrossRef]
41. Meza V, Arnold J, Díaz LA, Ayala Valverde M, Idalsoaga F, Ayares G, et al. Alcohol consumption: medical implications, the liver and beyond. Alcohol Alcohol 2022;57(3):283-291. [CrossRef]
42. Arab JP, Roblero JP, Altamirano J, Bessone F, Chaves Araujo R, Higuera De la Tijera F, et al. Alcohol-related liver disease: Clinical practice guidelines by the Latin American Association for the Study of the Liver (ALEH). Ann Hepatol 2019;18(4):518-535. [CrossRef]
43. Lu KH, Tseng HC, Liu CT, Huang CJ, Chyuan JH, Sheen LY. Wild bitter gourd protects against alcoholic fatty liver in mice by attenuating oxidative stress and inflammatory responses. Food Funct 2014;5(4):1027-1037. [CrossRef]
44. Llovet JM, Kelley RK, Villanueva A, Singal AG, Pikarsky E, Roayaie S, et al. Hepatocellular carcinoma. Nat Rev Dis Primers 2021;7(1):1-28. [CrossRef]
45. Zhang CZ, Fang EF, Zhang HT, Liu LL, Yun JP. *Momordica charantia* lectin exhibits antitumor activity towards hepatocellular carcinoma. Invest New Drugs 2015;33(1):1-11. [CrossRef]
46. Yue J, Sun Y, Xu J, Cao J, Chen G, Zhang H, et al. Cucurbitane triterpenoids from the fruit of *Momordica charantia* L and their anti-hepatic fibrosis and anti-hepatoma activities. Phytochemistry 2019;157:21-27. [CrossRef]
47. 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 Lett 2012;324(1):66-74. [CrossRef]
48. Ranasinghe KNK, Premarathna AD, Mahakapuge TAN, Wijesundera KK, Ambagaspitiya AT, Jayasooriya AP, et al. *In vivo* anticancer effects of *Momordica charantia* seed fat on hepatocellular carcinoma in a rat model. J Ayurveda Integr Med 2021;12(3):435-442. [CrossRef]
49. Choudhary N, Sekhon BS. An overview of advances in the standardization of herbal drugs. J Pharm Educ Res 2011;2(2):55-70.
50. Madrigal Santillán E, Madrigal Bujaidar E, Álvarez González I, Sumaya Martínez MT, Gutiérrez Salinas J, Bautista M, et al. Review of natural products with hepatoprotective effects. World J Gastroenterol 2014;20(40):14787-14804. [CrossRef]
51. Valgimigli L. Lipid peroxidation and antioxidant protection. Biomolecules 2023;13(9):1291. [CrossRef]
52. Rouf R, Ghosh P, Uzzaman MdR, Sarker DK, Zahura FT, Uddin SJ, et al. Hepatoprotective plants from Bangladesh: a biophytochemical review and future prospect. Evid Based Complement Alternat Med 2021;2021:1-39. [CrossRef]
53. Dandagi PM, Patil MB, Mastiholimath VS, Gadad AP, Dhumansure RH. Development and evaluation of hepatoprotective polyherbal formulation containing some indigenous medicinal plants. Indian J Pharm Sci 2008;70(2):265-268. [CrossRef]
54. Abdillah S, Inayah B, Kartiningsih, Febrianti AB, Nafisa S. Acute and subchronic toxicity of *Momordica charantia* L fruits ethanolic extract in liver and kidney. Syst Rev Pharm 2020;11(1):2249-2255.
55. Basch E, Gabardi S, Ulbricht C. Bitter melon (*Momordica charantia*): a review of efficacy and safety. Am J Health Syst Pharm 2003;60(4):356-359. [CrossRef]
56. Shah PA, Eck P, Nerurkar PV. Modulation of human cytochrome P450 by *Momordica charantia* (bitter melon). FASEB J 2009;23(Suppl 1):688.5. [CrossRef]
57. Eichelbaum M, Burk O. CYP3A genetics in drug metabolism. Nat Med 2001;7(3):285-287. [CrossRef]
58. Khan MF, Abutaha N, Nasr FA, Alqahtani AS, Noman OM, Wadaan MAM. Bitter gourd (*Momordica charantia*) possess developmental toxicity as revealed by screening the seeds and fruit extracts in zebrafish embryos. BMC Complement Altern Med 2019;19(1):1-13. [CrossRef]
59. Kesarwani K, Gupta R. Bioavailability enhancers of herbal origin: an overview. Asian Pac J Trop Biomed 2013;3(3):253-266. [CrossRef]
60. Çiçek SS. *Momordica charantia* L-diabetes-related bioactivities, quality control, and safety considerations. Front Pharmacol 2022;13:904643. [CrossRef]
61. Yavuz İ, Yılmaz EŞ. Nanoparticules with biological systems. GÜFFD 2021;2(2):93-108. [Turkish]
62. Rashid MdMO, Akhter KN, Chowdhury JA, Hossen F, Hussain MdS, Hossain MdT. Characterization of phytoconstituents and evaluation of antimicrobial activity of silver-extract nanoparticles synthesized from *Momordica charantia* fruit extract. BMC Complement Altern Med 2017;17(1):336. [CrossRef]
63. Alamri RK, Ali D, Alharthi WA, Yaseen KN, Almutairi BO, Alkahtani S, et al. Green synthesis of copper-iron nanoparticles using the peel of *Momordica charantia* and its cytotoxicity and apoptotic effect on human liver and breast cancer cells. Nat Prod Commun 2023;18(11). [CrossRef]
64. Najahi Missaoui W, Arnold RD, Cummings BS. Safe nanoparticles: are we there yet? Int J Mol Sci 2021;22(1):1. [CrossRef]