A REVIEW ON: PHYTOCHEMICAL PROFILE AND THERAPEUTIC POTENTIAL OF GENUS SONCHUS

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ABSTRACT

The genus *Sonchus* (family Asteraceae), commonly known as sow thistles, comprises numerous species that have been widely utilized as food and traditional medicines in different parts of the world. Among these, *Sonchus oleraceus* and *Sonchus arvensis* are the most extensively studied due to their rich phytochemical composition and diverse biological activities. These plants contain a variety of bioactive compounds, including flavonoids, phenolic acids, hydroxycinnamic acid derivatives, sesquiterpene lactones, tannins, vitamins, and essential minerals. Such constituents contribute significantly to their nutritional and medicinal value. Recent scientific investigations have demonstrated that *Sonchus* species possess a broad spectrum of pharmacological properties.

Extracts from different plant parts have shown remarkable antioxidant, anti-inflammatory, antimicrobial, hepatoprotective, cardioprotective, and anticancer activities. Their antioxidant effects are primarily associated with their ability to scavenge free radicals and reduce oxidative stress, while anti-inflammatory and antimicrobial actions support their traditional use in the management of various ailments. In addition, studies have highlighted their potential role in protecting liver function, promoting cardiovascular health, and inhibiting the growth of certain cancer cells. The growing interest in natural products and plant-based therapeutics has increased the importance of *Sonchus* species as promising sources of novel bioactive compounds. This review summarizes the current knowledge regarding the phytochemical profile and therapeutic potential of the genus *Sonchus*, emphasizing its significance in traditional medicine and its prospects for future pharmaceutical and nutraceutical applications.

KEYWORDS: *Sonchus*; Asteraceae; phytochemicals; flavonoids; phenolic acids; antioxidant activity; anti-inflammatory activity; antimicrobial activity; hepatoprotective activity; anticancer activity; medicinal plants; therapeutic potential.

1. INTRODUCTION:

In 2022, a study carried out by Galdino et al., identified the presence of minerals (K, Ca, Mg, Cu, Mn, Fe, Zn, Na, and Se) in S. oleraceus, S. asper, and S. arvensis. This study showed that S. arvensis had the highest concentration of potassium, while S. oleraceus was rich in iron. These species are therefore greatly enhanced in terms of food and nutrition because they are widely distributed, are reasonably priced, function as pesticides in their production systems, and are heavily consumed by many families and rural populations living in Asia. The roots of the S. oleraceus species were used as a galactagogue, febrifuge, sedative, and to treat various liver

disorders in many ancient medical systems, including Chinese medicine Medicinal plants have long been used in traditional medical systems all over the world. Among these, genus Sonchus that belongs to family Asteraceae and comprises 98 species, commonly known as sow thistles, has garnered attention due to its wide variety, high nutritional value, and range of pharmacological traits.[1] Numerous scientific studies have confirmed that it is edible and rich in minerals, flavonoids, phenolic acids, and vitamins A, D, and E.[2] Sonchus arvensis has a very high vitamin E content, according to several studies. The phytochemical composition and medicinal potential of these two species have been the subject of recent scientific studies. The traditional uses, pharmacological activities, and potential uses of this species in contemporary medicine are highlighted in this article, which compiles results from several studies.

In 2013, the "Shen Nong's Herbal Classic" shows that Sonchus species, especially Sonchus oleraceus and Sonchus arvensis, were used in ancient Chinese medicine. Recent research has also revealed that these species have strong medicinal properties, helping to prevent heart failure and showing hepatoprotective, anticancer, antioxidant, anti-inflammatory, and antimicrobial effects due to the presence of hydroxycinnamic acids flavonoids and sesquiterpenes [3,4] this species has grown in importance as one of the major plants and has a wide range of biological functions that enable it to survive in various environmental conditions. According to Dao et al., S. arvensis extract exhibited strong antioxidant activity through its significant DPPH radical-scavenging capacity and inhibition of lipid peroxidation.

Medicinal plants have served as an essential source of healthcare and therapeutic agents since ancient times. Even today, a significant proportion of the global population relies on plant-derived medicines for the prevention and treatment of various diseases. The growing interest in natural products has stimulated extensive research into medicinal plants as potential sources of novel bioactive compounds with pharmaceutical applications [5]. Among the diverse groups of medicinal plants, members of the family Asteraceae have attracted considerable attention because of their rich phytochemical composition and broad spectrum of biological activities [6].

The genus *Sonchus* belongs to the family Asteraceae and comprises approximately 98 species distributed throughout temperate and tropical regions of the world. Species of this genus, commonly known as sow thistles, are widely found in Asia, Europe, Africa, Australia, and the Americas. Although many *Sonchus* species are considered agricultural weeds, they possess considerable nutritional and medicinal value and have been used traditionally as food and herbal remedies for centuries. Among the various species, *Sonchus oleraceus*, *Sonchus arvensis*, and *Sonchus asper* have been the most extensively investigated owing to their therapeutic potential and abundance of bioactive constituents [7].

Traditional medicinal systems have documented the use of *Sonchus* species for the management of numerous health conditions. Historical records indicate that *Sonchus oleraceus* and *Sonchus arvensis* were employed in Traditional Chinese Medicine for treating fever, inflammation, liver disorders, digestive ailments, and other health problems. The roots of *S. oleraceus* have been traditionally used as a galactagogue, sedative, febrifuge, and remedy for hepatic disorders. In several Asian countries, the aerial parts of these plants are consumed both as food and medicine, reflecting their importance in ethnomedicine and primary healthcare practices [8].

2. PHARMACOLOGICAL ACTIVITES

2.1Anti inflammatory effect

The antioxidant and anti-inflammatory properties of *Sonchus arvensis* and *Sonchus oleraceus* have attracted considerable scientific interest due to their rich phytochemical composition. These species contain substantial amounts of phenolic compounds and flavonoids, which are known to neutralize free radicals and reduce oxidative stress. By limiting oxidative damage, these bioactive constituents may help protect tissues and organs from the harmful effects of reactive oxygen species.

Studies have demonstrated that *S. arvensis* possesses notable antioxidant potential. The plant extract has shown effective free-radical scavenging activity in DPPH assays and has been reported to suppress lipid peroxidation, indicating its ability to prevent oxidative deterioration of cellular components. Furthermore, the extract exhibited strong reducing power, highlighting its capacity to act as an electron donor and counteract oxidative reactions [9,22].

Recent investigations have also confirmed the anti-inflammatory potential of *S. oleraceus*. Experimental studies conducted under both laboratory and animal conditions revealed significant antioxidant and anti-inflammatory effects. These biological activities are largely associated with the presence of flavonoids, phenolic constituents, and terpene lactones, which collectively contribute to the plant's therapeutic properties [23,24].

In addition, animal studies have shown that *S. arvensis* extracts rich in luteolin, quercetin, and apigenin can effectively reduce inflammatory responses. These compounds were found to alleviate inflammation caused by monosodium urate crystal deposition in synovial tissues. Among them, quercetin plays an important role by suppressing cellular processes involved in the progression of inflammation, thereby contributing to the overall anti-inflammatory effect of the plant [25].

ANTI INFLAMMATORY ACTION:

The extracts of S. arvensis and S. oleraceus contained the highest levels of phenolic and flavonoid compounds, which are capable of scavenging free radicals and removing toxins from the body while protecting the kidneys from their harmful effects. These properties contribute significantly to their antioxidant activity.[26] In a study conducted by Dao et al., S. arvensis extract exhibited strong antioxidant potential by effectively scavenging DPPH radicals and suppressing lipid peroxidation. Furthermore, at a concentration of 500 µg mL^{-1}, the extract showed the highest reducing power with an A700 value of 0.80. According to a 2024 study by Naunyn et al., Sonchus oleraceus demonstrated significant antioxidant and anti-inflammatory activities in both in vitro and in vivo models. These beneficial effects were mainly attributed to its rich content of bioactive constituents, especially flavonoids, phenolic compounds, and terpene lactones. [27,28]

Moreover, recent research involving thirty rats revealed that S. arvensis extract, which is rich in luteolin, quercetin, and apigenin, reduced inflammation induced by the deposition of monosodium urate crystals in synovial tissues. Quercetin, one of the major flavonoids present in S. arvensis, contributes to this effect by inhibiting the proliferative phase of inflammation.[29]

2.2 Antihypertensive effect:

Several studies have demonstrated the beneficial effects of *Sonchus* species on cardiovascular health, particularly in the management of hypertension and the protection of cardiac tissues. These therapeutic effects are largely attributed to the presence of bioactive phytochemicals, especially flavonoids and other phenolic compounds.

Mushtaq et al. investigated the antihypertensive potential of aerial parts of *Sonchus asper* in experimental rats with diet-induced hypertension. The findings revealed a significant and dose-dependent reduction in both blood pressure and heart rate following administration of the plant extract. The highest dose tested (1000 mg/kg) produced the greatest antihypertensive effect, supporting the traditional use of *S. asper* as a natural remedy for hypertension [30].

Further evidence of the blood pressure-lowering activity of *Sonchus* species was reported in a 2021 study using male Wistar rats. Hypertension was induced through epinephrine administration, and blood pressure was monitored using a CODA® non-invasive blood pressure system. Treatment with the plant extract resulted in significant reductions in both systolic and diastolic blood pressure when compared with baseline values, confirming its antihypertensive potential [31].

In addition to its effects on blood pressure regulation, *Sonchus arvensis* has demonstrated notable cardioprotective properties. Studies have shown that aqueous extracts of the plant can protect cardiac tissues from inflammatory damage induced by tumour necrosis factor-alpha (TNF-α). This protective effect is believed to be associated with the high flavonoid content of the extract, which helps reduce oxidative stress and inflammatory responses within the cardiovascular system [32].

Experimental investigations have also suggested that *Sonchus* extracts may provide protection against myocardial injury. In animal models of isoproterenol-induced myocardial infarction, treatment with plant extracts improved cardiac function and reduced markers of oxidative stress and tissue damage. These findings indicate that *Sonchus* species possess significant potential as natural cardioprotective agents and may contribute to the prevention and management of cardiovascular disorders [33].

Overall, the available evidence highlights the potential of *Sonchus* species as promising sources of antihypertensive and cardioprotective compounds. Their ability to regulate blood pressure, reduce cardiac

inflammation, and protect against myocardial damage supports their traditional medicinal use and warrants further pharmacological and clinical investigation.

2.3 Antimicrobial effect:

Species belonging to the genus *Sonchus* have demonstrated considerable antimicrobial potential and are reported to possess antibacterial, antifungal, and antiviral properties. These biological activities are primarily associated with the presence of diverse phytochemicals, including flavonoids, phenolic compounds, terpenoids, and tannins. Such compounds are known to interfere with microbial growth and survival while also providing antioxidant protection, thereby enhancing the therapeutic value of *Sonchus* species [34].

Several studies have investigated the antibacterial activity of *Sonchus* extracts against clinically important pathogens. In a study conducted by Rizwana et al. (2021), crude extracts of *Sonchus asper* were evaluated against multidrug-resistant bacterial strains. The tested microorganisms included Gram-positive bacteria such as *Staphylococcus aureus* and *Bacillus subtilis* subsp. *B. spizizinii*, as well as Gram-negative bacteria including *Escherichia coli* and *Pseudomonas aeruginosa*. Among the different extracts tested, the methanolic extract of *S. asper* exhibited the most pronounced antibacterial activity, particularly against *S. aureus*, while also showing significant inhibitory effects against the other bacterial species examined [35].

Further evidence supporting the antimicrobial potential of the genus was provided by a study conducted in China, which evaluated six *Sonchus* species, namely *S. oleraceus*, *S. arvensis*, *S. asper*, *S. uliginous*, *S. brachyotus*, and *S. lingianus*. The investigation revealed notable differences in biological activities among the species. *S. arvensis* demonstrated superior antioxidant performance, exhibiting strong free-radical scavenging activity, effective inhibition of lipid peroxidation, and high reducing power. In contrast, *S. oleraceus* displayed the most potent antibacterial activity against both Gram-positive and Gram-negative bacteria, including *Staphylococcus aureus*, *Escherichia coli*, *Salmonella enterica*, and *Vibrio parahaemolyticus* [36].

The antimicrobial efficacy observed in *Sonchus* species is believed to result from the synergistic action of multiple phytochemical constituents that disrupt microbial cell structures, inhibit essential metabolic pathways, and reduce microbial proliferation. These findings support the traditional medicinal use of *Sonchus* plants and highlight their potential as natural alternatives to synthetic antimicrobial agents.

Overall, the available evidence suggests that the genus *Sonchus* represents a promising source of bioactive compounds with significant antimicrobial activity. In addition to their medicinal applications, these plants may also serve as valuable functional foods with added health-promoting benefits, warranting further investigation into their therapeutic and pharmaceutical potential.

- **Concentrations of carotenoids and vitamins in *Sonchus* species**

Variables	*S. oleraceus*	*S. asper*	*S. arvensis*
Moisture (g/100 g)	91.83 ± 0.25[a]	91.77 ± 0.76[a]	92.31 ± 0.66[a]
Total dietary fiber (g/100 g)	3.97 ± 0.05[b]	4.38 ± 0.34[a]	4.30 ± 0.02[a]

Variables	*S. oleraceus*	*S. asper*	*S. arvensis*
Ash (g/100 g)	1.06 ± 0.02[b]	1.12 ± 0.01[a]	1.16 ± 0.02[a]
Lipids (g/100 g)	1.12 ± 0.01[b]	1.32 ± 0.08[a]	1.06 ± 0.05[b]
Carbohydrates (g/100 g)	0.17 ± 0.04[b]	0.34 ± 0.07[a]	0.12 ± 0.03[b]
Proteins (g/100 g)	1.88 ± 0.01[a]	1.97 ± 0.02[a]	1.55 ± 0.02[b]
Caloric density (kcal/100 g)	18.31 ± 0.25[b]	21.13 ± 0.91[a]	16.29 ± 0.62[c]

2.4 Anticancer effect:

The genus *Sonchus*, particularly *Sonchus oleraceus*, has attracted considerable attention for its potential anticancer properties. Traditionally, *S. oleraceus* has been used in Chinese medicine for the treatment of tumors and various chronic ailments. Recent scientific investigations have provided evidence supporting its cytotoxic and antiproliferative effects against different cancer cell lines, highlighting its potential as a source of natural anticancer agents [37].

A study conducted by Ting et al. demonstrated that aqueous extracts of *S. oleraceus* effectively inhibited the proliferation of HepG-2 (human liver cancer) and K562 (human leukemia) cells. The extract reduced cell viability and promoted programmed cell death (apoptosis) by regulating the expression of genes associated with apoptotic pathways. These findings suggest that the anticancer activity of *S. oleraceus* may be mediated through the induction of apoptosis and suppression of cancer cell growth [38].

The anticancer potential of *S. oleraceus* has also been investigated through its essential oil constituents. Essential oils extracted from the aerial parts of the plant exhibited moderate cytotoxic activity against HepG2 liver cancer cells. Treatment with the essential oil reduced cancer cell viability in a concentration-dependent manner, with more pronounced effects observed at higher concentrations. Although its cytotoxic activity was lower than that of the standard anticancer drug doxorubicin, the results indicate the presence of bioactive compounds capable of exerting anticancer effects [39].

Further evidence of the therapeutic potential of *S. oleraceus* was provided by in vitro studies evaluating different solvent extracts. Among the tested preparations, ethanol extracts showed the strongest inhibitory effect on the

growth of gastric cancer cells, suggesting that ethanol may efficiently extract compounds responsible for the plant's anticancer activity [40].

Additional investigations have examined the effects of both hot and cold aqueous extracts of *S. oleraceus* on various cancer cell lines, including AMN-3 and Hep-2 cells. The results demonstrated that higher extract concentrations significantly reduced cell growth and proliferation within 24 hours of treatment. These observations further support the cytotoxic potential of *S. oleraceus* and indicate that its bioactive constituents may interfere with cellular processes essential for cancer cell survival and multiplication [41].

The anticancer activity of *Sonchus* species is believed to be associated with the presence of flavonoids, phenolic compounds, sesquiterpene lactones, and other secondary metabolites that possess antioxidant, anti-inflammatory, and cytotoxic properties. These phytochemicals may act through multiple mechanisms, including induction of apoptosis, inhibition of cell proliferation, modulation of signalling pathways, and reduction of oxidative stress within tumor cells.

Overall, current studies suggest that *Sonchus oleraceus* possesses promising anticancer potential against a variety of cancer cell types. Although most investigations have been limited to in vitro experimental models, the findings provide a scientific basis for its traditional use and support further research aimed at identifying active compounds, elucidating their mechanisms of action, and evaluating their effectiveness in clinical settings.

2.5 Wound healing effect:

Species of the genus *Sonchus* have been traditionally employed in both folk and modern medicine for the treatment of skin disorders, wound management, and the promotion of tissue regeneration. These plants have also been used in the management of vitiligo and other dermatological conditions due to their potential to support skin repair and healing processes [42].

The wound-healing properties of *Sonchus* species are largely attributed to their rich phytochemical composition. Bioactive constituents such as flavonoids, phenolic compounds, terpenoids, and other secondary metabolites play important roles in tissue repair by reducing oxidative stress, controlling inflammation, and promoting cellular regeneration. Among these compounds, flavonoids are particularly important because they stimulate fibroblast proliferation, enhance collagen synthesis, and accelerate the formation of new connective tissue, all of which are essential steps in wound healing [43].

Experimental studies have provided scientific evidence supporting the traditional use of *Sonchus* species in wound management. Nonato et al. (2018) investigated the wound-healing efficacy of an ointment prepared from *Sonchus oleraceus* using Wistar rat models. Standardized wounds were induced on the dorsal region of the animals, followed by daily application of the ointment. Clinical observations demonstrated a progressive reduction in wound size throughout the treatment period. Histopathological examination and collagen analysis performed after 15 days revealed enhanced tissue regeneration and increased collagen deposition in treated animals. Notably, complete wound contraction was observed within 10 days, indicating a significant acceleration of the healing process [44].

The effectiveness of *S. oleraceus* in wound repair may be associated with its ability to stimulate collagen formation, promote tissue remodeling, and facilitate re-epithelialization of damaged skin. Increased deposition of type I and type III collagen fibers contributes to improved tissue strength and structural integrity, thereby enhancing wound closure and recovery.

In addition to wound healing, the antioxidant and anti-inflammatory activities of *Sonchus* phytochemicals may further support skin regeneration by minimizing oxidative damage and reducing inflammatory responses at the site of injury. These combined effects create a favorable environment for tissue repair and restoration of normal skin architecture [45].

Overall, the available evidence suggests that *Sonchus* species possess considerable wound-healing and skin-regenerative potential. Their rich phytochemical profile and demonstrated ability to enhance tissue repair support their traditional use in dermatological applications and highlight their promise as natural therapeutic agents for wound management and skin health [46,49].

3.PHYTOCHEMICAL PROPERTIES OF THE GENUS SONCHUS

The therapeutic value of the genus *Sonchus* is primarily attributed to its diverse and complex phytochemical composition. Numerous phytochemical investigations have revealed that different *Sonchus* species contain a wide range of bioactive compounds, including flavonoids, phenolic acids, hydroxycinnamic acid derivatives, sesquiterpene lactones, terpenoids, tannins, alkaloids, saponins, glycosides, vitamins, and essential minerals. These phytochemicals contribute significantly to the nutritional, medicinal, and pharmacological properties of the plants.

Among the identified constituents, flavonoids represent one of the most important groups of secondary metabolites in *Sonchus* species. Several flavonoids, including quercetin, luteolin, apigenin, kaempferol, and their glycosidic derivatives, have been isolated from *Sonchus* extracts. These compounds are well known for their antioxidant, anti-inflammatory, antimicrobial, cardioprotective, hepatoprotective, and anticancer activities. Flavonoids exert their biological effects by scavenging free radicals, regulating inflammatory mediators, and modulating various cellular signaling pathways involved in disease progression.

Another major class of phytochemicals present in *Sonchus* species is phenolic compounds. Phenolic acids such as chlorogenic acid, caffeic acid, ferulic acid, and p-coumaric acid have been frequently reported. These compounds possess strong antioxidant properties and play a crucial role in protecting cells against oxidative damage. Their ability to neutralize reactive oxygen species contributes to the prevention of chronic diseases associated with oxidative stress.

Hydroxycinnamic acid derivatives are also abundant in several *Sonchus* species. These compounds are recognized for their antioxidant and anti-inflammatory properties and are believed to contribute significantly to the therapeutic potential of the genus. Studies have shown that hydroxycinnamic acids help inhibit lipid peroxidation and reduce cellular damage caused by free radicals.

Sesquiterpene lactones constitute another important group of bioactive constituents found in *Sonchus*. These compounds are characteristic of many members of the Asteraceae family and are associated with anti-inflammatory, antimicrobial, and cytotoxic activities. Research suggests that sesquiterpene lactones may contribute to the anticancer properties of *Sonchus* species by inducing apoptosis and inhibiting tumor cell proliferation.

In addition to these compounds, *Sonchus* plants contain various terpenoids, which exhibit diverse biological activities including antioxidant, antimicrobial, and anti-inflammatory effects. Terpenoids also play an important role in plant defense mechanisms and contribute to the medicinal value of the genus. Tannins are another group of phytochemicals commonly detected in *Sonchus* species. These polyphenolic compounds possess astringent,

antimicrobial, antioxidant, and wound-healing properties. Tannins can interact with proteins and microbial cell membranes, thereby inhibiting the growth of pathogenic microorganisms and supporting tissue repair processes.

Several studies have also reported the presence of alkaloids and saponins in *Sonchus* species. Although present in relatively lower concentrations compared with flavonoids and phenolics, these compounds contribute to the overall pharmacological profile of the plants. Alkaloids are known for their diverse biological activities, while saponins exhibit antimicrobial, anti-inflammatory, and immunomodulatory properties. A part from secondary metabolites, *Sonchus* species are rich sources of essential vitamins and minerals. Nutritional analyses have identified vitamins A, D, E, and K, along with important minerals such as potassium, calcium, magnesium, iron, zinc, manganese, copper, sodium, and selenium. These nutrients not only enhance the nutritional value of the plants but also contribute to their health-promoting effects.

Recent chromatographic and spectroscopic studies, including High-Performance Liquid Chromatography (HPLC), Gas Chromatography–Mass Spectrometry (GC–MS), Liquid Chromatography–Mass Spectrometry (LC–MS), and Nuclear Magnetic Resonance (NMR) spectroscopy, have facilitated the identification and characterization of numerous phytochemicals present in *Sonchus* species. These analytical techniques have improved our understanding of the chemical diversity and therapeutic potential of the genus.

Overall, the phytochemical richness of *Sonchus* species provides a strong scientific basis for their traditional medicinal uses and reported pharmacological activities. The synergistic interactions among flavonoids, phenolic acids, sesquiterpene lactones, terpenoids, tannins, and other bioactive compounds are believed to be responsible for the antioxidant, anti-inflammatory, antimicrobial, hepatoprotective, cardioprotective, anticancer, and wound-healing properties associated with the genus *Sonchus*.

4.ANTIMICROBIAL ANTI-INFLAMMATORY AND ANTIOXIDANT PROPERTIES

Phytochemicals possess a wide range of biological activities that contribute significantly to human health and disease prevention. Among their most important therapeutic effects are antimicrobial, anti-inflammatory, and antioxidant activities, which have attracted considerable attention in pharmaceutical and biomedical research.

The antimicrobial potential of phytochemicals offers a promising approach to addressing the growing challenge of drug-resistant microorganisms. Bioactive compounds such as flavonoids, alkaloids, terpenoids, and phenolic substances have demonstrated inhibitory effects against a variety of pathogenic bacteria, including *Mycobacterium* species. These compounds can interfere with microbial growth by disrupting cell membranes, inhibiting essential enzymes, and affecting nucleic acid synthesis, ultimately reducing microbial survival and proliferation. In addition, essential oils, phenolic acids, and alkaloids exhibit broad-spectrum activity against bacteria, fungi, viruses, and parasites, highlighting their potential as natural antimicrobial agents [50].

The anti-inflammatory effects of phytochemicals are largely attributed to their ability to regulate inflammatory pathways. Many plant-derived compounds suppress the production of pro-inflammatory cytokines and inhibit key enzymes such as cyclooxygenase (COX) and lipoxygenase (LOX), which are involved in the synthesis of inflammatory mediators. Furthermore, they reduce the formation of prostaglandins and leukotrienes, thereby helping to alleviate inflammation and associated tissue damage [51].

Phytochemicals also play an important role in protecting cells against oxidative stress. Their antioxidant activity is achieved through several mechanisms, including neutralization of free radicals, chelation of metal ions, stimulation of endogenous antioxidant enzymes, and activation of cellular defense pathways such as the Nrf2–

ARE signaling system. These actions help maintain cellular integrity and reduce oxidative damage linked to various chronic diseases [52,53]. Collectively, the antimicrobial, anti-inflammatory, and antioxidant properties of phytochemicals underscore their potential as multifunctional therapeutic agents for the prevention and management of infectious, inflammatory, and oxidative stress-related disorders.

5.CASE STUDIES OF SELECTED PHYTOCHEMICAL-RICH MEDICINAL PLANTS OF GENUS SONCHUS

5.1. Sonchus oleraceus L. (Common Sow Thistle)

Sonchus oleraceus is one of the most extensively investigated species of the genus *Sonchus* due to its rich phytochemical composition and broad therapeutic potential. Phytochemical analyses have identified the presence of flavonoids, phenolic acids, hydroxycinnamic acid derivatives, sesquiterpene lactones, tannins, vitamins, and essential minerals [54,55]. Major bioactive compounds such as quercetin, luteolin, chlorogenic acid, and caffeic acid contribute significantly to its antioxidant and anti-inflammatory activities [56].

Traditionally, *S. oleraceus* has been used for the treatment of liver disorders, fever, inflammation, digestive ailments, and skin diseases [57]. Experimental studies have demonstrated antioxidant, antimicrobial, hepatoprotective, wound-healing, and anticancer activities. Ting et al. reported that aqueous extracts of *S. oleraceus* inhibited the growth of HepG2 and K562 cancer cells by inducing apoptosis and reducing cell viability [58]. Furthermore, Nonato et al. demonstrated that topical application of *S. oleraceus* ointment accelerated wound contraction and increased collagen deposition in Wistar rats, confirming its wound-healing potential [59].

5.2. Sonchus arvensis L. (Field Sow Thistle)

Sonchus arvensis is widely recognized for its high content of phenolic compounds and flavonoids. Phytochemical investigations have revealed the presence of quercetin, luteolin, apigenin, chlorogenic acid, and other hydroxycinnamic acid derivatives responsible for its pharmacological activities [60].

Traditionally, the plant has been used in the management of inflammation, fever, kidney disorders, and cardiovascular diseases [61]. Dao et al. demonstrated that *S. arvensis* exhibited strong antioxidant activity through effective DPPH radical scavenging, inhibition of lipid peroxidation, and high reducing power [62]. Recent animal studies further revealed that extracts rich in quercetin, luteolin, and apigenin significantly reduced inflammation induced by monosodium urate crystal deposition, supporting its anti-inflammatory activity [63]. In addition, aqueous extracts of *S. arvensis* have shown cardioprotective effects against inflammatory and oxidative stress-mediated cardiac damage [64].

5.3. Sonchus asper (L.) Hill. (Spiny Sow Thistle)

Sonchus asper is another medicinally important species characterized by the presence of flavonoids, phenolic compounds, tannins, alkaloids, and terpenoids [65]. These phytochemicals contribute to its antioxidant, antimicrobial, and antihypertensive properties.

Mushtaq et al. investigated the antihypertensive activity of *S. asper* in experimental rats and reported significant dose-dependent reductions in blood pressure and heart rate. The highest tested dose (1000 mg/kg) produced the most pronounced antihypertensive effect, supporting its traditional use in hypertension management [66]. Rizwana et al. evaluated the antibacterial activity of *S. asper* extracts against multidrug-resistant bacterial pathogens and found that methanolic extracts exhibited strong inhibitory activity against *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Bacillus subtilis* [67].

5.4. Comparative Significance of Major *Sonchus* Species

Although all three species possess valuable medicinal properties, differences in phytochemical composition influence their therapeutic applications. *S. oleraceus* is particularly recognized for its wound-healing, hepatoprotective, and anticancer activities. *S. arvensis* demonstrates superior antioxidant and anti-inflammatory effects due to its high flavonoid content, while *S. asper* is especially notable for its antihypertensive and antibacterial properties.

The pharmacological potential of these species is closely linked to the synergistic action of their phytochemicals, including flavonoids, phenolic acids, hydroxycinnamic acids, sesquiterpene lactones, and terpenoids. These compounds contribute to multiple biological activities such as antioxidant defense, inflammation control, microbial inhibition, cardiovascular protection, and cancer cell suppression.

5.5. Future Perspectives

The increasing body of evidence supporting the medicinal value of *Sonchus* species highlights their importance as potential sources of novel therapeutic agents. Further research focusing on phytochemical isolation, mechanism-of-action studies, toxicity evaluation, and clinical trials is necessary to facilitate the development of standardized herbal formulations and pharmaceutical products. The integration of traditional knowledge with modern scientific approaches may further enhance the utilization of *Sonchus* species in healthcare, nutraceuticals, and drug discovery.

6.CONCLUSION:

The present review highlights the medicinal significance of various species belonging to the genus Sonchus, which exhibit diverse biological activities owing to the presence of numerous bioactive constituents, particularly flavonoids. Findings from several studies indicate that these compounds contribute substantially to the therapeutic potential of the genus. Furthermore, Sonchus species may serve as supportive therapeutic agents in the management of cancer, skin disorders, and other health conditions. The study also emphasizes the need for additional research and clinical investigations on extracts obtained from these plants to isolate and characterize more bioactive molecules, especially flavonoids. Such studies could reveal further pharmacological activities and promote the future application of Sonchus-derived compounds in industrial pharmacy. Scientific studies have demonstrated that Sonchus species possess a wide range of pharmacological activities, including antioxidant, anti-inflammatory, antimicrobial, antihypertensive, hepatoprotective, nephroprotective, antidiabetic, wound-healing, cardioprotective, and anticancer effects. The strong antioxidant activity is mainly attributed to its high phenolic and flavonoid content, which helps neutralize free radicals and reduce oxidative stress. Anti-inflammatory and antimicrobial properties further support its traditional use in treating infections, skin disorders, and inflammatory conditions.

Experimental evidence from both in vitro and in vivo studies indicates that Sonchus extracts can promote tissue regeneration, accelerate wound healing, lower blood pressure, improve cardiovascular health, and inhibit the growth of certain cancer cells. These findings validate many of the traditional medicinal uses of the genus. Despite its promising therapeutic potential, further clinical studies are required to establish standardized dosages, long-term safety, mechanisms of action, and efficacy in humans. Overall, the genus Sonchus represents a valuable natural source of bioactive compounds with significant potential for the development of novel therapeutic agents and supportive treatments for various diseases. Its broad spectrum of biological activities highlights its importance in both traditional medicine and modern pharmaceutical research.

Polygonum minus is an important aromatic and medicinal plant that possesses a diverse range of phytochemicals and pharmacologically active compounds. The present review highlights its rich phytochemical composition, including various secondary metabolites that contribute to its biological and therapeutic properties. Among these constituents, aldehydes such as **decanal** and **dodecanal** are major components responsible for the characteristic aroma of the plant and its potential application in the fragrance and perfume industries.

Several phenolic compounds identified in *P. minus*, including **gallic acid** and **coumaric acid**, have been associated with significant biological activities such as antioxidant and gastroprotective effects. Studies investigating the antioxidant potential of the plant suggest that it may serve as a natural antioxidant source and could be utilized as a food preservative to enhance product stability and shelf life.

Research on callus and cell suspension cultures of *P. minus* has revealed the production of valuable bioactive compounds that are either absent or present in very low concentrations in intact plants. Notably, **5-hydroxymethylfurfural (HMF)** has demonstrated potential inhibitory effects on sickle cell formation, while **repandin A** has been reported to possess antidiabetic activity. These findings indicate that tissue culture techniques may provide an effective strategy for the large-scale production of pharmaceutically important metabolites from *P. minus*.

Furthermore, available toxicity studies suggest that extracts of *P. minus* exhibit a favorable safety profile. Experimental investigations have shown that the plant extracts do not produce significant toxic effects, even at relatively high doses, and are generally well tolerated in the tested cell lines.

Overall, the available evidence supports the potential of *Polygonum minus* as a valuable source of natural bioactive compounds with applications in food, pharmaceutical, and cosmetic industries. Nevertheless, further studies focusing on the isolation of active constituents, elucidation of their mechanisms of action, and clinical evaluation are necessary to fully explore and validate the therapeutic potential of this medicinal plant.

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