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REVIEW ARTICLE

Exploring The Medicinal Value of *Viburnum opulus* (Guelder Rose): A Comprehensive Review of Its Biological Activities

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ABSTRACT
Viburnum opulus, commonly known as guelder rose or cramp bark, is a deciduous shrub native to Europe, North Africa, and parts of Asia. Recognized for its ornamental beauty and medicinal properties, it has been utilized in traditional medicine for centuries. The plant contains a range of bioactive compounds, including flavonoids, phenolic acids, iridoid glycosides, and tannins, contributing to its diverse pharmacological activities such as antioxidant, anti-inflammatory, antispasmodic, antimicrobial, and antidiabetic effects. Traditionally, V. opulus has been employed to treat muscle cramps, menstrual discomfort, gastrointestinal disturbances, and anxiety, with the bark being particularly valued for its cramp-relieving properties. Scientific research has validated many of these ethnopharmacological claims, confirming its therapeutic potential. While the plant's fruits contain toxic cyanogenic glycosides, the plant's bark and leaves are generally considered safe when used appropriately. Despite its promising therapeutic applications, further studies are required to determine the optimal dosage, confirm its efficacy, and ensure safety for medicinal use. This review summarizes the botanical, phytochemical, and ethnopharmacological aspects of V. opulus, highlighting its biological activities and potential for future therapeutic applications.
Keywords: Viburnum opulus, phytochemistry, ethnopharmacology, biological activities, cramp bark, medicinal plant

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INTRODUCTION

Viburnum opulus, commonly known as the guelder rose, European cranberry bush, or snowball tree, is a deciduous shrub in the family Adoxaceae. Native to Europe, North Africa, and parts of Central and Western Asia, this versatile plant is celebrated for its decorative appeal and medicinal value. Its adaptability and striking aesthetic, marked by prominent clusters of white flowers and vibrant red berries, have made it a popular ornamental plant in gardens and landscapes around the world. *V. opulus* thrives in a range of habitats, from woodlands and forest edges to moist meadows and riverbanks, often flourishing in regions with moist, well-drained soils and cool to temperate climates [1].

Botanical Description and Ecological Characteristics *of Viburnum opulus*

The guelder rose is a medium-sized shrub that can reach heights of 2 to 4 meters, with spreading branches and lobed leaves that resemble those of maple trees. In early to mid-spring, *V. opulus* produces spherical clusters of creamy white flowers. These blooms consist of larger sterile flowers surrounding smaller fertile ones, creating the distinctive "snowball" effect that lends the plant one of its common names. Following the flowering season, the plant produces bright red, berry-like drupes that mature in the fall and persist into winter, providing a striking contrast against the green or golden autumn foliage. These berries, though mildly toxic when raw, offer significant ecological benefits by providing a food source for various bird species and other wildlife during colder months [2,3] (Ecologically, *V. opulus* is highly adaptable and thrives in diverse habitats, including woodlands, forest edges, and wetlands. It prefers moist, well-drained soils and can often be found near rivers, streams, and in lowland areas. *Viburnum opulus* demonstrates tolerance to partial shade but grows best in areas with full sunlight. The

shrub's berries, although mildly toxic to humans when raw, are a valuable food source for birds, which aid in seed dispersal [2]. Furthermore, *V. opulus* plays a role in supporting biodiversity by attracting pollinators such as bees and butterflies to its flowers, enhancing its ecological importance within its native regions [1].

Crops and Cultivars of *Viburnum opulus*

The various cultivars of *Viburnum opulus* contribute to its popularity in horticulture, each offering unique visual appeal and adaptability to different garden settings. Cultivars such as 'Roseum' provide spectacular floral displays, while 'Xanthocarpum' and 'Compactum' add unique berry colors and compact forms, respectively. These cultivars enhance biodiversity by providing food sources for birds and pollinators, highlighting the plant's ornamental and ecological significance. These cultivars vary in terms of flower structure, berry color, and growth form, making them popular additions to gardens and landscapes.

'Roseum' (Snowball Viburnum)

One of the most popular cultivars is *Viburnum opulus* 'Roseum,' also known as the snowball bush or snowball viburnum. This cultivar is known for its large, sterile, rounded clusters of white flowers that resemble snowballs, which bloom in late spring. The flowers gradually transition from green to white and can persist for several weeks, making it a favored choice for ornamental use. Unlike the wild type, 'Roseum' does not produce berries, as it lacks the fertile flowers needed for fruiting [4].

'Compactum'

Viburnum opulus 'Compactum' is a dwarf cultivar, growing to about half the size of the typical species, making it suitable for smaller gardens and landscape designs where space is limited. This cultivar retains the striking fall color and berry production of the species but in a more compact form. The bright red berries produced by 'Compactum' are particularly attractive to birds, adding ecological value to garden spaces [5].

'Xanthocarpum'

Another unique cultivar, *Viburnum opulus* 'Xanthocarpum,' is known for its yellow or golden berries, which provide a distinctive variation from the typical red berries of *V. opulus*. This cultivar is similar in growth and structure to the wild type but offers a different aesthetic with its unusual berry color. 'Xanthocarpum' is valued for its ornamental appeal and adds diversity to garden landscapes [6].

'Nanum'

Viburnum opulus 'Nanum' is a compact, dwarf form with a low-growing habit, making it an ideal choice for ground cover or as a border plant. This cultivar rarely flowers or fruits but is appreciated for its dense foliage and manageable size. The foliage provides seasonal color, with leaves turning from green to shades of red and purple in the fall [5].

'Notcutt's Variety'

This cultivar is noted for its exceptionally large clusters of red berries, which appear in abundance after flowering. *Viburnum opulus* 'Notcutt's Variety' is a hardy shrub that tolerates a range of soil types and is often used in hedges or as a standalone specimen in gardens. It attracts wildlife and offers seasonal interest with both flowers and berries [4].

Therapeutic Importance of Viburnum opulus and Its Parts

The therapeutic potential of *Viburnum opulus* is well-recognized in traditional medicine, where it is used for its antispasmodic, antioxidant, anti-inflammatory, and sedative properties. While each part of the plant offers unique benefits, the bark is particularly effective for muscle cramps and menstrual discomfort, while the berries are valued for their cardiovascular and antioxidant benefits. These medicinal properties are largely attributed to the plant's rich phytochemical composition, which includes phenolic compounds, flavonoids, tannins, and vitamins. Continued research into *V. opulus* may expand its applications in herbal medicine and dietary supplements, further validating its therapeutic significance.

Bark: Antispasmodic and Uterine Health Support

The bark of *Viburnum opulus*, often referred to as "cramp bark," is highly valued for its antispasmodic properties. This part of the plant contains compounds such as viburnin, which are known to relax smooth muscle tissues, making it beneficial for conditions associated with muscle spasms and cramps. Traditionally, the bark has been used to relieve menstrual cramps, lower back pain, and spasms related to digestive or urinary issues. For these reasons, it has been frequently used in herbal remedies for gynecological health, helping to alleviate dysmenorrhea (painful menstruation) and prevent premature labor contractions in pregnant women [2, 3].

Berries: Antioxidant and Cardiovascular Benefits

The berries of *Viburnum opulus* are rich in vitamin C, flavonoids, carotenoids, and other phenolic compounds, giving them strong antioxidant properties. Antioxidants help neutralize free radicals, protecting cells from oxidative damage that can lead to chronic diseases. The antioxidant activity of *V. opulus* berries has been shown to support cardiovascular health by reducing blood pressure, lowering LDL cholesterol levels, and improving overall heart function. Additionally, the berries are thought to have a mild anti-inflammatory effect, which may contribute to their protective benefits against atherosclerosis and other inflammatory conditions [7,8]

Anti-Inflammatory and Immune-Modulating Effects

Both the bark and berries of *V. opulus* contain compounds with anti-inflammatory and immune-modulating properties. These components, including tannins and organic acids, have been shown to reduce inflammation by inhibiting the release of pro-inflammatory mediators. This makes *V. opulus* potentially beneficial in treating inflammatory conditions, such as arthritis, gastrointestinal discomfort, and certain skin conditions. The immune-modulating effects of *V. opulus* are also thought to support immune response, enhancing the body's ability to resist infections and heal from wounds.

Digestive Health Support

The bark of *V. opulus* has traditionally been used as a remedy for digestive issues, such as indigestion, diarrhea, and colic. The antispasmodic and astringent qualities of the bark help to soothe the digestive tract, reduce cramping, and prevent loose stools. In addition, the mild bitterness of viburnin in the bark is thought to stimulate digestion and improve appetite, which can be particularly beneficial for individuals recovering from illness or experiencing digestive discomfort [7].

Skin Health and Wound Healing

The antimicrobial and anti-inflammatory properties of *V. opulus* extracts, particularly from the berries, make them useful in topical applications for skin health. The berries can help soothe inflamed or irritated skin, and they may aid in treating mild infections or wounds when applied externally. The high antioxidant content also supports skin health by reducing oxidative damage and promoting a healthy complexion [2].

Sedative and Relaxing Effects

The bark of *Viburnum opulus* has mild sedative properties, which have traditionally been used to reduce anxiety and promote relaxation. This calming effect on the nervous system may also make the bark useful in managing symptoms of insomnia and stress. The sedative and muscle-relaxing effects can provide a natural means of easing tension and helping the body achieve a restful state, which is beneficial for those with anxiety-related muscle tension or sleep disturbances [3].

Phytochemical Composition

The medicinal value of *Viburnum opulus* is rooted in its rich phytochemical profile, which includes phenolic compounds, flavonoids, tannins, and organic acids. These compounds contribute to the plant's documented antioxidant, anti-inflammatory, and antimicrobial properties, making it a valuable resource in traditional and modern herbal medicine. The bark, which is particularly rich in viburnin, has antispasmodic properties and has been used to alleviate menstrual cramps, muscle spasms, and gastrointestinal discomfort. Additionally, the berries contain high levels of vitamin C, as well as carotenoids and polyphenols, which have demonstrated antioxidant activity, protecting cells from damage caused by free radicals [8, 3].

Research supports many of these traditional uses, and studies have found that *V. opulus* extracts may help reduce blood pressure, modulate the immune response, and protect cardiovascular health. For example, Golubkina et al. [9] report that the plant's phytochemicals exhibit antihypertensive effects, potentially making it beneficial for cardiovascular support. In addition to its cardioprotective properties, some studies indicate that *V. opulus* extracts may be useful as a natural treatment for skin conditions due to their antimicrobial and anti-inflammatory effects, further highlighting the plant's medicinal versatility [2].

Phenolic Compounds

Phenolic acids are one of the most abundant classes of secondary metabolites in *V. opulus*. These compounds possess potent antioxidant properties, which help neutralize free radicals and reduce oxidative stress. **Chlorogenic Acid**: Chlorogenic acid is one of the most significant phenolic acids found in *V. opulus*. This compound is known for its strong antioxidant capacity and is often linked to the plant's anti-inflammatory and anti-cancer properties [8]. **Caffeic Acid**: Another important phenolic acid found in the plant is caffeic acid, which contributes to the antioxidant activity and may also support immune function and metabolic regulation [9]. These phenolic acids are believed to play a role in the therapeutic

properties of *V. opulus*, particularly in managing diseases associated with oxidative stress, such as cardiovascular and neurodegenerative conditions.

Flavonoids

Flavonoids are another significant group of compounds present in *Viburnum opulus*. They are well-known for their antioxidant, anti-inflammatory, and anti-cancer properties. The following flavonoids have been isolated from *V. opulus*: **Quercetin**: Quercetin is a common flavonoid that has demonstrated various bioactivities, including anti-inflammatory, anti-allergic, and anti-oxidative effects. It is particularly noted for its ability to reduce inflammation and oxidative damage [3]. **Kaempferol**: This flavonoid has strong antioxidant effects and has been associated with neuroprotective properties, as well as a reduction in the risk of cardiovascular diseases. Kaempferol also exhibits anti-inflammatory and anti-cancer properties [7]. These flavonoids contribute to the plant's therapeutic effects, particularly in alleviating conditions such as hypertension, arthritis, and cardiovascular diseases.

Iridoids

Iridoids are monoterpenoid glycosides that have been identified in the flowers, fruits, and leaves of *Viburnum opulus*. These compounds are believed to be responsible for several pharmacological actions, including anti-inflammatory, antispasmodic, and immunomodulatory effects. **Loganic Acid**: One of the major iridoids found in *V. opulus*, loganic acid, has been shown to exhibit significant anti-inflammatory properties and may help relieve spasms, which aligns with its use in treating menstrual cramps and gastrointestinal disorders [7]. **Geniposidic Acid**: This iridoid is also present in *V. opulus* and is known for its ability to modulate the immune system and reduce inflammation, further supporting its traditional use for conditions involving smooth muscle spasms [2]. The presence of these iridoids enhances the plant's value as a remedy for pain and inflammation, particularly in gynecological and digestive disorders.

Triterpenoids

Triterpenoids are a class of secondary metabolites that have been isolated from the leaves and bark of *Viburnum opulus*. These compounds possess a wide range of pharmacological activities, including antimicrobial, anti-inflammatory, and antioxidant effects. **Ursolic Acid**: Ursolic acid is one of the most prominent triterpenoids found in *V. opulus*. It is well-documented for its anti-inflammatory, antimicrobial, and anticancer activities. Ursolic acid has also shown to promote wound healing and exhibit liver-protective effects [10]. **Oleanolic Acid**: Oleanolic acid is another important triterpenoid compound found in *V. opulus*. It is known for its hepatoprotective effects, as well as its ability to reduce cholesterol levels, making it beneficial for cardiovascular health [10]. These triterpenoids contribute to the plant's anti-inflammatory and antimicrobial properties and support its use in the management of metabolic and liver-related conditions.

Essential Oils

The essential oils of *Viburnum opulus* are primarily derived from the flowers and leaves and contain several volatile compounds with therapeutic properties. While the concentration of essential oils is lower than other phytochemicals, they contribute to the plant's sedative and mild analgesic effects. **Linalool**: A major constituent in the essential oil of *V. opulus*, linalool is known for its calming, anti-anxiety, and analgesic effects. It is widely used in aromatherapy for its ability to reduce stress and promote relaxation [8]. **β-Caryophyllene**: This compound is found in trace amounts in *V. opulus* and is known for its anti-inflammatory and analgesic properties. It has potential therapeutic applications for pain management and inflammatory diseases [2]. The essential oils enhance the plant's overall therapeutic value, particularly for relaxation and stress relief.

Alkaloids

Although less commonly studied in *V. opulus*, there are reports of small quantities of alkaloids, particularly in the bark and roots. Alkaloids in plants are often associated with analgesic and sedative effects, although more research is needed to fully understand their role in *V. opulus* [7].

The phytochemical investigation of *Viburnum opulus* through advanced analytical techniques such as Gas Chromatography-Mass Spectrometry (GC-MS), High-Performance Liquid Chromatography (HPLC), Thin-Layer Chromatography (TLC), Liquid Chromatography-Mass Spectrometry (LC-MS), and High-Performance Thin-Layer Chromatography (HPTLC) has provided in-depth insights into the plant's chemical composition. These methods are crucial for identifying and quantifying the bioactive compounds that contribute to the medicinal properties of the plant. Below is a detailed overview of these analytical techniques and their findings related to *Viburnum opulus*.

GC-MS (Gas Chromatography-Mass Spectrometry) Studies

GC-MS is widely used for the analysis of volatile and semi-volatile compounds. It has been employed to analyze essential oils and other volatile constituents of *Viburnum opulus*. GC-MS studies have identified several compounds in the essential oils of *V. opulus* flowers and leaves. Notable compounds include

linalool, β-caryophyllene, α-pinene, terpinen-4-ol, and eucalyptol, which are associated with anti-inflammatory, antimicrobial, and sedative effects [8]. GC-MS analysis of the leaf extract revealed a range of aliphatic hydrocarbons, fatty acids, and terpenoids, including linoleic acid, palmitic acid, oleic acid, and squalene [11]. These compounds are linked to the plant's antioxidant, anti-inflammatory, and wound-healing activities.

HPLC (High-Performance Liquid Chromatography) Studies

HPLC is an essential technique for the separation and quantification of phenolic compounds, flavonoids, and other bioactive molecules in plant extracts. HPLC has been used to quantify various phenolic acids and flavonoids in *V. opulus* extracts, such as chlorogenic acid, caffeic acid, quercetin, and kaempferol. These compounds contribute to the plant's antioxidant, anti-inflammatory, and anti-cancer properties [3]. For instance, a study by Velioglu et al. [8] used HPLC to analyze the phenolic compounds in the fruit extract of ***V. opulus***, identifying significant amounts of chlorogenic acid and quercetin as major active constituents.

TLC (Thin-Layer Chromatography) Studies

TLC is a qualitative technique used to separate and identify individual compounds in a complex mixture. It has been employed for the preliminary screening of phytochemicals in *V. opulus* extracts. TLC analysis of *V. opulus* leaf and bark extracts has shown the presence of several bioactive compounds, such as tannins, flavonoids, and saponins. These compounds are often used as indicators of the plant's medicinal potential, particularly for their antimicrobial and anti-inflammatory properties [7]. It has been utilized to identify triterpenoid compounds, such as ursolic acid and oleanolic acid, in the leaves and bark of ***V. opulus***. These compounds are associated with liver protection and anti-inflammatory effects [2].

LC-MS (Liquid Chromatography-Mass Spectrometry) Studies

LC-MS is a powerful tool for the identification and quantification of complex bioactive molecules in plant extracts. It allows for the analysis of both polar and non-polar compounds. LC-MS has been employed to identify a broad range of compounds in the fruit, leaf, and flower extracts of *V. opulus*. This includes the detection of iridoids such as loganic acid, geniposidic acid, and other glycosides [2]. It has been used to quantify key compounds like chlorogenic acid, caffeic acid, and quercetin in the fruit extract, which are considered the primary contributors to the plant's antioxidant and anti-inflammatory properties [8].

HPTLC (High-Performance Thin-Layer Chromatography) Studies

HPTLC is an advanced form of TLC that provides better resolution and quantitative analysis. It is often used for the analysis of phenolic compounds, alkaloids, and flavonoids. HPTLC analysis of *V. opulus* fruit and leaf extracts has allowed for the identification and quantification of key phytochemicals, including **quercetin**, **kaempferol**, **chlorogenic acid**, and **caffeic acid** [3]. This technique is particularly useful for quality control and standardization of herbal products. It is used to compare the phytochemical profiles of different extracts of ***V. opulus***, providing valuable insights into the distribution of active constituents across various plant parts.

Ethnopharmacology of Viburnum opulus and Its Parts

The ethnopharmacology of *Viburnum opulus* highlights its broad therapeutic potential, especially in the treatment of gynecological disorders, inflammation, and oxidative stress-related conditions. Across various cultures, the plant's different parts (fruits, leaves, bark, and flowers) have been used to treat a range of ailments, from menstrual cramps to anxiety and digestive issues. The therapeutic value of *Viburnum opulus* is largely due to its rich phytochemical profile, which includes flavonoids, iridoids, phenolic acids, and triterpenoids. This ethnopharmacological background provides a foundation for further scientific research into the pharmacological and clinical applications of this plant.

Traditional Medicinal Uses

Fruits of *Viburnum opulus*

The fruits of *Viburnum opulus* have been used traditionally in many cultures, particularly in Europe, as a remedy for a variety of ailments, especially in women's health. In traditional European medicine, the fruits of *Viburnum opulus* have been used as an herbal remedy for menstrual irregularities, dysmenorrhea (painful menstruation), and as a uterine tonic. The plant is known to have a muscle-relaxant effect on the uterine smooth muscle, which may help alleviate menstrual cramps and improve overall uterine health. This therapeutic property is attributed to the presence of valerenic acid and flavonoids that act on smooth muscle [12]. Abortifacient Properties: In some cultures, the fruits were used in smaller doses as an abortifacient or to facilitate labor, although this use has largely fallen out of favor due to safety concerns [13]. Antioxidant and Anti-inflammatory: The fruits are rich in phenolic compounds such as chlorogenic acid and quercetin, which contribute to their antioxidant and anti-

inflammatory properties. These properties make the fruit beneficial in combating oxidative stress-related conditions and in supporting general well-being [2].

Leaves of *Viburnum opulus*

The leaves of *Viburnum opulus* have been historically used in folk medicine for their therapeutic potential. They are most commonly used as astringents and for their antimicrobial and anti-inflammatory effects. Antimicrobial Activity: Traditionally, the leaves have been used in poultices and infusions to treat wounds, cuts, and skin infections. Studies have shown that leaf extracts exhibit antimicrobial activity against several pathogens, including bacteria and fungi, which supports their use in folk medicine for wound healing and skin protection [9]. Anti-inflammatory Uses: The leaves also possess anti-inflammatory properties, and in folk medicine, they have been applied topically or consumed as infusions to reduce inflammation in conditions like arthritis and muscle pain. This effect is attributed to the presence of flavonoids and phenolic acids [2].

Bark of *Viburnum opulus*

The bark of *Viburnum opulus* is another medicinal part of the plant used in traditional medicine, especially in some European cultures. Sedative and Relaxant: In traditional herbal medicine, the bark of *Viburnum opulus* was used as a sedative and for relieving anxiety and stress. It was believed to have mild tranquilizing properties, which could help treat conditions like insomnia and nervous disorders. The sedative effects are thought to be due to the presence of iridoid glycosides like loganic acid [8]. **Antispasmodic Effect**: The bark is also used as a remedy for cramps and spasms. It has been employed to treat gastrointestinal disorders, such as colic, and to relieve muscle spasms. The spasmolytic activity is likely attributed to the presence of flavonoids and triterpenoids in the bark [13].

Flowers of *Viburnum opulus*

The flowers of *Viburnum opulus* are traditionally used for their soothing and calming properties, making them popular in folk medicine for treating nervous disorders and promoting relaxation. **Calming and Antidepressant Effects**: The flowers are considered mild sedatives in folk medicine and have been used to reduce symptoms of anxiety, stress, and mild depression. The soothing effects of the flowers are attributed to the presence of flavonoids and other aromatic compounds [13].

Anti-inflammatory and Analgesic Effects: The flowers have also been used in traditional treatments for headaches and inflammatory conditions. In some European folk practices, flower infusions are consumed to treat colds and flu due to their mild anti-inflammatory properties [2].

Ethnopharmacological Applications Across Different Cultures

Europe: In European herbalism, *Viburnum opulus* is a staple remedy, particularly for gynecological health. Its use in treating menstrual cramps and its reputation as a uterine tonic has been passed down through generations. In some regions, the plant is considered a "women's herb" and used in the treatment of menopausal symptoms, menstrual disorders, and as an aid for childbirth.

North America: Native American tribes, such as the Iroquois, have also utilized *Viburnum opulus*, primarily for treating various forms of uterine complaints and menstrual disorders. However, there is some variation in its application, and it is often paired with other medicinal plants for enhanced effect.

Asia: In traditional Chinese medicine, though not as widely used as other plants, *Viburnum opulus* has been employed for its anti-inflammatory and pain-relieving properties, particularly for conditions affecting the liver and digestive systems [2].

Phytochemical Constituents Contributing to Ethnopharmacological Uses

The medicinal properties of *Viburnum opulus* can be attributed to the diverse phytochemical compounds found in its different parts:

Iridoid Glycosides: Compounds such as loganic acid and geniposidic acid are found in the leaves and bark of the plant. These iridoids are believed to contribute to the anti-inflammatory, sedative, and antispasmodic properties of *Viburnum opulus* [8].

Flavonoids: Compounds such as quercetin, kaempferol, and **rutin** are present in significant amounts in the fruits, flowers, and leaves. These flavonoids provide antioxidant, anti-inflammatory, and analgesic effects [3].

Triterpenoids: Ursolic acid and oleanolic acid, found in the bark and leaves, contribute to the plant's anti-inflammatory and hepatoprotective effects [2].

Phenolic Acids: **Chlorogenic acid**, **caffeic acid**, and other phenolic compounds are present in the fruit and leaves. These compounds have strong antioxidant and anti-inflammatory activities [13].

Biological Activities of *Viburnum opulus* Confirmed by Scientific Research

Viburnum opulus, commonly known as cramp bark, guelder rose, or snowball tree, has a long history of use in traditional medicine for various ailments, particularly for its soothing effects on the muscles and

reproductive system. Scientific studies have confirmed its diverse biological activities, which make it a valuable therapeutic agent in modern pharmacology. The following sections explore the biological activities of *Viburnum opulus* extracts, based on available scientific research.

Antispasmodic and Muscle Relaxant Effects

One of the most well-established medicinal uses of *Viburnum opulus*, particularly its bark (referred to as cramp bark), is its antispasmodic and muscle-relaxant properties. These effects have been studied in detail, and the mechanisms are well understood. The primary bioactive compounds responsible for its antispasmodic action are iridoid glycosides, including **viburnoside** and **loganic acid**, which have a direct relaxing effect on smooth muscles. These compounds inhibit the contraction of smooth muscles, particularly in the uterus and gastrointestinal tract [8, 14]. In laboratory experiments, *Viburnum opulus* extracts have demonstrated the ability to reduce uterine contractions and alleviate menstrual cramps, making it useful in treating dysmenorrhea. Animal studies also confirm its ability to reduce smooth muscle contraction in the intestines, indicating potential use in managing gastrointestinal spasms [2]. Traditionally, cramp bark has been used to alleviate menstrual cramps, labor pains, and muscle cramps. This action is particularly useful for conditions like irritable bowel syndrome (IBS) and other gastrointestinal disorders characterized by spasms.

Anti-inflammatory Activity

The anti-inflammatory properties of *Viburnum opulus* have been widely studied, especially in the context of its potential use for inflammatory disorders. *Viburnum opulus* extracts have shown the ability to reduce the levels of pro-inflammatory cytokines, such as TNF-α (Tumor Necrosis Factor-alpha) and interleukins (IL-1β, IL-6). The plant also suppresses the activity of cyclooxygenase (COX-2) and lipoxygenase, enzymes involved in the production of pro-inflammatory mediators [9, 14]. Studies using human cell lines have shown that *Viburnum opulus* extracts decrease the production of inflammatory cytokines, thereby modulating the inflammatory response. The flavonoids and phenolic acids in the plant are thought to contribute to its anti-inflammatory effects [9]. In animal models of inflammation, such as carrageenan-induced paw edema, *Viburnum opulus* extracts significantly reduced swelling, demonstrating its potential as a natural anti-inflammatory agent [3].

Antioxidant Activity

The antioxidant properties of *Viburnum opulus* are among its most notable pharmacological effects. Oxidative stress plays a critical role in the development of various chronic diseases, including cancer, cardiovascular disease, and neurodegenerative conditions. The fruit and leaf extracts of *Viburnum opulus* exhibit significant antioxidant activity, as confirmed by assays such as DPPH (2,2-diphenyl-1-picrylhydrazyl), ABTS (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)), and ferric reducing antioxidant power (FRAP). This activity is primarily attributed to phenolic compounds, such as **quercetin**, **kaempferol**, and **chlorogenic acid**, which scavenge free radicals and protect cells from oxidative damage [13]. In animal models, *Viburnum opulus* extracts have been shown to increase the levels of endogenous antioxidants, such as superoxide dismutase (SOD) and catalase, while simultaneously reducing lipid peroxidation. This suggests that the plant's antioxidant capacity extends to systemic protection against oxidative damage [13].

Antimicrobial Activity

The antimicrobial activity of *Viburnum opulus* extracts has been evaluated against a wide range of pathogens, including bacteria, fungi, and viruses. *Viburnum opulus* has shown antibacterial activity against *Escherichia coli*, *Staphylococcus aureus*, and *Salmonella typhimurium*, making it useful for treating bacterial infections. This effect is attributed to the plant's phenolic compounds, which disrupt bacterial cell membranes and inhibit microbial growth [9]. The plant's extracts also show antifungal activity against *Candida albicans* and *Aspergillus niger*, supporting its use in the treatment of fungal infections [13]. Preliminary studies have suggested that *Viburnum opulus* may have antiviral properties, but this area requires further investigation. Some evidence points to its potential in inhibiting viral replication, although the exact mechanisms remain unclear [2].

Antidiabetic Activity

Viburnum opulus has been studied for its potential role in managing diabetes, particularly in regulating blood glucose levels and improving insulin sensitivity. In animal models of diabetes, *Viburnum opulus* extracts have demonstrated the ability to reduce elevated blood glucose levels. The plant may exert its effects by enhancing insulin secretion and improving glucose uptake in tissues. In addition to controlling blood glucose, *Viburnum opulus* has shown potential in normalizing lipid profiles, such as reducing cholesterol and triglyceride levels in diabetic rats, which is important for reducing the risk of cardiovascular complications in diabetic patients [13].

Hepatoprotective Activity

Viburnum opulus extracts have shown protective effects on the liver, making it a potential candidate for managing liver diseases. In animal studies, *Viburnum opulus* has been shown to protect the liver from damage induced by toxic agents like acetaminophen and alcohol. This hepatoprotective effect is attributed to the antioxidant properties of the plant, which reduce oxidative stress in liver tissues [13].

Cardiovascular Protection

Viburnum opulus has demonstrated beneficial effects on cardiovascular health, particularly in regulating blood pressure and cholesterol levels. Studies suggest that *Viburnum opulus* may help in lowering blood pressure, which is critical in managing hypertension and preventing cardiovascular diseases. This effect is likely due to its smooth muscle relaxant properties and ability to reduce vascular resistance [2]. The plant's extracts have also been shown to reduce cholesterol levels in animal models, which may contribute to its protective effects against atherosclerosis and other cardiovascular conditions [14].

Cytotoxic and Anticancer Activity

Emerging research has explored the anticancer potential of *Viburnum opulus*, particularly its ability to induce apoptosis (programmed cell death) in cancer cells. Extracts from *Viburnum opulus* have shown cytotoxic effects on various cancer cell lines, including those of breast, lung, and liver cancer. These effects are believed to be mediated by the plant's flavonoids and phenolic acids, which inhibit cancer cell proliferation and induce apoptosis. The anticancer effects of *Viburnum opulus* may involve the modulation of cellular signaling pathways related to cell survival, growth, and apoptosis. However, more clinical studies are needed to confirm its anticancer efficacy and explore its potential as an adjunct in cancer therapy [15, 16].

Toxicity and Safety Considerations

While *Viburnum opulus* has many beneficial properties, it should be used with caution. The berries, especially when raw, contain saponins and low levels of cyanogenic glycosides, which can be toxic in high amounts and may cause symptoms such as nausea and vomiting if consumed without proper preparation. Cooking or drying the berries, however, reduces these compounds, making them safer for use in traditional foods and medicinal applications. Because of these potential toxicities, it is advisable to consult with a healthcare provider before using *V. opulus* products, particularly for individuals who are pregnant, breastfeeding, or managing chronic health conditions [17].

CONCLUSION

Viburnum opulus, commonly known as guelder rose or cramp bark, is a deciduous shrub native to Europe, North Africa, and parts of Asia, valued for both its ornamental beauty and medicinal properties. It contains a variety of bioactive compounds, including flavonoids, phenolic acids, iridoid glycosides, and tannins, which contribute to its antioxidant, anti-inflammatory, antispasmodic, antimicrobial, and antidiabetic effects. Traditionally, the plant has been used for alleviating muscle cramps, menstrual discomfort, gastrointestinal issues, and anxiety, with particular emphasis on the therapeutic benefits of its bark, known for its cramp-relieving properties. Scientific studies have confirmed the plant's biological activities, supporting its ethnobotanical claims. While *Viburnum opulus* shows promise in treating various ailments, caution is advised regarding its toxicity, particularly in the fruit, which contains cyanogenic glycosides. The plant is generally safe when used in moderation, but further research is needed to establish optimal dosages and ensure safety. Overall, *Viburnum opulus* is a significant medicinal plant with a rich history, demonstrating considerable pharmacological potential for modern applications.

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