***Houttuynia cordata* (Fish Mint): A Medicinal Plant with Diverse Therapeutic Benefits**

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**Abstract**

India has become a global center for the study and cultivation of medicinal plants due to its vast biodiversity and long history of traditional medical systems. Fish mint, or *Houttuynia cordata*, is a perennial herb that is extensively utilized in traditional medicine, particularly in Northeastern India. The bioactive elements of the plant flavonoids, alkaloids, essential oils, and polysaccharides that give it antibacterial, anti-inflammatory, and antioxidant qualities are highlighted in this review. Its powerful medicinal properties are notably attributed to quercetin, hyperoside, and houttuynin. Due to the plant's antioxidant qualities, oxidative stress is lessened, which may help avoid chronic conditions including cancer, diabetes, and heart problems. *H. cordata* is also useful in treating respiratory conditions, liver diseases, urinary tract infections, and immune-related problems because of its immune-modulating, diuretic, and detoxifying properties. Even though current research and traditional use highlight its therapeutic benefits, more research is required to completely comprehend the mechanisms underlying its bioactive components and establish standardized clinical uses.

**Keywords:** Antioxidant activity, bioactive compounds, traditional medicine, therapeutic potential, immune modulation

**Introduction**

India possesses an extensive history of therapeutic herbs deeply rooted in conventional and cultural approaches. Millions of people still rely heavily on this wide range of botanical resources for their healthcare needs, which have been used for ages in many traditional health care systems, like Unani, Siddha, and Ayurveda. There are already over 8,000 known plant species having therapeutic qualities in India, a result of the country's unique climate and geographic position (Kataria Kaur 2013). These plants can be found in a variety of habitats, from the coastal plains to the Himalayan Mountains and each one has a unique species with a particular use in medicine. Indian traditional knowledge systems, like Ayurveda, have recorded the usage of therapeutic herbs for treating a broad variety of illnesses, comprising skin concerns, digestive troubles, respiratory difficulties, and even mental health problems. Many traditional treatments that are still in use today are based on this information that has been passed down through the generations (Patwardhan et al. 2005). The therapeutic potential of Indian medicinal herbs is being supported by more and more contemporary scientific study. Research has revealed that *Houttuynia cordata* is a reservoir of diverse bioactive compounds, including, flavonoids, alkaloids, terpenoids, and phenolics, which exhibit a wide range of therapeutic properties (Kumar et al. 2014). In preclinical and clinical trials, these medicines have demonstrated encouraging outcomes for a range of disorders, including diabetes, cancer, cardiovascular diseases, and infectious diseases.

Since ages, using therapeutic plants to treat illness is a long standing custom. India and other Asian countries have a long history of using natural plants as the primary means of therapy, which is a reflection of their herbal medicine heritage. These plants are essential to 70–95% of basic therapies, which highlights their importance in these regions' healthcare practices. This method frequently makes use of the various chemical components found in these plants, each of which has distinct biological properties, to efficiently treat and mitigate prevalent clinical illnesses. Drasar and Khripach (2019) propose a comprehensive healthcare strategy that integrates conventional knowledge systems with natural therapies derived from medicinal plants. The benefits of medicinal herbs for wellbeing have garnered increased attention, particularly in view of their possible antiaging properties (Drasar and Khripach 2019). Numerous bioactive substances with strong antiaging properties have been found by researchers, including polysaccharides, alkaloids, flavonoids, and saponins produced from plants. Research has indicated that these substances may be able to slow down the aging process and improve the general health and vigor of the skin. For example, flavonoids are well-known for their antioxidant qualities, which can aid in scavenging dangerous free radicals and shielding cells from oxidative stress a major contributing cause to aging. It has been discovered that saponins increase skin suppleness and collagen formation, giving the illusion of younger skin. By supporting skin barrier function and moisture retention, polysaccharides help to nourish and hydrate the skin. Conversely, alkaloids may have skin-soothing and anti-inflammatory qualities that help lessen aging symptoms like redness and irritation. It is highly possible to create anti-aging products using these bioactive components derived from medicinal plants. Through utilizing these chemicals' inherent qualities, scientists hope to develop skincare formulas that can successfully target and solve aging related issues, providing customers with safer and possibly more sustainable options than traditional antiaging therapies. Investigating both traditional herbal knowledge and modern scientific approaches is essential to fully realizing the advantages of medicinal plants for improving one's overall well-being (Shen et al. 2017). Indeed, an intriguing approach to medication research is the investigation of molecules produced from plants for medical uses. Artemisinin, which comes from the herb *Artemisia annua*, is a well-known illustration of the potential of such natural sources (Fu et al. 2021). *Houttuynia cordata*, a member of the Saururaceae family, is a versatile perennial herb used in both traditional Chinese medicine and as a culinary ingredient. *H. cordata* Thunb. is the sole representative of the Saururaceae family, formerly categorized as Houttuyniae and recognized for its herbal properties. The physiological appearance of *H. cordata* plant and its stem is shown in figure 1 and 2 respectively. The discovery of *Houttuynia cordata* is attributed to Karl Peter Von Thunberg, a renowned Swedish naturalist often dubbed the "father of South African Botany" and the "Japanese Linnaeus," in 1983. Houttuynia cordata boasts an array of colloquial names reflecting its widespread usage, including Fish wort, Chameleon, and Lizard's tail, as well as region-specific terms like Yu-Xing-Cao and Jiu-Jie-Lian in China, Dokdame in Japan, Khaotong in Thaland , E-Sung-Cho in Korea, Nuichua in Nagaland, Gandhi Jhar in Nepal, Pnar-Jarmendo, Tengalai, Ashundary in Assam, Ithinthang in Mizoram, Ghaandhay Jhar in Sikkim and North Bengal, Tokningkhok in Manipur and Siiya hamang in Arunachal Pradesh among others. Thriving in North-East India and the North-West Himalayan region, this herbaceous plant boasts a wide distribution encompassing countries like Nepal, Myanmar, China, Thailand, and others across Southeast and East Asia (Luo et al. 2022; Wu et al. 2021). *Houttuynia cordata*, a rhizomatous herb, is characterized by its expansive, ovate-cordate leaves adorned with dense barbs, net-like venation, and four faint, elongated, petal-like bracts.



**Fig. 1 *Houttuynia cordata* plant**



**Fig. 2 *Houttuynia cordata*’s stem**

The plant typically reaches a height of 30 to 60 cm. It has narrow root systems and greenish yellow blooms with triple stamens that are purplish red, sterile seeds that are dicotyledonous, pubescent petioles, subpubescent peduncles, glabrous nodes, and an upright apical stem. Seeds, rhizomes, or roots can all be used to spread *H. cordata*. On the other hand, plants that are grown from seeds are usually not fertile; roots normally begin to sprout after the winter, and harvesting occurs in the summer (Ghosh et al. 2022; Chang et al. 2001). Due to the existence of lauric aldehyde, *H. cordata* Thunb. is recognized for having a naturally occurring scent and a slightly astringent taste and fishy smell are attributed to lauric aldehyde (Li et al. 2014). It is consumed as diet as well as being utilized medicinally. Tender stems and foliage can be eaten raw or cooked, the foliage are additionally useful as a salad dressing. It is used for food and medicine by indigenous populations for millennia, its elicate shoots and foliage are consumed as raw, cooked, or in salads. In Japan, it's made into herbal tea called "dokudami cha" or it can also be called as "*H. cordata* tea" (Miyata et al. 2010; Do Ngoc Dai et al. 2015). It grows best in warm, wet soil conditions. The applications of *Houttuynia cordata* have been reported across various Asian countries, notably in China, Korea, Japan, and India, with several Chinese provinces experiencing significant benefits. In addition to using it as medicine for the past few millennia, the native people now gather *H. cordata* for daily use as food and medicine in the Yarlung Zangbo Valley in Assam, India (Kumar et al. 2014). *H. cordata* is a herb that can be utilized medicinally in its entirety. Traditional Chinese medicine utilizes *Houttuynia cordata* in conjunction with forsythia and magnolia to treat viral pneumonia, as documented by Park et al. (2005). Multiple studies, including Muluye et al. (2014), have demonstrated the potent antiviral activity of *H. cordata*, showcasing its ability to inhibit viral infection and replication. *H. cordata* was included on the list of medications for the treatment of severe acute respiratory syndrome (SARS) during the 2003 outbreak of the SARS virus (Muluye et al. 2014; Lau et al. 2008).

*H. cordata* has been used in conventional Indian medication for the treatment of wide range of circumtances, like digestive issues, skin conditions, and respiratory infections (Kumar et al. 2023). Its leaves and roots are used in decoctions and poultices due to its anti-inflammatory, antiviral, and antibacterial qualities. H. cordata contains numerous bioactive substances, such as, essential oils, phenolic acids, and flavonoids. The plant's diverse pharmacological properties, which have been demonstrated in numerous preclinical and clinical investigations, are attributed to these substances (Kumar et al. 2023).

In some Asian marketplaces, it's also offered as a creeping decorative plant. It is well known that its varied nutritional profile can strengthen the human immune system's ability to combat microbes and aid in the battle against a number of infectious disorders. The culinary and therapeutic applications of *H. cordata* are widespread due to its established antiviral properties (Verma et al. 2017; Zhang et al. 2008). *Houttuynia cordata* boasts a wide array of pharmacological properties, ranging from antimicrobial and anti-inflammatory to anticancer and antidiabetic effects, as evidenced by Atanasov et al. (2021) and Pan et al. (2016).There are various derived components found in the plant, but flavonoids including rutin, isoquercitrin, quercetin, and quercitrin are particularly important (Taechowisan et al. 2013) and display a wide range of pharmacological actions. Worldwide, dermatitis, tumors, inflammatory illnesses, and other microbial infectious ailments are treated with these chemicals and the plant itself. Due to its application in the food, beauty products, and pharmaceutical sectors, the plant has significant financial worth. It is vital to comprehend the various roles played by *H. cordata*, particularly its significance in nutrition, pharmaceutical treatments, bioactive substances, and potential applications.

**Bioactive components**

The possibility of therapeutic trees to be an abundant supply of functionally active chemicals used for traditional medicine has led to a current surge in interest of these plants (Sharifi-Rad et al. 2021; Jia et al. 2022). Substances that affect living things, tissues, or cells are known as bioactive components. They are different from vital nutrients, which aren't always necessary because the body can operate without them or achieve comparable results (Mana et al. 2023; Haokip et al. 2023; Abou Baker et al. 2023). Medicinal plants typically include a variety of bioactive ingredients that can work singly, in combination, or cooperatively to enhance health. Research suggests that these constituents possess diverse therapeutic potential, exhibiting antimicrobial, antihistamine, and antiviral activities, as evidenced by Singh et al. (2022), Das et al. (2021) and Inthi et al. (2023). Because of the constituent’s great efficacy and low toxicity, active ingredients produced from botanical sources particularly medicinal plants have recently garnered a great deal of attention in the biomedical sector (Zhang et al. 2008; Dash et al. 2020; Subhawa et al. 2020). Several substances were found after a thorough chemical examination of the entire *H. cordata* plant. *H.cordata* Thunb. a noteworthy botanical resource  which may produce endophytic fungus with unique metabolites for application as biofungicides (Wu et al. 2021; Huang et al. 2021). Numerous investigations have demonstrated the efficaciousness of *H. cordata* as a botanical agent with a range of medicinal advantages, including as inflammatory modulating and free radical scavenger capabilities (Chen et al. 2003; Kanou and Tsurunaga 2021). The sole identified bioactive metabolite from H. cordata has demonstrated the ability to combat Aspergillus niger and other fungal infections. This metabolite is categorized as a polyketide (Cai et al. 2012).

The primary bioactive components of *H. cordata* are thought to take accountability for its positive outcomes. *Houttuynia cordata* boasts a rich phytochemical profile, encompassing phenolic compounds, flavonoids, volatile organic compounds (including myrcene and D-limonene), fatty acids (such as palmitic and linoleic acid), cellulose, cordarine, and potassium sulfate (Bao et al. 2023; Bhatia et al. 2022). Research has demonstrated that *H. cordata Thunb* has a broad variety of bioactive substances, including lactones, cyanogenics, tannins, quinines, terpenes, fatty acids, and glycosides (Abou Baker et al. 2023; Wigraiboon et al. 2016). Mene et al. (2023)have identified a variety of compounds within *Houttuynia cordata*, including terpenes like camphene and beta-pinene, aldehydes, esters like geraniol ester and tetradecanoyl eiter, as well as other constituents like glycones, 4-terpineol, sabinene, and tetradecanoyl-phorbol-acetate.

Asiatic native *Houttuynia cordata* Thunb. (HCT) is a recurrent plant with a long history of traditional medicinal usage. Its extensive range of therapeutic benefits is attributed to its various chemical contents, which comprise of phenolic acids, alkaloids, essential oils, and flavonoids. The main active ingredients in HCT, flavonoids and essential oils, are important in its historic utilized to treat a wide range of illnesses, comprising tumors, mumps, pneumonia, fever, cough, and colds. Traditional Chinese medicine has made great use of the plant's stems and leaves. Rafiq et al. (2022) reviewed on the effect of extracts of *Houttuynia cordata* and found its positive effect on inflammation by regulating different inflammatory pathways. It improves respiratory conditions, by fighting off bacterial and viral infections. HCT is also associated with oxidative damage which is linked to a number of diseases. HCT demonstrated encouraging anticancerous action against malignancies of the liver, lung, breast, and colon, possibly by causing apoptosis and preventing cell division. This plant also enhances the immune system of human body.

Nguyen et al. (2020) studied the phytochemical arrangement of the commonly used medicinal herb *Houttuynia cordata Thunb*. (HCT). They concluded that extracts contained a variety of bioactive substances, including flavonoids, saponins, alkaloids, tannins, and steroids, according to a preliminary phytochemical screening. These substances are well known for having a wide range of pharmacological effects, which enhances HCT's therapeutic potential.

Pradhan et al. (2023) conducted an investigation on this plant for its structure, geography, and customary application, nutritive makeup, pharmaceutical characteristics, significant functional ingredients, medicinal uses, and possible future developments of this plant. HC is a versatile plant with a wide range of therapeutic applications attributed to its diverse bioactive compounds. Research conducted by Pradhan et al. (2023) has revealed its effectiveness against various pathogens, including bacteria, fungi, and viruses. Furthermore, *Houttuynia cordata* has exhibited numerous therapeutic properties, including anticancer, antimutagenic, anti-obesity, antiviral (encompassing anti-coronavirus), antioxidant, and anti-inflammatory effects. Key bioactive compounds identified in HC include quercetin, quercitrin, and isoquercitrin, which are flavonoids renowned for their diverse biological activities. These compounds contribute significantly to the plant's therapeutic potential. The versatility of HC as a natural resource is evident in its traditional use and growing recognition in modern medicine. Its therapeutic properties extend to the management of infections, persistent illness like cancer, and different inflammatory conditions. The existence of significant biologically active components, notably flavonoids, underscores its possible use for medical and nutraceutical applications (Pradhan et al. 2023).

A useful method for evaluating the standard of therapeutic herbs is chemical profiling utilizing HPLC (High Performance Liquid Chromatography) along with multivariate analysis. In order to quantify and evaluate the standard of *Houttuynia cordata* (HC) instances according to their flavonoid profiles, Nguyen et al. (2023) recently studied by concentrating on creating an HPLC approach combined with multivariate analysis. 32 fresh leaf samples and four powder products of HC were analyzed, which required developing an optimal RP-HPLC method to quantify five important flavonoids in HC which include hyperin, rutin, isoquercitrin, quercetin and quercitrin. To assess the similarity and variance between the samples, peak regions from the HPLC analysis underwent HCA (Hierarchical Cluster Analysis) and PCA (Principal Component Analysis). The samples were grouped into several subgroups according to their flavonoid profiles, and the principle components of the PCA showed that hyperin and quercetin were the main contributors (Nguyen et al. 2023).

Jiangang et al. (2013) reviewed contemporary advancements in the phytochemistry, pharmaceuticals, and quality assurance of HCT. Numerous physiologically significant phytoconstituents in HCT have been discovered throughout the years, including fatty acids, alkaloids, flavonoids and other polyphenols, and essential oils. These substances are in charge of the several pharmacological effects linked to HCT. After a thorough review of the literature, it was determined that HCT has a variety of pharmaceuticals actions, comprising antiviral, antitumor, antimicrobial, counter-inflammatory, and antioxidative impacts. These results underscore the potential of HCT for modern therapeutics and lend support to its traditional use in a variety of medical practices. Comprehensive assessments of the quality control methods employed for this plant are lacking, despite advancements in research on HCT's pharmacological effects.

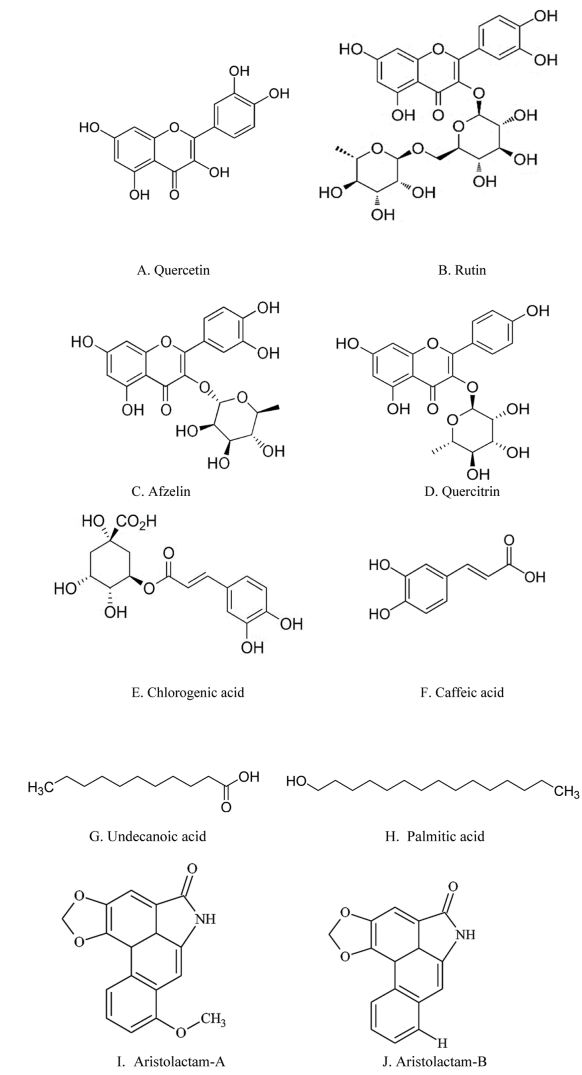
A key area of research, as highlighted by Tian et al. (2012), focuses on the water-soluble polysaccharide HCP, a major bioactive component found in *H. cordata*. Tian et al.(2011) conducted an analysis that compares the antioxidant capacities of HCP and different *H. cordata* solvent extracts and revealed that the water extract, rich in HCP, showed the greatest scavenging and reducing capability against hydroxyl, superoxide, and 1,1-diphenyl-2-picrylhydrazyl (DPPH) radicals. These results strongly suggest that HCP is a major contributor to the antioxidant effect of *H. cordata*. Further analysis of HCP's chemical composition using HPLC revealed it to be an acidic heteropolysaccharide primarily composed of 29.4% of galactouronic acid and 24.0% of galactose. Other significant monosaccharide components include 17.2% of rhamnose, 13.5% of arabinose, 6.8% of glucuronic acid, 5.3% of glucose, 2.1% of xylose, and 1.8% of mannose. The presence of these monosaccharides, particularly the acidic sugars, is believed to contribute to the antioxidant attributes of HCP. HCP's strong antioxidant properties, as demonstrated by Tian et al. (2011), make it a promising candidate for uses in the culinary and health sectors. In the health sector, it is possible to employ HCP as an organic antioxidant supplement to prevent oxidative stress related diseases. In the food industry, HCP could be incorporated into functional foods or utilized as a natural preservative to increase a product's shelf life.

**Characterization and Identification of Bioactive Compounds**

The characterization and identification of isolated bioactive compounds are essential for understanding their chemical structures, properties, and potential therapeutic applications. Various spectroscopic techniques, comprising MS (mass spectrometry), IR (infrared spectroscopy), UV (ultraviolet spectroscopy), and NMR (nuclear magnetic resonance spectroscopy), are employed for this purpose (Abubakar and Haque 2020). These techniques give useful details regarding the molecular weight, functional groups, and structural arrangement of the compounds, aiding in their characterization and identification. The main bioactive components present in *H. cordata* are:

***Phenolic compound***

Phenolic chemicals, the secondary metabolites found in many trees, which protect the plants from UV light and combat pathogenic antagonists. Chlorogenic acids and quercetin are two examples of the phenolic components found in *H. cordata* that give biological processes antioxidant activity and either stop or cure destruction brought on by oxidative substances (Yadav and Vijaya 2016). Because of their strong scavenging action, the chemicals that are phenolic found in *H. cordata* have been shown in epidemiological and biological investigations to potentially be good for human health. *Houttuynia cordata* contains a plethora of compounds, including catechin, aristolactam B, crypto-chlorogenic acid, procyanidin B, quercetin hexoside, piperolactam A, rutin, hyperin, Cepharadione B, and neochlorogenic acid, demonstrating promising anticancer and anti-mutagenic properties **(**Fig 3**)**. Additionally, catechin in this plant demonstrates antiproliferative, hypolipidemic, and immunomodulatory properties (Yadav and Vijaya 2016).



**Fig. 3** Different Phenoloc chemicals extracted from *H. cordata* and their structures: A. Quercetin, B. Rutin, C. Afzelin, D. Quercitrin, E. Chlorogenic acid, F. Caffeic acid, G. Undecanoic acid, H. Palmitic acid, I. Aristolactam-A, J. Aristolactam-B (Pradhan et al. 2023).

***Flavanoids***

Flavonoids are a broad family of polyphenolic substances that are generated by plants and structurally obtained from the same constituents, flavones (Hasanuzzaman et al. 2020). Everyday diets contain large levels of flavonoids, which are naturally occurring chemicals found throughout the vegetable kingdom (Kang et al. 2013). Flavonoids possess notable abilities to modulate cellular activities and impact various cellular structures, potentially contributing to significant effects such as antiosteoporotic, antihepatotoxic, antiallergic, anticancer, and anti-inflammatory actions (Kwon et al. 2023). Flavonoids are believed to exert significant pharmacological and biological effects by decreasing the production of reactive oxygen species (ROS), thereby playing a pivotal function to counteract oxidative stress and demonstrating substantial antioxidant activity in vitro (Salehi et al. 2020). Research reveals that *H. cordata's* flavonoid content makes it a possible source of natural antioxidants. Chemically defined flavonoids, including rutin, quercetin, hyperoside, isoquercitin, naringin, luteoin, and myricetin have been found to be exixtence in *H. cordata* (Kang et al. 2013). Compared to the roots, the leafy parts of *H. cordata* have greater flavonoid content (Chojnacka et al. 2020). Essential parts of *H. cordata* Thunb are flavonoids, which have the ability to show anticancer action against cells that cause lung cancer (Adedayo et al. 2021). Furthermore, it has been found that the fermentation process of souring increases the flavonoid content and that *H. cordata* inhibits the growth of the hepatocellular cancer cell line (HepG2 cell) (Aghababaei and Hadidi 2023).

***Volatile oil***

The complex mixes of components that make up volatile oils primarily consist of hydrocarbons with similar structural themes, like sesquiterpenes and monoterpenes (Jiang et al. 2021). Although these oils are extensively dispersed across the kingdom of plants, they are only found in trace concentrations in therapeutic plants. Many pharmacological properties are exhibited by the volatile oils, such as antiviral, insecticidal, antibacterial, antiallergic, antimutagenic, and neurodegenerative actions (Reddy et al. 2020). The amount of volatile oil in *H. cordata* is contingent upon several aspects, including the kind of plant, domesticated or wild, the geographic area, and the various components within the plant, like root, stem, and leaves (Wigraiboon et al. 2016). Decanoyl acetaldehyde, the main ingredient in volatile oil, has strong pharmaceutical properties but is fragile and readily oxidized during storage and purification (Shi et al. 2021). In order to analyze the volatile components found in plant material, extraction, distillation, and simultaneous purification are usually required. The examination of *H. cordata* Thunb's volatile components holds significant value for both scientific inquiry and the nutraceutical sector. Because of its antiviral, antifungal, antibacterial, and antiallergic qualities, volatile oil is regarded as an essential bioactive component in contemporary pharmacological systems. The volatile elements of newly collected *H. cordata* have been analyzed using the GC-MS fingerprinting technique (Chen et al. 2018).

***Alkaloids***

Liver-protective properties and PTP1B action are present in the alkaloids that have been extracted from *H. cordata* (Ma et al. 2017). Bioactive alkaloids, such as splendidine, Cepharadione B, piperolactam A, Aristolactam B, Splendidine and Norcepharadione B, were identified by the use of bioactivity-guided fractionation (Kumar et al. 2014).

***Essential oil***

Essential oils extracted from *H. cordata* contain a variety of phytochemicals, such as cymene, 4-carene, sabinene, comphene dodecene, and trans-nerolidol (Kumar et al. 2014). Prior phytochemical research carried out on *H. cordata*, have discovered a number of biological constituents, such as steroids, 5, 4-dioxoporphines, oxiaporphin and aminolactams. Table no. 1 shows the functions, health benefits and mechanism of action of different bioactive components present in *H. cordata*.

**Table 1: Diverse Therapeutic benefits of *Houttuynia cordata***

|  |  |  |  |
| --- | --- | --- | --- |
| **Therapeutic compounds** | **Benefits** | **Mechanism of Action** | **References** |
| Flavonoids (e.g., Quercetin, Hyperoside) | Antioxidant, Anti-inflammatory, Anticancer, Cardioprotective | Scavenges free radicals, reduces oxidative stress, inhibits inflammatory cytokines, induces apoptosis in cancer cells, Protects against myocardial ischemia | (Li et al. 2014; Chen et al. 2018) |
| Alkaloids | Antimicrobial, Antiviral | Inhibits microbial growth, interferes with viral replication | (Chen et al. 2018; Ma et al. 2017) |
| Essential Oils (e.g., Methyl n-nonyl ketone, Decanoyl acetaldehyde) | Antibacterial, Antifungal, Antiviral | Disrupts microbial cell membranes, inhibits fungal spore germination, Inhibits growth of pathogenic bacteria, Inhibits viral replication, reduces inflammation | (Zhang et al. 2008; Chen et al. 2018) |
| Polysaccharides | Immunomodulatory, Anti-inflammatory | Enhances immune response, modulates cytokine production | (Park et al. 2005) |
| Houttuynin | Antibacterial, Anti-inflammatory, Diuretic | Inhibits bacterial growth, reduces inflammation, promotes urine production | (Chen et al. 2003; Kanou and Tsurunaga 2021) |

**Health benefits**

***Anti-inflammatory properties***

*Houttuynia cordata* has two bioactive chemicals that are well-known for their strong anti-inflammatory effects: quercetin and isoquercitrin. It has been demonstrated that these compounds significantly contribute to the reduction of inflammation. For example, quercetin and isoquercitrin can help to reduce inflammation in the lining of the stomach, which can help lessen symptoms like pain, diarrhea, and cramping while dealing with inflammatory bowel disease (IBD). These substances have also been researched for their potential to help treat arthritis, a painful inflammatory disease of the joints. Quercetin and isoquercitrin can lessen the severity of arthritic symptoms and enhance joint function by blocking pro-inflammatory pathways and lowering oxidative stress. These findings highlight the therapeutic potential of *Houttuynia cordata* in the management of inflammatory disorders (Wu et al. 2021).

***Antioxidant activity***

*Houttuynia cordata* is a great source of antioxidants, including flavonoids and polyphenols, which are important for deactivating cells from oxidative damage. Oxidative stress arises from an imbalance between the body's ability to use antioxidants to combat the damaging effects of free radicals, which are unstable chemicals capable of causing damage to cells. *Houttuynia cordata* contains flavonoids and polyphenols that work to neutralize free radicals and stop them from damaging cells. Oxidative stress plays a major role in the development of cancer by promoting tumor growth and causing DNA alterations. *Houttuynia cordata's* antioxidant activity may lessen this risk by preserving cellular integrity and guarding against DNA damage. In a similar way, the antioxidants in the herb also support heart health. Because they cause oxidative damage to blood vessels and encourage the accumulation of plaque in arteries, free radicals can play a role in the development of heart disease. The antioxidants in *Houttuynia cordata* may help to reduce the incidence of atherosclerosis and other heart-related disorders by counteracting these dangerous compounds. Studies emphasizes *Houttuynia cordata's* potential as a natural way to enhance general health and lower the risk of chronic diseases, lend credence to these advantages (Yang et al. 2017).

***Antimicrobial effects***

*Houttuynia cordata* is useful against a variety of bacteria and viruses since it has shown strong antibacterial qualities. According to research, this plant can stop a variety of diseases from growing and proliferating, including ones that have become resistant to traditional antibiotics. This is especially crucial when it comes to drug-resistant illnesses, which are getting harder and harder to cure with conventional medical treatments. *Houttuynia cordata* contains bioactive substances such flavonoids and alkaloids that support its antibacterial properties. These substances function by rupturing the bacterial cell membranes, preventing the bacteria from proliferating and spreading. They can also prevent viruses from replicating, which lessens the intensity and duration of viral infection. *Houttuynia cordata* exhibits potential as a natural alternative or adjunctive treatment for infections brought on by drug-resistant types of bacteria and viruses because of its broad-spectrum antibacterial action. In light of the fact that conventional antibiotics are losing their efficacy due to antibiotic resistance, this could be very helpful in addressing the expanding global health concern (Wu et al. 2021).

***Immune system modulation***

*Houttuynia cordata* is an important immune system modulator. Its special capacity to control immunological responses makes it very useful when it comes to boosting and inhibiting the immune system. *Houttuynia cordata* can strengthen immunological function in response to an illness, enabling the body's defensive mechanisms to more successfully fend off infections. This involves activation of immune cells such as lymphocytes and macrophages. These cells are vital for recognizing and getting rid of pathogenic intruders. On the other hand, *Huttuynia cordata* has demonstrated the ability to reduce exaggerated immunological reactions in the setting of autoimmune illnesses, which occur when the body's own tissues are mistakenly attacked by the immune system (Lu et al. 2006). The herb aids in lowering autoimmune-related inflammation and tissue damage by preventing the immune system from over-stimulating. *Houttuynia cordata* is a good option for immune response balancing because of its dual action, which enables the body to create a robust defense against infections while avoiding detrimental overreactions that may result in chronic autoimmune illnesses.

***Potential anti-cancer effects***

According to research, *Houttuynia cordata* may have anticancer potential. This is especially true given its capacity to cause cancer cells to undergo apoptosis, or programmed cell death. Apoptosis is an essential mechanism that aids in the body's removal of defective or damaged cells, such as cancer cells, stopping their unchecked proliferation. Research has indicated that elements found in *Houttuynia cordata*, like flavonoids and polysaccharides, can cause several kinds of cancer cells to undergo apoptosis. This activity lowers the risk of tumor development and progression in addition to stopping the proliferation of these dangerous cells. Furthermore, it has been noted that *Houttuynia cordata* obstructs the signalling pathways that cancer cells depend on for proliferation and viability. The herb can effectively suppress the development of cancer cells by interrupting these pathways, which can slow down or even stop the disease's spread. *Houttuynia cordata* is therefore a viable option for cancer therapy, especially when used in conjunction with other established treatments. Huang et al. (2021)'s studies emphasize the necessity of conducting more thorough research to confirm these findings and investigate *Houttuynia cordata's* potential as a component of an all-encompassing cancer therapy regimen.

***Other Potential Benefits***

According to preliminary study, the herb could help with the condition of obesity, diabetes, and allergies. Nevertheless, additional research is required to validate these impacts. The herb seems to affect metabolic functions that are important for controlling blood sugar and body weight. *Houttuynia cordata*, for example, has been demonstrated to lower blood glucose levels and enhance insulin sensitivity, two important aspects of diabetes care. Furthermore, it may benefit weight control efforts by reducing the chronic low-grade inflammation that is frequently linked to obesity thanks to its anti-inflammatory and antioxidant qualities. *Houttuynia cordata* may lessen the severity of allergic reactions by regulating the immune system's responsiveness to allergens in the context of allergies. Since an overactive immune response can cause uncomfortable and occasionally severe symptoms in disorders like asthma and allergic rhinitis, its capacity to moderate immunological activity and lower inflammation may be especially helpful in these cases. Even with these encouraging results, it's crucial to remember that the current body of research is still in its infancy. To validate these effects and completely comprehend the mechanisms by which *Houttuynia cordata* may help people with obesity, diabetes, and allergies, more thorough clinical research is required. By establishing suitable dosages, possible adverse effects, and long-term safety, such research would open the door for the herb to be included in standard treatment regimens for various ailments.

**Medicinal Importance**

*Houttuynia cordata*, due to its remarkable biological qualities, essential oil (HEO) is extensively employed in conventional Chinese medicine. But its effectiveness and safety have been compromised by contaminants and improper preparation techniques. Pang et al. (2017) conducted this research to introduce an innovative strategy to the production of safe and efficient HEO through the combination of solvent extraction and flexible macroporous resin purification, which is then encapsulated within a microemulsion. Through the use of adsorption-desorption tests and orthogonal experimental design, the extraction as well as purification processes were optimized. With an average houttuynin concentration of 44.3% ± 2.01%, the resultant pure HEO showed great promise for industrial uses. High-pressure homogenization was then used to create a pure HEO-loaded microemulsion, which was then thoroughly characterized. The microemulsion that was synthesized had a typical particle size of 179.1 nm and an elevated encapsulation rate at 94.7%. Remarkably, purification using D101 resin led to significant increases in HEO's safety and activity, which were further enhanced by microemulsion encapsulation, according to both tests for security evaluations and in situ antiviral assessments. These highlight the possibility of employing macroporous resin to purify HEO and then encapsulating it in a microemulsion as a workable strategy to increase the commercial use of HEO in antiviral treatments (Pang et al. 2017).

*Houttuynia cordata Thunb*. (HC), has shown antiviral efficacy against the SARS virus and the herpes simplex virus (HSV). Its antiviral action's underlying mechanisms are yet not fully known. The antiviral potential of HC, and more, especially its hot water extract (HCWE), against HSV-2 via blocking NF-κB activation is the main emphasis. Chen et al. (2011) demonstrated the critical role that nuclear factor kappa-light-chain-enhancer of activated B cells (NF-κB) activation plays in the replication of HSV-1 and HSV-2 and HSV contamination can be effectively repressed by inhibiting this transcription factor. HCWE demonstrates strong inhibitory effects against HSV-2 infection. The lyophilized HCWE powder's estimated IC50 value was 50µg/ml. Infectious HSV-2 generation was greatly inhibited when HCWE was added at greater quantities (150 and 450 µg/ml). Interestingly, this antiviral action was concurrent with the reduction of HSV-2-induced NF-κB activation. Since HSV replication and growth have been linked to both NF-κB and Erk MAPK activation, it is possible that HCWE's antiviral mechanism is specifically mediated through the NF-κB pathway because it selectively reduced NF-κB activation without affecting HSV-2-induced Erk activation. Major water extractable flavonoids found in HC include isoquercitrin, quercetin, and quercitrin. It has been demonstrated that treatment with these flavonoids greatly reduces HSV-2 infection. This implies that these flavonoids might be essential to HC's overall antiviral efficacy (Chen et al. 2011).

In the early 2000s, the SARS coronavirus, or SARS-CoV, began to pose a threat to international health. This virus causes severe acute respiratory syndrome, or SARS. Because there were no reliable Western medications available at the time, *Houttuynia cordata* (HC), was taken into consideration as a possible treatment due to its historical use for pneumonia. The immunological and antiviral mechanisms of HC against SARS-CoV are examined in the study conducted by Lau et al. (2008). HC prevents SARS by concentrating on its immune-suppressive and antiviral characteristics. There was a dose-dependent pattern seen for the proliferation of mouse splenic lymphocytes in response to HC water extract. Flow cytometry examination revealed a rise in the proportion of CD8+ T cells and CD4+, which are important players in adaptive immune responses, splenic lymphocytes secreted IL-2, a T-cell growth factor, and IL-10, modulating inflammatory cytokine, in a significant amount, indicating that HC has the potential to control the immune system. Two crucial SARS-CoV enzymes, RdRp (RNA-dependent RNA polymerase) and 3CLpro (3C-like protease), were significantly inhibited by HC. RdRp is involved in the production of viral RNA, whereas 3CLpro is necessary for the spread of viruses. It is possible that inhibition of these enzymes will upset the viral life cycle. Significantly, HC's safety profile was shown by test that showed it was not harmful to the lab animals, even at an elevated dose of 16 g/kg (Lau et al. 2008)*.*

A research by Chiow et al. (2016) looked into the in vitro antiviral action of the ethyl acetate (EA) fraction of HC as well as three of its flavonoid constituents that is rutin , quercetin and rutin counter to MHV (murine coronavirus) and DENV-2 (dengue virus type 2). The EA fraction of HC exhibited potent antiviral activity, inhibiting up to six days of viral infection capacity. This activity was significantly greater than that of cinanserin hydrochloride, a known antiviral compound, which only inhibited MHV for 2 days. The IC50 values for the EA fraction against MHV and DENV-2 were 0.98µg/mL and 7.50µg/mL, respectively, demonstrating its effectiveness against both viruses. Importantly, the EA fraction did not show any cytotoxicity in vitro. Furthermore, an acute toxicity through oral tests in mice disclosed no signs of poisoning or abnormal histological features of major organs even at 2000 mg/kg high dosage, demonstrating its safety record. The individual flavonoids exhibited varying degrees of antiviral activity. Quercetin showed moderate activity against both MHV and DENV-2, while quercitrin only inhibited DENV-2. Rutin, on the other hand, didn't exhibit any form of limitation against virus. Interestingly, when quercitrin and quercetin were merged, they demonstrated reduced cytotoxicity and enhanced anti-DENV-2 activity compared to their individual effects. However, this synergistic effect was still less potent than the antiviral activity of the EA fraction itself (Chiow et al. 2016). They concluded that the combined activity of several components in the extract is probably what gives the HC EA fraction its enhanced antiviral potency. The promise of HC as a source for antiviral medicines against dengue viruses and corona viruses is further strengthened by its lack of cytotoxicity and acute toxicity (Chiow et al. 2016).

*Houttuynia cordata* *Thunb*. (HCT) has demonstrated to have a number of biochemical qualities, encompassing antiviral, antibacterial, and antileukemic effects. Its impact on colorectal cancer and the underlying molecular pathways, however, were yet unknown. The impact of HCT on primary colorectal cancer cells obtained from three patients. The study conducted by Lai et al. (2010) revealed that HCT exhibited dose-dependent inhibition of cancer cell proliferation, indicating its potential cytotoxic effect. Investigation also revealed that the HCT treatment that is 250μg/ml for 24 hours caused these cancer cells to undergo apoptosis, a type of planned cell death. It was discovered that the process of HCT-induced apoptosis was mitochondria-dependent. The cancer cells treated with HCT produced more free radicals and had a lower mitochondrial membrane potential. The activation of the intrinsic apoptotic cascade resulted from this disturbance of mitochondrial function, as indicated by the high levels of caspase-3 and 9, Apaf-1 and cytochrome C (Lai et al. 2010). Additionally, Lai et al. (2010) found that HCT therapy altered the ratio of pro-apoptotic BAX to anti-apoptotic BCL-2 protein. The activation of caspase-9 and 3, which ultimately resulted in apoptotic cell demise, was further facilitated by this imbalance (Lai et al. 2010).

Chen and Huang (2022) conducted an investigation on HCT's potential to treat diabetes, cancer, and inflammation and it has shown strong inflammation modulating impacts of HCT in a number of experimental animals. It has indicated that HCT extracts have the capacity to inhibit the production of pro-inflammatory cytokines, such as TNF-α, IL-1β, and IL-6, and to stop inflammatory signaling pathways, such as MAPK and NF-κB, from being activated. These imply that HCT might be a useful treatment for inflammatory conditions as well as encouraging antitumor benefits as well. HCT extracts can cause several cancer cell lines, including those from the lung, liver and breast to undergo apoptosis, or programmed cell death. The complex processes that underpin HCT's anticancer effect include the regulation of several signaling pathways, which can lead to angiogenesis suppression, cell cycle arrest induction, and reduction of cell proliferation. HCT has shown promise in the management of diabetes together with its anti-inflammatory properties and anticancer qualities (Chen and Huang 2022)*.* They also demonstrated that in diabetic animal models, HCT extracts can reduce blood sugar levels, boost insulin sensitivity, and enhance glucose tolerance and its antioxidant qualities and capacity to regulate important enzymes involved in glucose metabolism, such as α-amylase and α-glucosidase are in charge of these advantages (Chen and Huang 2022)*.*

Wu et al. (2021) reviewed a thorough summary of the therapeutic effects of HCT and found a variety of distinctive components, like volatile oils, phenolic acids, flavonoids and alkaloids that are present in HCT. Its pharmacological activities have been attributed to volatile oils and flavonoids, which are the primary components that are active. By lowering the discharge of substances that cause inflammation, HCT has an influence on organ protection and lessens lung harm. HCT fortifies immune barriers in the digestive system, oral cavity, and vagina while controlling immunological responses. Its antiviral and antibacterial qualities work together to effectively lower pathogen infection. HCT has been demonstrated to have potent anti-inflammatory effects both in vitro and in vivo. Additionally, several of its chemical compounds exhibit promising anti-rheumatoid arthritis properties. HCT is a noteworthy treatment for a number of tumor types, including breast, liver, colon, and lung cancers. Due to its, anti-inflammatory, organ-protective, immunomodulatory and anticancer attributes, it is a good option for creating new medicines for a variety of illnesses (Wu et al. 2021).

The potential hepatoprotective benefits of the EAF (Ethyl acetate fraction) derived out of Houttuynia cordata tea and found that it contained phenolic compounds, exhibited antioxidant activity, and offered defense counter to CCl4 (Carbon tetrachloride-induced liver injury). Excellent antioxidant activity was shown by the EAF in both in vitro and in vivo situations, exhibiting powerful FRAP (ferric-reducing antioxidant power) and efficiently neutralizing DPPH radicals. In addition, EAF treatment decreased hepatic oxidative stress caused by CCl4, indicating that it may offer protection against oxidative damage. Phenolic chemicals were found to be abundant in the EAF, with hyperoside, quercitrin, and quercetin being the most common constituents. These polyphenols are well known for their hepatoprotective and antioxidant qualities. The raised levels of total bilirubin, hepatic malondialdehyde (MDA), and serum liver enzymes (AST, ALT, and alkaline phosphatase) in mice were considerably decreased by applying 1000 mg/kg body weight of EAF as a pretreatment before being exposed to CCl4. EAF also stopped CCl4 from depleting GSH (glutathione), SOD (superoxide dismutase) and CAT (catalase). These findings, corroborated by liver histopathology, suggest that EAF provides significant defense against acute liver injury brought on by CCl4. Since phenolic chemicals make up the majority of EAF's significant antioxidant activity, it is most likely responsible for the hepatoprotective benefits that have been seen. These substances can prevent oxidative damage to liver cells through consuming harmful free radicals, preventing lipid peroxidation, and regulating antioxidant enzyme activity (Chen and Huang 2022).

UVB rays are a primary cause of skin damage because they degrade collagen, induce oxidative stress, and cause inflammation. These effects ultimately result in premature maturing of the skin. Mapoung et al. (2021) studied potential photoprotective benefits of the traditional medicinal herb Houttuynia cordata Thunb. (HCT) to determine if a hyperoside-enriched fraction derived from HCT (HcEA) could effectively protect human dermal fibroblasts from UVB-induced skin aging. The process of solvent partitioning of HCT extracts produced the hyperoside-enriched fraction (HcEA). It was determined that hyperoside, quercitrin, chlorogenic acid, and rutin were the active ingredients in HcEA. HcEA and hyperoside were tested for their photoprotective properties against UVB-irradiated human skin fibroblasts. Hyperoside and HcEA showed strong photoprotective properties against UVB-induced damage. They successfully decreased the production of intracellular free radicals and the discharge of inflammatory cytokines (IL-6 and IL-8). Moreover, they discovered that HcEA enhanced the synthesis of collagen type I, an essential constituent of the skin's structural integrity, and deregulated the expression of the matrix metalloproteinase-1 (MMP-1) gene and protein. They also discovered that the alteration of the MAPK (mitogen-activated protein kinase) signaling route is part of HcEA's photoprotective mechanism. JNK, ERK, and c-Jun are important elements of the MAPK pathway that are activated in UVB-induced skin injury, and HcEA reduced their activation. HCT extract, particularly the hyperoside-enriched fraction, could be incorporated into pharmaceutical or cosmetic formulations in order to guard against UVB-induced skin damage and premature aging (Mapoung et al. 2021).

Song et al. (2021) examined the antimicrobial properties of three Chinese therapeutic herbs Lobelia chinensis, Selaginella uncinata and Houttuynia cordata. The study examined the plants' activity against the Chikungunya virus, various fungi, and gram-positive and gram-negative bacteria. The hexane extract of H. cordata demonstrated broad-spectrum antifungal activity, inhibiting the growth of all six tested fungal species with minimum inhibitory concentrations (MICs) varying between 0.08 to 1.25 mg/ml (Song et al. 2021).

**Conclusion**

India is a worldwide center for the study and cultivation of medicinal plants because of its abundant biodiversity and long history of using traditional medicines like Ayurveda, Siddha, and Unani. These plants unique phytochemical contents, which give them medicinal qualities, present prospective possibilities for the development of safe, efficient, and reasonably priced remedies for a wide range of illnesses, from simple infections to chronic diseases.

*Houttuynia cordata* was chosen for its varied traditional usage, extensive ethnopharmacological history, and promising pharmacological properties as described in early research. Its potential as a useful source of novel therapeutic agents is further highlighted by its cultural relevance in traditional medicine systems and its extensive availability throughout many regions of India. Flavonoids, essential oils, and other bioactive components make up the plant's distinctive phytochemical profile, which indicates an array of possible uses in the defense and management of many illnesses.

The review not only contribute to the existing body of knowledge on *H. cordata* but also emphasize the need for further exploration of indigenous medicinal plants and their sustainable utilization for prospective uses in a range of industries, including pharmaceuticals, nutraceuticals, and cosmeceuticals. Further studies could explore the efficacy of these extracts against a wider range of pathogenic bacteria, including those relevant to food safety and healthcare settings. This review opens doors to work for the advanced of new food product using the bioactive components of this plant.

**Acknowledgement**

None

**Conflict of Interest**

None

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