

Medical Wonders of *Chrysanthemum morifolium*: Fusion of Traditional Chinese Medicine and Modern Science

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Abstract Chrysanthemum is an important component of traditional Chinese medicine (TCM), has been highly praised for its special therapeutic effects for over 2000 years. This study integrate the research results of traditional and modern medicinal effects of chrysanthemum, in order to broaden its application prospects and develop new drugs, health products, etc. The active ingredients of chrysanthemum, such as naringenin and apigenin, have shown antidepressant effects by regulating various metabolic pathways such as tryptophan and phenylalanine metabolism; The synergistic effect of active ingredients such as apigenin and kaempferol in chrysanthemum has the effect of treating diseases such as gout by inhibiting the activity of xanthine oxidase. Chrysanthemum extract exhibits strong antibacterial properties against *Streptococcus* mutans and other bacteria, and is expected to become a candidate drug for the treatment of postoperative sore throat. Ethnic pharmacology research emphasizes that chrysanthemum extract has multiple pharmacological activities, including anti-inflammatory, antioxidant, and therapeutic effects on cardiovascular diseases. Combining traditional uses with modern medical research achievements, exploring the potential of chrysanthemum as a modern medical raw material.

Keywords *Chrysanthemum morifolium*; Traditional Chinese medicine; Biological activity; Extractive; Clinical application

1 Introduction

Chrysanthemum morifolium is a flower and medicinal plant with a long history of cultivation and medicinal use. (Lee et al., 2021). Chrysanthemum revered in Traditional Chinese medicine (TCM) for thousands of years, this herb has been utilized for its remarkable therapeutic properties, chrysanthemum has a wide range of disease treatments, including inflammation, eye diseases, immunity, etc. It is a treasure gifted to humans by nature. The chrysanthemum's medicinal lore is steeped in ancient texts and traditional practices, symbolizing a bridge between nature's bounty and human health.

In recent years, the close combination of modern medical technology and traditional Chinese herbal medicine further reveals the credibility of chrysanthemum medicine, that hold promise for contemporary medicine. The combination of traditional Chinese medicine decoctions and modern medical research results has prompted people to have a new understanding of the therapeutic potential of chrysanthemum. This not only proves the efficacy of traditional Chinese medicine decoctions, but also discovers new therapeutic effects, which may have a revolutionary turning point for the treatment of diseases in traditional Chinese medicine (Chen et al., 2020; Wang et al., 2022).

This study aims to comprehensively study the pharmacological properties of chrysanthemums and their therapeutic potential, combining traditional uses with modern scientific discoveries. Research results on active ingredients such as flavonoids, phenolic acids, and essential oils in chrysanthemum, as well as mechanisms of related pharmacological and pharmacological activities. In particular, the focus is on the integration of traditional applications within the framework of contemporary clinical research, highlighting the advantages and characteristics of traditional Chinese medicine combined with modern science and technology, guiding the research, development, production, management, and application of traditional Chinese medicine to meet the

needs of social development. We hope to pave the way for future research and clinical applications that will lead to a deeper understanding of the importance of chrysanthemums in both traditional and modern contexts.

2 Botanical Description and Cultivation

2.1 Taxonomy and morphology

Chrysanthemum belongs to the genus *Chrysanthemum* in the family Asteraceae. Including hybrid cultivated varieties and wild species, it has extremely high ornamental value, and as a Chinese medicinal herb with medicinal and edible homology, it has high medicinal value. The medicinal part of chrysanthemum is a dry head shaped inflorescence, with a history of over 2200 years of medicinal use. During the Han Dynasty, chrysanthemum tea was used as a health supplement. Chrysanthemum is rich in various active ingredients (polysaccharides, flavonoids, volatile oils, etc.), some of which have been widely studied and reported (Yang et al., 2019; Chen et al., 2020).

2.2 Growth conditions and geographical distribution

China is the origin center of chrysanthemum cultivation and the distribution center of chrysanthemum resources, with a history of over 3000 years of chrysanthemum cultivation and application. Chrysanthemum has strong adaptability and is distributed in East Asia. It is widely planted in China and Japan and is one of the important Chinese medicinal materials. It is also one of the top ten fresh cut flowers in China and an important raw material for tea and beverages. Chrysanthemum is suitable for sandy loam and loam, as well as sandy ginger black soil with good soil quality, loose texture, convenient drainage and irrigation, and medium to high fertility, to avoid repeated cropping. Chrysanthemums usually grow in temperate climates and have strong adaptability. They have both medicinal value and strong ornamental value, making them a multifunctional crop. Most medicinal chrysanthemums are named after their place of origin, with the most famous being the "Hangju", "Huaiju", "Boju", "Gongju", and "Chuju" in China, which are distributed in Zhejiang Province, Henan Province, Anhui Province, and other regions. They have a wide geographical distribution range and adapt to diverse climates (Feng et al., 2016; Hao et al., 2022).

2.3 Cultivation practices and varieties

The reproduction methods of chrysanthemums mainly include root splitting and cutting propagation, with root splitting as the main method. There are about 40 species of chrysanthemum plants worldwide, with over 20 species distributed in China. Among them, there are 11 medicinal chrysanthemums, 3 varieties, and 9 cultivated varieties. According to reports, there are about 3000 varieties of chrysanthemum cultivation, including medicinal, ornamental, and edible varieties. According to the size and shape of the inflorescence, it can be divided into single petal and double petal; Flat, spherical; Long floc, short floc, flat floc, and rolled floc; Hollow and solid; Straight and drooping, with a variety of styles and complex varieties. According to the natural flowering period, it can be divided into spring chrysanthemum (May chrysanthemum), summer chrysanthemum (July chrysanthemum), early autumn chrysanthemum (blooming in September), autumn chrysanthemum (October to November), and winter chrysanthemum (December to January). According to the size of the flower diameter, it can be divided into large chrysanthemum series (those with a diameter of more than 18 cm), medium chrysanthemum series (those with a diameter of 9-18 cm), and small chrysanthemum series (those with a diameter of less than 9 cm). The daisy series can be divided into disc type, lotus type, peony type, hydrangea type, button type, etc; The Chinese chrysanthemum system can be further divided into osmanthus type, plum type, jasmine type, lychee type, ten thousand bell type, etc; The Little Chrysanthemum series is mostly full of stars in the sky. According to the valve type, it can be divided into five types: flat valve, tubular valve, spoon valve, cinnamon valve, and deformity valve, with more than ten types. According to cultivation and shape, it can be divided into single stem chrysanthemum, desk chrysanthemum, multi head chrysanthemum, small standing chrysanthemum, large standing chrysanthemum, tower chrysanthemum, cliff chrysanthemum, bonsai chrysanthemum, grafted chrysanthemum, and cut chrysanthemum. According to their efficacy and use, they can be divided into medicinal chrysanthemums, tea chrysanthemums, ornamental chrysanthemums, and edible chrysanthemums (Xia et al., 2021).

3 Historical and Traditional Uses in Chinese Medicine

3.1 Historical context and cultural significance

Chrysanthemum morifolium, commonly known as chrysanthemum, has a rich history in Chinese culture and traditional medicine. It has been used for centuries, not only as a decorative flower but also as an important component of herbal medicine. Chrysanthemums are endowed with auspicious and longevity meanings in ancient mythological legends, where it is celebrated for its beauty and medicinal properties. Historical texts and classic books of Traditional Chinese medicine (TCM) have documented its use in treating various ailments, highlighting its importance in traditional Chinese medicine treatment (Hao et al., 2022).

3.2 Traditional medicinal uses

In traditional Chinese medicine, *Chrysanthemum morifolium* is renowned for its therapeutic applications. It is primarily used to treat respiratory and cardiovascular diseases due to its antimicrobial, anti-inflammatory, and neuroprotective properties (Zou et al., 2021). The flower is also known for its effects on the cardiovascular system, making it a popular remedy for conditions such as hypertension and liver-fire hyperactivity syndrome. Additionally, it has been used to alleviate symptoms of colds, headaches, and dizziness, showcasing its versatility in traditional medicinal practices.

3.3 Preparation and dosage forms in traditional medicine

Modern pharmacological studies have shown that chrysanthemum contains components such as volatile oil, flavonoids, chlorogenic acid, inulin, adenine, choline, stachydrine, amino acids, and various trace elements. Chrysanthemum can be prepared in various forms to maximize its medicinal value. Common preparations include tea, infusion, and soup. Dried flower heads are directly brewed into tea for consumption, which has strong antioxidant and anti-inflammatory properties (Li et al., 2019; Zhang et al., 2019). The combination of chrysanthemum and other herbs (such as goji berries) has significant therapeutic effects in fields such as wind heat, cold, and antiviral effects; Traditionally, dried flower heads of chrysanthemums are used as medicinal decoctions, and the dosage or usage is determined based on individual differences in the human body or disease characteristics to make decoctions or tea drinks. These methods can extract bioactive compounds from flowers, such as flavonoids and caffeoyl quinic acid, providing a rich source of health promoting substances.

4 Chemical Composition and Bioactive Compounds

4.1 Overview of phytochemical constituents

Chrysanthemum morifolium, a traditional Chinese medicinal herb, is rich in various phytochemicals that contribute to its medicinal properties. The primary constituents include flavonoids, essential oils, volatile compounds, and other bioactive components. Studies have identified numerous compounds within these categories, highlighting the plant's potential for therapeutic applications (Kim et al., 2009).

4.2 Flavonoids and their functions

Flavonoids are one of the most significant groups of bioactive compounds in *Chrysanthemum morifolium*. Key flavonoids identified include luteolin-7-glucoside, quercitrin, acacetin, and kaempferol (Sun et al., 2010; Wang et al., 2015; Chen et al., 2020). Chrysanthemum has anti-inflammatory, anti thrombotic, antioxidant, anti allergic, antibacterial, analgesic, and vasodilatory effects (Liu et al., 2017). Among them, chrysanthemum extract is the most valuable flavonoid substance, which has been used as a traditional medicine since ancient times. Its low toxicity and side effects mainly affect endothelial cells, lower blood pressure and blood sugar, and inhibit platelet aggregation (Zeinali et al., 2017). Luteolin and quercetin have been shown to enhance the plant's antioxidant capacity, which is crucial for its medicinal use (Hodaei et al., 2018). Additionally, flavonoids like acacetin and kaempferol contribute to the plant's anti-inflammatory properties, making it effective in treating conditions like liver-fire hyperactivity syndrome of hypertension (Figure 1) (Wang et al., 2022).

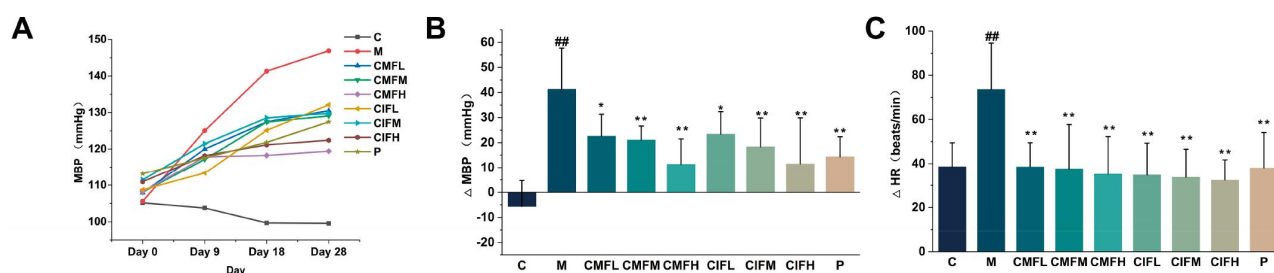


Figure 1 The competence of CMF and CIF in lowering blood pressure and HR (Adopted from Wang et al., 2022)
 Image caption: (A)—The change of MBP under four measurements; (B)—Difference value between the last and the first measurement of MBP; (C)—Difference value between the last and the first measurement of HR. Values shown are mean \pm SD. ## $p < 0.01$ compared with C group; * $p < 0.05$, ** $p < 0.01$ compared with M group (Adopted from Wang et al., 2022)

Wang et al. (2022) demonstrated the effects of flavonoids on cardiovascular function in rats under different physiological states. As can be seen from Figure 1A, compared with the control group, flavonoids significantly affected the changes in blood pressure, especially in the later stages of the experiment. Figure 1 B and Figure C show the effects of flavonoids on mean blood pressure and heart rate in rats, with some combinations showing significant physiological effects, reducing increases in heart rate and blood pressure, suggesting that these compounds may help regulate cardiovascular function, and may have preventive or therapeutic effects on cardiovascular disease. These results highlight the importance of further exploring the use of flavonoids in cardiovascular health.

4.3 Essential oils and volatile compounds

The essential oils and volatile compounds of *Chrysanthemum morifolium* are another critical component of its chemical profile. Most of the volatile oil substances are terpenoids, such as monoterpenes, sesquiterpenes, etc., as well as hydrocarbons, esters, aldehydes, ketones, phenols, and organic acids. Volatile compound component camphor, α -humulene, and ledene oxide-(I) (Youssef et al., 2020; Liu et al., 2022). These compounds are known for their antimicrobial, antioxidant, and anti-inflammatory activities. For example, camphor, a major constituent, has demonstrated significant antiviral and antimicrobial properties, making it a potential natural preservative. There are significant differences in the content and composition of volatile compounds in different varieties of chrysanthemums, and it is possible to cultivate quality specific varieties to improve their therapeutic potential (Yang et al., 2017). The content and composition of volatile oil substances in chrysanthemums may also vary due to different processing techniques, extraction techniques, and types of compounds.

4.4 Other notable bioactive components

In addition to flavonoids and essential oils, *Chrysanthemum morifolium* contains other bioactive components such as polysaccharide substances, caffeoylquinic acids, phenolic glycosides, and lignans. Polysaccharides are also important medicinal components of chrysanthemum, with certain effects in antioxidant, antiviral, anti-tumor, blood pressure lowering, anti-inflammatory, immune regulation, and health care. The effects of polysaccharides are closely related to the variety, origin, and extraction method of chrysanthemum. Caffeoylquinic acids, for instance, are known for their antioxidant and anti-inflammatory properties, contributing to the plant's overall therapeutic potential. Phenolic glycosides and lignans have also been identified as significant neuroprotective agents, offering potential benefits in treating neurodegenerative diseases (Yang et al., 2019). Furthermore, compounds like lupeol and α -amyrin have shown cytotoxic effects against various cancer cell lines, highlighting the plant's potential in cancer therapy (Sayed, 2023).

5 Pharmacological Activities

5.1 Anti-inflammatory and antioxidant properties

The liver, as an important organ for metabolizing drugs and toxic substances in the human body, plays an important role in many physiological processes. Many active ingredients in chrysanthemum are believed to be beneficial for protecting the liver. A type of tetrandrin extracted from North Yellow Chrysanthemum can inhibit

the production of NO and PGE2 in mouse macrophages RAW264.7 induced by lipopolysaccharide (LPS), as well as the induction of pro-inflammatory cytokines TNF-alpha and IL-1 β . Further research has found that tetrandrine can also inhibit the binding activity of NF kappaB with nuclear proteins, reduce the transcriptional activity of NF kappaB, and thus inhibit acute inflammation. The combination of chrysanthemum and goji berry has strong antioxidant activity, which can reduce the expression of inflammatory markers such as iNOS, TNF- α , IL-1 β , and IL-6 in macrophages (Zhang et al., 2019). Additionally, the hot-water extracts of *Chrysanthemum morifolium* were found to activate the PI3K/Akt-mediated Nrf2/HO-1 signaling pathway, thereby enhancing the expression of antioxidant enzymes and reducing oxidative stress in ARPE-19 cells (Hao et al., 2021). Chrysanthemum has antioxidant potential in clearing free radicals and inhibiting lipopolysaccharide induced inflammatory response (Li et al., 2019).

5.2 Antimicrobial and antiviral effects

Chrysanthemum has certain antibacterial and antiviral effects, which can effectively inhibit *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Bacillus cereus*, *Pseudomonas aeruginosa*, and other bacteria. The essential oils extracted from chrysanthemums have anti *Streptococcus agalactiae* and *Helicobacter pylori* properties, including significant minimum inhibitory concentration (MIC) values (Youssef et al., 2020). And it also has antiviral activity against viruses such as herpes simplex type-1 (HSV-1) and vesicular stomatitis virus (VSV), indicating their potential use as natural preservatives and anti-infective agents.

The chemical components of the volatile oil extracted from chamomile flowers (*Matricaria chamomilla* L.) can effectively inhibit the activity of *Listeria monocytogenes* and *Staphylococcus aureus* (Stanojevic et al., 2016). The content and antibacterial activity of phenolic and flavonoid compounds in Iranian chrysanthemum were evaluated, and it was found that phenolic and flavonoid substances have significant inhibitory effects on *Salmonella enterica* and *Bacillus cereus* (Hodaie et al., 2021). Oji et al. (2012) found that the components of flower oil, stem oil, and leaf oil in chrysanthemum are different. Among them, leaf oil is the most abundant and has a certain inhibitory effect on both Gram positive and Gram negative bacteria. The essential oil extracted from leaves and stems has the strongest inhibitory effect. In addition to inhibiting bacterial activity, chrysanthemum essential oil can also inhibit fungal activity.

5.3 Cardiovascular benefits

The cardiovascular protective effects of *Chrysanthemum morifolium* have been well-documented. Extracts from the flower have been shown to reduce the expression of intercellular adhesion molecule-1 (ICAM-1) and E-selectin in human umbilical vein endothelial cells, which are critical markers of cardiovascular inflammation (Lii et al., 2010). Additionally, *Chrysanthemum morifolium* extract ameliorated doxorubicin-induced cardiotoxicity by decreasing apoptosis and improving heart function in animal models (Figure 2), suggesting its potential in protecting against chemotherapy-induced heart damage (Ono et al., 2022). Chrysanthemum protein can also inhibit the development of atherosclerosis by reducing vasculitis (Farkhondeh et al., 2019).

In Ono et al.'s (2022) study, the repair effect of CME on DOX induced cardiac dysfunction was investigated, and several different measurement indicators were used to evaluate the progression of changes in cardiac function and structure. It can be seen from the M-mode image in Figure 2A, the cardiac structure of the group treated with DOX plus CME appears to be better preserved compared to the group treated with DOX alone. This suggests that CME may help protect the heart from the toxic effects of DOX. Figures 2D and Figures 2E show the ratio of body weight and heart weight to tibia length (HW/TL ratio), respectively, which are indicators of cardiac hypertrophy and overall health. The results showed that CME treatment was able to attenuate DOX-induced weight loss and heart weight increase, further confirming its potential for cardioprotection. This study provides strong evidence that CME can offset the adverse effects of DOX on the heart, This provides strong evidence of potential benefits for cancer patients who require DOX treatment.

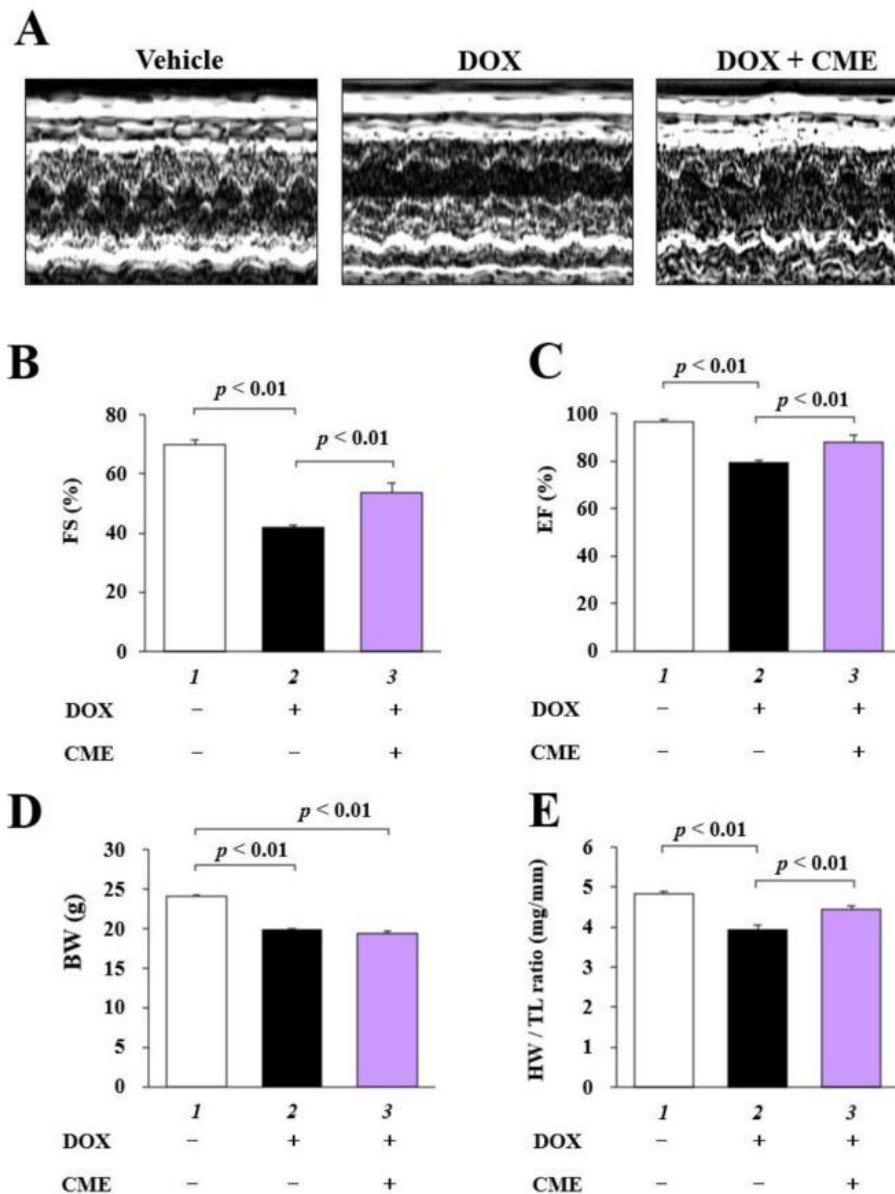


Figure 2 DOX-induced cardiac dysfunction was inhibited by CME (Adopted from Ono et al., 2022)
 Image caption: (A) Representative photographs of M-mode images. (B) FS, fractional shortening. (C) EF, ejection fraction. (D) BW, body weight. (E) HW, heart weight; TL, tibia length. Values are presented as the mean SEM of 10 individual measurements (Adopted from Ono et al., 2022)

5.4 Neuroprotective and cognitive enhancing effects

Chrysanthemum morifolium has shown promise in neuroprotection and cognitive enhancement. The flower extract was found to protect human neuroblastoma SH-SY5Y cells against MPP⁺-induced cytotoxicity, a model for Parkinson's disease, by reducing oxidative stress and apoptosis (Kim et al., 2009). Chrysanthemum extract improves mitochondrial function and increases the expression of genes related to mitochondrial biosynthesis in muscle tissue, which can alleviate neurodegenerative diseases (Lee et al., 2021).

5.5 Anticancer potential

The anticancer potential of *Chrysanthemum morifolium* is supported by its cytotoxic effects on various cancer cell lines. Acetone extracts from the flower demonstrated significant cytotoxicity against breast cancer (MCF-7), lung cancer (A549), and hepatocellular carcinoma (HepG2) cell lines, highlighting its potential as a source of bioactive compounds for cancer treatment (Sayed, 2023). Chrysanthemum extract has an active site that inhibits osteoclast

differentiation and bone resorption ability in managing bone metastasis and other cancer-related bone disorders (Jang et al., 2020).

6 Modern Clinical Applications and Research

6.1 Integration into modern therapeutics

Chrysanthemum is a traditional Chinese herbal medicine that contains various bioactive ingredients and has the potential to treat various diseases. It has been widely integrated into modern therapeutic science. Chrysanthemum is rich in flavonoids, volatile oils, and other phytochemicals, which contribute to its wide range of health benefits, including anti-inflammatory, antioxidant, and neuroprotective effects (Sun et al., 2010; Hao et al., 2022; Ojha et al., 2023). Modern research has demonstrated that *Chrysanthemum morifolium* can be used to treat various conditions such as hypertension, depression, and neurodegenerative diseases, making it a valuable addition to contemporary medical practices (Kim et al., 2009; Wang et al., 2022).

6.2 Recent clinical studies and findings

Recent clinical studies have highlighted the efficacy of *Chrysanthemum morifolium* in various therapeutic applications. Chrysanthemum combined with goji berries has significant antioxidant and anti-inflammatory activities, suggesting potential benefits in managing oxidative stress and inflammation-related conditions (Zhang et al., 2019). Another study demonstrated the anti-depressive effects of *Chrysanthemum morifolium*, naringenin, and apigenin, which were found to have ameliorate depression-like behavior through modulation of metabolic pathways (Liu et al., 2020). Additionally, research on the neuroprotective properties of *Chrysanthemum morifolium* extract showed its potential in protecting neuronal cells against Parkinsonian toxins, indicating its potential application in the treatment of neurodegenerative diseases.

6.3 Challenges and limitations in clinical application

Despite the promising therapeutic potential of *Chrysanthemum morifolium*, several challenges and limitations hinder its widespread clinical application. One major concern is the variability in the chemical composition of different *Chrysanthemum morifolium* cultivars, which can affect the consistency and efficacy of its therapeutic effects (Chen et al., 2020). Moreover, there is a need for more rigorous clinical trials to establish standardized dosages and formulations. Safety concerns also arise from the potential for adverse interactions with other medications and the lack of comprehensive toxicity studies (Ojha et al., 2023). Addressing these challenges requires a multidisciplinary approach, integrating traditional knowledge with modern scientific methodologies.

6.4 Future directions for research

Future research on *Chrysanthemum morifolium* should focus on several key areas to enhance its clinical application. Conduct comprehensive research on different chrysanthemum varieties to determine their chemical composition and therapeutic effects. The use of advanced technologies such as metabolomics and network pharmacology has the potential to identify therapeutic effects of potential biomarkers and elucidate mechanisms of action (Wang et al., 2022). More extensive clinical trials are necessary to determine optimal dosages, formulations, and safety profiles. Strengthen collaborative efforts between traditional medicine practitioners and modern scientists can facilitate the development of novel therapeutic strategies, ensuring the safe and effective integration of *Chrysanthemum morifolium* into modern healthcare.

7 Mechanisms of Action

7.1 Molecular pathways involved

Chrysanthemum (CM) active ingredients have multiple metabolic pathways and exhibit various therapeutic effects. One important pathway is the AMPK/SIRT1 pathway, and studies have shown that chrysanthemum extract can activate the AMPK and SIRT1 pathways, thereby increasing mitochondrial biosynthesis and function in muscle tissue, and reducing inflammation and fat generation in obese rats, indicating that chrysanthemum extract has a positive effect in regulating energy metabolism and inflammation (Zhang et al., 2019). Chrysanthemum extract can regulate the PI3K/Akt signaling pathway and play a role in protecting cardiovascular function by inhibiting the expression of adhesion molecules such as ICAM-1 and E-selectin in endothelial cells (Kim et al., 2009).

Importantly, the c-fos/NFATc1 pathway of chrysanthemum extract indicates significant potential in the treatment of osteoporosis and related diseases through osteoclast differentiation (Yang et al., 2019).

7.2 Interaction with cellular targets

Chrysanthemum extract interacts with various cellular targets to exert its effects. For instance, in neuroblastoma cells, CM extract has been shown to inhibit oxidative stress-induced cytotoxicity by modulating the expression of apoptotic proteins such as Bcl-2 and Bax, and by preventing the cleavage of caspase-3 and PARP. In the context of obesity and dyslipidemia, CM leaf extract and its constituent luteolin have been demonstrated to normalize lipid profiles by affecting lipidomic biomarkers such as cholesteryl esters, lysophosphatidylcholines, and sphingomyelins (Shon et al., 2020). Moreover, CM's anti-inflammatory properties are partly attributed to its ability to inhibit the production of pro-inflammatory cytokines and enzymes, such as TNF- α , IL-1 β , IL-6, and iNOS, through the inactivation of MAPKs and NF- κ B pathways (Zhang et al., 2019).

7.3 Synergistic effects with other compounds

When chrysanthemum is combined with other Chinese herbs, its therapeutic effect can be enhanced. For example, a combination of chrysanthemum and wolfberry (*Lycium barbarum*) has shown synergistic antioxidant and anti-inflammatory effects. This combination significantly reduced oxidative stress and inflammation in macrophages, with the most potent effects observed at a 1:1 ratio of chrysanthemum to wolfberry. Additionally, the flavonoids apigenin and luteolin, which are abundant in CM, have been found to work synergistically to inhibit the expression of adhesion molecules and oxidative stress markers in endothelial cells, further enhancing CM's cardiovascular protective effects (Lii et al., 2010). These findings suggest that CM's bioactive compounds can interact synergistically with other natural products to amplify its therapeutic benefits.

8 Safety and Toxicology

8.1 Toxicological studies and safety profile

Chrysanthemum morifolium, commonly used in traditional Chinese medicine, has been extensively studied for its therapeutic benefits. However, its safety profile is equally important. Toxicological studies have shown that extracts from *Chrysanthemum morifolium* are generally safe and exhibit low toxicity. A study on the neuroprotective effects of *Chrysanthemum morifolium* extract demonstrated it effectively inhibited cytotoxicity and improved cell viability without adverse effects. Additionally, the flower extract has been shown to ameliorate obesity-induced inflammation in rats without causing significant toxicity (Lee et al., 2021). These findings suggest that *Chrysanthemum morifolium* is safe for use in both traditional and modern medicinal applications.

8.2 Potential side effects and contraindications

Despite its general safety, some potential side effects and contraindications of *Chrysanthemum morifolium* should be noted. Chrysanthemum extract can cause mild gastrointestinal disorders in some populations. Due to the strong bioactive components of chrysanthemum, it may interfere with the action sites of certain drugs. For example, chrysanthemum has been shown to interfere with other drugs targeting the PI3K/Akt signaling pathway when regulating it (Feng et al., 2022). In addition, some people are allergic to Asteraceae plants, and taking chrysanthemum related drugs may cause allergic reactions (Yang et al., 2019).

8.3 Guidelines for safe usage

To ensure the safe use of *Chrysanthemum morifolium*, several guidelines should be followed: Adhere to recommended dosages as excessive intake may lead to adverse effects. The use of specific concentrations (0.2% and 0.4% CE) of chrysanthemum has a good therapeutic effect on obesity and is non-toxic. It is important to follow traditional formulas and consult a professional doctor when taking chrysanthemum and its combination drugs (Zhang et al., 2019). Individuals with chrysanthemum allergy should undergo patch testing or consult a professional doctor before using chrysanthemum products (Ojha et al., 2023). There is limited data on the safety of using chrysanthemums in pregnant and lactating women. Therefore, it is recommended that pregnant and lactating women use it with caution and consult a professional doctor.

9 Concluding Remarks

Chrysanthemum morifolium, a traditional Chinese medicinal herb, has demonstrated significant potential in modern scientific research for its diverse therapeutic properties. Chrysanthemum is rich in bioactive compounds such as flavonoids and volatile oils, giving it a rich pharmacological activity. Research has shown that chrysanthemum extract (CE) can enhance muscle mitochondrial content and activate the AMPK/SIRT1 pathway, improving inflammation caused by obesity. Chrysanthemum has traditionally been shown to have therapeutic effects on respiratory and cardiovascular diseases in medical history. Modern medical research has shown that chrysanthemum has antibacterial, anti-inflammatory, anticancer, and neuroprotective effects. Unlike wild chrysanthemums, chrysanthemums have unique chemical components and therapeutic properties, mainly reflected in the treatment of hypertension and metabolic disorders. Chrysanthemum leaf extract exhibits anti obesity effects by regulating lipid metabolism and reducing lipid toxicity intermediates. The new bioactive compounds isolated from chrysanthemum extract exhibit neuroprotective effects, further expanding their medicinal applications.

The findings from these studies underscore the importance of *Chrysanthemum morifolium* in both traditional and modern medicine. Future research should focus on elucidating the precise molecular mechanisms underlying its therapeutic effects, especially in the mechanisms of metabolism and inflammatory diseases. Investigating the synergistic effects of *Chrysanthemum morifolium* with other medicinal herbs could lead to the development of novel combination therapies. The bioactive compounds identified from chrysanthemums will enhance our understanding of their pharmacological effects. Clinical trials are necessary to validate the efficacy and safety of *Chrysanthemum morifolium*-based treatments in humans. The integration of traditional knowledge with modern scientific approaches will pave the way for innovative applications of *Chrysanthemum morifolium* in healthcare and beyond.

Chrysanthemum morifolium represents a remarkable fusion of traditional Chinese medicine and modern scientific research. Its diverse bioactive compounds and therapeutic properties make it a valuable resource for addressing various health challenges. The convergence of traditional wisdom and contemporary science has not only validated the historical uses of *Chrysanthemum morifolium* but also uncovered new dimensions of its medicinal potential. As research progresses, *Chrysanthemum morifolium* is poised to play a significant role in the development of natural, effective, and sustainable therapeutic solutions. The journey of *Chrysanthemum morifolium* from ancient herbal remedies to modern medical marvels exemplifies the enduring relevance of traditional medicine in the quest for holistic health and well-being.

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Conflict of Interest Disclosure

The authors affirm that this research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.

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