



Sonchus arvensis: A Multifunctional Medicinal Weed with Nutraceutical and Therapeutic Value

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1. Introduction

The genus *Sonchus*, a member of the Asteraceae (sunflower) family, encompasses a diverse group of plants commonly known as sow thistles. While many species within this genus are dismissed globally as invasive agricultural weeds, this classification belies their complex ecological roles and, more significantly, their long history of human use. Among these, *Sonchus arvensis* L. (perennial sow thistle, field sow thistle) stands out as a particularly resilient and widespread species. Its persistence, owing to a deep and extensive creeping root system, has made it a significant challenge for farmers, yet this same tenacity is indicative of a robust phytochemistry that has been recognized by traditional medicine systems for centuries.

Historically, *S. arvensis* has held a place in ethnobotany across continents. In Europe, Asia, and North America, its leaves have been consumed as a potherb, and its milky latex and roots have been employed in various folk remedies. Despite its ubiquitous presence, often in disturbed habitats, roadsides, and cultivated fields, the plant's full potential as a source of bioactive compounds has only recently begun to be explored through the lens of modern science. Its adaptability to a wide range of climates and soil types has resulted in a near-cosmopolitan distribution, making it a readily available, if often overlooked, natural resource.

This chapter aims to provide a comprehensive review of *Sonchus arvensis*, bridging the gap between its traditional reputation and contemporary scientific validation. We will explore its botanical characteristics, ethnopharmacological background, detailed phytochemical profile, and the diverse pharmacological activities from antioxidant to anticancer effects that have been reported in preclinical studies. Furthermore, this chapter will delve into its nutritional value, toxicological safety, and potential applications in

biotechnology and agriculture. By synthesizing this information, we seek to re-evaluate *S. arvensis*, proposing a shift in perspective from a problematic weed to a valuable, multifunctional plant with significant nutraceutical and therapeutic potential.

2. Botanical Description

2.1 Taxonomic Classification

The classification of *Sonchus arvensis* situates it firmly within one of the largest and most evolved families of flowering plants:

- **Kingdom:** Plantae
- **Clade:** Tracheophytes
- **Clade:** Angiosperms
- **Clade:** Eudicots
- **Clade:** Asterids
- **Order:** Asterales
- **Family:** Asteraceae
- **Genus:** *Sonchus* L.
- **Species:** *Sonchus arvensis* L.

2.2 Morphological Characteristics

Sonchus arvensis is a perennial herb, distinguished by several key features:

- **Root System:** Its most defining characteristic is its deep, creeping rhizomatous root system. These horizontal roots can extend several meters and produce new shoots, making the plant notoriously difficult to eradicate and enabling its rapid vegetative spread.
- **Stem:** The stems are erect, typically hollow, sparsely branched, and can reach heights of 50 to 150 cm (approx. 1.5 to 5 feet). When broken, the stem and leaves exude a characteristic milky white latex, common to many members of the Cichorieae tribe.
- **Leaves:** The leaves are alternate, variable in shape (oblong to lanceolate), and often pinnatifid (deeply lobed). The leaf margins are typically spinulose (bearing small spines), though these are generally softer than those of its relative, *S. asper* (prickly sow thistle). The upper leaves are often sessile (stalkless) and clasp the stem with rounded auricles (ear-like lobes).
- **Flowers:** The inflorescence consists of bright yellow, dandelion-like flower heads (capitula), which are typically 2-4 cm in diameter. These heads are composed entirely of ligulate (strap-shaped) florets. The bracts surrounding the flower head (involucre) are often covered in glandular hairs.
- **Fruits and Seeds:** The fruit is a small, dry, single-seeded achene, typically reddish-brown, flattened, and strongly ribbed, with a crown of fine, white bristles (the pappus) that facilitates wind dispersal.

2.3 Growth Habits and Ecological Adaptations

S. arvensis is a highly successful colonizer, thriving in a variety of disturbed sites, particularly agricultural fields, gardens, roadsides, and waste areas. Its success is largely due to its dual mode of reproduction: prolific seed production (up to 10,000 seeds per plant) and vigorous vegetative propagation via its rhizomes. Even small fragments of the root are capable of regenerating into a new plant. This adaptability allows it to outcompete native vegetation and cultivated crops for light, water, and nutrients.

2.4 Identification and Differentiation from Related Species

S. arvensis is often confused with its annual relatives, *Sonchus oleraceus* (common sow thistle) and *Sonchus asper* (prickly sow thistle).

- *S. arvensis* is a **perennial** with deep, creeping **rhizomes**. Its flower heads are generally larger and a brighter yellow.
- *S. oleraceus* is an **annual** with a **taproot**. Its leaves are softer, less spiny, and the auricles that clasp the stem are typically pointed.
- *S. asper* is also an **annual** with a **taproot**, but it is easily distinguished by its much stiffer, spiner leaves and rounded, clasping auricles.

3. Traditional and Ethnomedicinal Uses

The use of *Sonchus arvensis* in traditional medicine is widespread, reflecting its global distribution. While specific applications vary by region, common themes emerge, particularly related to detoxification, inflammation, and digestive health.

- **European Systems:** In European folk medicine, *S. arvensis* was used as a "blood purifier" and a diuretic. The milky latex was applied topically to warts, similar to dandelion latex. Poultices made from the leaves were commonly used to reduce inflammation associated with boils, abscesses, and mastitis. The young leaves were also consumed as a spring tonic, believed to cleanse the system after winter.
- **Asian Systems:** In Traditional Chinese Medicine (TCM), plants of the *Sonchus* genus are often used to "clear heat and remove toxins." *S. arvensis* decoctions have been employed to treat hepatitis, dysentery, and pharyngitis. In Ayurvedic medicine in India, the plant has been noted for its use as a hepatic tonic and for treating gastrointestinal complaints, including indigestion and constipation.
- **African Systems:** Various African communities have utilized *S. arvensis* to treat fevers, stomach ailments, and as a general pain reliever. The root, in particular, is often decocted for hepatic disorders and as an anthelmintic (to expel parasitic worms).
- **Local Diets:** Beyond its medicinal use, *S. arvensis* is a well-regarded wild edible. The young, tender leaves are harvested before the plant flowers (when they become excessively bitter) and are eaten raw in salads, steamed, or boiled as a potherb, similar to spinach or dandelion greens. This dual use as both food and medicine underscores its role as a "functional food" in traditional healing practices.

4. Phytochemical Constituents

The diverse biological activities of *Sonchus arvensis* are a direct result of its complex phytochemical profile. Modern analytical techniques (such as HPLC, GC-MS, and NMR) have identified several major classes of bioactive compounds.

- **Phenolic Acids:** *S. arvensis* is a rich source of phenolic acids, which are powerful antioxidants. Key compounds include caffeic acid, chlorogenic acid, and cichoric acid (dicaffeoyltartaric acid). These compounds are primary contributors to the plant's antioxidant and hepatoprotective effects.
- **Flavonoids:** A variety of flavonoids have been isolated, primarily glycosides of luteolin and apigenin. Luteolin-7-O-glucoside and apigenin-7-O-glucoside are particularly abundant. These flavonoids are known for their anti-inflammatory, antioxidant, and enzyme-inhibiting properties.
- **Sesquiterpene Lactones:** This class of compounds is characteristic of the Asteraceae family and is responsible for the plant's bitter taste and potent anti-inflammatory effects. Guaianolide-type sesquiterpene lactones, such as sonchuside A and jacquinelin, have been identified. These compounds are known to interact with key inflammatory pathways, such as NF- κ B.
- **Triterpenoids and Sterols:** The plant contains common phytosterols, including β -sitosterol and stigmasterol, as well as triterpenes like taraxasterol and lupeol. These compounds contribute to the plant's overall anti-inflammatory and potential hypolipidemic (cholesterol-lowering) profile.
- **Other Compounds:** *S. arvensis* also contains alkaloids (in trace amounts), carotenoids (in leaves), vitamins (notably Vitamin C and Vitamin A precursors), and minerals (potassium, calcium).

The concentration of these compounds can vary significantly based on the plant's geographical location, season of harvest, and environmental stressors, which presents a challenge for standardization.

5. Pharmacological and Biological Activities

Preclinical research, both *in vitro* and *in vivo*, has begun to validate many of the traditional uses of *S. arvensis*.

5.1 Antioxidant Activity

The high concentration of phenolic acids and flavonoids in *S. arvensis* extracts endows it with significant antioxidant capacity. *In vitro* studies using assays such as DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging and FRAP (ferric reducing antioxidant power) consistently demonstrate that leaf and root extracts can neutralize free radicals, suggesting a potential role in mitigating oxidative stress-related diseases.

Sl No.	Plant Part Used	Solvent Used	Antioxidant (Assay)	Value	Reference
1	Leaves	Ethyl acetate	IC ₅₀ : 8.27 ± 4.93 μ g/mL (DPPH)		Wahyuni DK (2023a) et. al.
2	Leaves	Ethanol	IC ₅₀ : 12.36 ± 10.40 μ g/mL		Wahyuni DK

			(DPPH)	(2023a) et. al.
3	Leaves	Methanol	IC ₅₀ : 31.35 ± 3.27 µg/mL (DPPH)	Wahyuni DK (2023a) et. al.
4	Leaves	n-Hexane	IC ₅₀ : 108.59 ± 11.24 µg/mL (DPPH)	Wahyuni DK (2023a) et. al.
5	Leaves (Fraction IV)	Ethyl acetate	IC ₅₀ : 22.56 µg/mL (DPPH)	Wahyuni DK (2023b) et. al.
6	Leaves (10 accessions)	96% Alcohol (Ethanol)	IC ₅₀ : 238.29 to 825.90 µg/mL (DPPH)	Raisawati T (2020) et. al.
7	Leaves (10 accessions)	96% Alcohol (Ethanol)	0.51 to 0.85 mg QE/g (Total Flavonoid)	Raisawati T (2020) et. al.

5.2 Anti-inflammatory and Analgesic Effects

This is one of the most well-supported activities, linking directly to traditional use. The anti-inflammatory effects are largely attributed to the sesquiterpene lactones and flavonoids. These compounds have been shown to inhibit the production of pro-inflammatory mediators like nitric oxide (NO) and prostaglandins, as well as cytokines such as TNF- α and IL-6. *In vivo* studies, using models like carrageenan-induced paw edema in rats, have shown that *S. arvensis* extracts can significantly reduce swelling and exhibit analgesic (pain-relieving) properties.

Sl. No.	Part(s) Used	Solvent(s) Used	Pharmacological Effect(s)	Reference
1	Aerial parts	Methanol	Strong Anti-inflammatory (Carrageenan test). 400 mg/kg extract showed higher activity than 10 mg/kg diclofenac.	Prasad B et al. (2015)
2	Aerial parts	Methanol	Significant Analgesic (Hot plate & acetic acid writhing methods). Showed a dose-dependent effect.	Prasad B et al. (2015)
3	Leaves	Water fraction (from ethanol extract)	Anti-inflammatory (Anti-gout model). Potently reduced pro-inflammatory cytokines IL-1 β and TNF- α .	Hidayat H et al. (2021)
4	Leaves	Extract (Solvent not specified)	Anti-inflammatory (Anti-gout model). Decreased expression of pro-inflammatory cytokines IL-1 β and TNF- α .	Sutriono S et al. (2020)

5.3 Antimicrobial and Antifungal Potential

Various extracts of *S. arvensis* have demonstrated broad-spectrum antimicrobial activity. They have been shown to be effective *in vitro* against a range of human pathogens, including Gram-positive bacteria (e.g.,

Staphylococcus aureus, *Bacillus subtilis*) and Gram-negative bacteria (e.g., *Escherichia coli*, *Pseudomonas aeruginosa*). Antifungal activity against species like *Candida albicans* has also been reported.

Sl. No.	Part(s) Used	Solvent(s) Used	Pharmacological Effect(s)	Reference
1	Leaves	Ethyl acetate fraction	Antimicrobial (against <i>Escherichia coli</i> & <i>Staphylococcus aureus</i>). Showed significant inhibition zones (19.22 mm and 17.167 mm, respectively).	Wahyuni DK et al. (2022)
2	Aerial parts	Methanol	Antibacterial (against food spoilage bacteria including <i>E. coli</i> , <i>S. enterica</i> , <i>V. parahaemolyticus</i> , <i>S. aureus</i>).	Xia D et al. (2011)
3	Leaves	Ethanol	Antibacterial (Noted for its properties, linked to flavonoid compounds that enhance immune response against bacteria like <i>S. dysenteriae</i>).	Manurung B et al. (2021)
4	Roots, Stems, Leaves	Methanol	No inhibitory effect (against <i>Escherichia coli</i> & <i>Candida utilis</i>). The study suggests solvent type or extraction time may be factors.	Rosli SM et al. (2021)
5	Leaves	Methanol	No growth inhibition (against <i>Bacillus cereus</i> , <i>Staphylococcus aureus</i> , <i>Salmonella enterica</i> , <i>Escherichia coli</i>).	Kanani K et al. (2015)

5.4 Antidiabetic and Hypolipidemic Properties

Emerging research suggests *S. arvensis* may have benefits for metabolic disorders. Some studies have indicated that its extracts can inhibit α -amylase and α -glucosidase, key enzymes in carbohydrate digestion, which could help lower post-prandial blood glucose levels. Animal models have also shown that administration of the extract can improve lipid profiles, reducing levels of total cholesterol and triglycerides, which is attributed in part to its sterol and flavonoid content.

Sl. No.	Part(s) Used	Solvent(s) Used	Pharmacological Effect(s)	Reference
1	Leaves	Ethanol	Antidiabetic (Significant reduction in blood sugar levels in alloxan-induced diabetic rats).	Dutta et al. (2020)
2	Leaves	Ethanol	Antidiabetic (Effective in reducing blood glucose levels in streptozotocin-induced diabetic rats).	Tandi J et al. (2020)

3	Leaves	Water (Aqueous infusion)	Antidiabetic (Reduced postprandial blood glucose elevation and blood glucose levels in diabetic mice).	Haryta et al. (2023)
4	Folium (Leaves)	Maceration extract (formulated as Nanosuspension)	Antihyperlipidemic (Showed significant lipid-lowering effects, comparable to simvastatin).	Aldeeb et al. (2025)
5	Aerial parts (Phenolic compounds)	Phenolic extract	Glucolipid Metabolism (Showed protective effects against high sucrose- and high stearic acid-induced damage).	An Q et al. (2023)

5.5 Anticancer and Cytotoxic Studies

The cytotoxic potential of *S. arvensis* is an active area of investigation. Specific compounds isolated from the plant, particularly sesquiterpene lactones, have shown selective cytotoxicity against various human cancer cell lines *in vitro*, including breast, colon, and liver cancer lines. These compounds are believed to induce apoptosis (programmed cell death) in cancer cells. However, this research is still in the early stages, and *in vivo* and mechanistic studies are needed.

Sl. No.	Plant Part Used	Solvent Use	Anticancer / Cytotoxic Value	Reference
1.	Whole Plant	70% Ethanol (EtOH) , followed by fractionation (e.g., Chloroform, Ethyl Acetate) to isolate compounds.	Specific isolated steroids (compounds 1 and 8) demonstrated moderate cytotoxic activity against two human endometrial carcinoma cell lines (ECC-1 and Ishikawa) with IC ₅₀ values reported as 11.2 & 9.1 µM and 5.4 & 8.6 µM, respectively.	Xia Z (2020) et. al.
2.	Leaf	n-hexane, ethyl acetate, and ethanol (used in successive maceration).	The crude extracts were evaluated for cytotoxicity (MTT assay) against human hepatic cell lines and were found to have low cytotoxic effects .	Wahyuni DK (2023) et. al.

5.6 Hepatoprotective Activity

Validating its use as a "liver tonic," animal studies have shown that *S. arvensis* extracts can protect the liver from damage induced by toxins like carbon tetrachloride (CCl₄) and paracetamol. This protective effect is characterized by a reduction in serum liver enzymes (ALT, AST) and is attributed to the potent antioxidant activity of its phenolic constituents, which prevent lipid peroxidation in liver tissues.

Sl No.	Plant Part Used	Solvent Use	Hepatoprotective Activity Value	Reference
1	Whole Plant	Methanol	The extract significantly reversed the CCl ₄ -induced elevation of serum marker enzymes (like AST, ALT) and cholesterol. It also restored normal liver tissue architecture upon histopathological examination.	Rahmatgon (2014) et. al
2	Leaves	Ethyl Acetate	Showed significant hepatoprotective activity in Plasmodium berghei-infected mice. The extract (at 100 mg/kg) significantly lowered the elevated serum levels of SGOT and SGPT compared to the infected control group.	Jusniar (2021) et. al
3	Roots	Ethanol (70%)	The extract demonstrated significant hepatoprotective effects against CCl ₄ -induced liver toxicity in rats. It markedly reduced the high serum levels of ALT, AST, and total bilirubin that were caused by the toxin.	Tseveendorj (2020) et. al
4	Aerial Parts	Aqueous-Ethanol	The extract provided significant protection against paracetamol-induced liver damage. It caused a dose-dependent reduction in serum SGPT, SGOT, ALP, and bilirubin levels, and histopathology showed reduced necrosis.	Ahmad (2014) et. al

6. Nutritional and Functional Aspects

As a wild edible, *Sonchus arvensis* offers a valuable nutritional contribution, especially in food-scarce regions or as a supplemental "wild green."

- **Macronutrient and Micronutrient Composition:** The leaves are low in calories but rich in nutrients. They provide a significant source of dietary fiber. In terms of micronutrients, they are an excellent source of Vitamin A (via β -carotene), Vitamin C (ascorbic acid), and Vitamin K. They also contain essential minerals, most notably potassium, calcium, and iron.
- **Edible Uses and Functional Food Potential:** The young leaves are best consumed in the spring before the plant bolts. Their slightly bitter taste can be reduced by boiling or blanching. This bitterness, however, is indicative of the presence of the same bioactive compounds (like sesquiterpene lactones and phenolics) that provide its health benefits. This dual role makes *S.*

arvensis a classic example of a functional food—a food that provides physiological benefits beyond basic nutrition.

- **Comparative Nutritional Profile:** When compared to other leafy weeds like dandelion (*Taraxacum officinale*) or even cultivated greens like spinach (*Spinacia oleracea*), *S. arvensis* holds a comparable or, in some cases, superior nutritional profile, particularly in its mineral and antioxidant content.

7. Toxicological Evaluation and Safety Profile

The long history of *S. arvensis* as an edible plant provides strong anecdotal evidence of its general safety when consumed in moderation.

- **Acute and Sub-chronic Toxicity:** Scientific toxicological data is limited but supportive. Acute toxicity studies in rodents (e.g., LD50 tests) have generally found that methanolic and aqueous extracts of *S. arvensis* are non-toxic, even at high doses, suggesting a wide therapeutic index. Sub-chronic toxicity studies (e.g., 28-day or 90-day oral administration) have largely shown no significant adverse effects on hematological parameters, organ weight, or histopathology.
- **Possible Contraindications and Adverse Effects:** Despite its safety profile, some considerations exist. As with other leafy greens grown in fertilized agricultural areas, *S. arvensis* can accumulate nitrates, which could be a concern if consumed in very large quantities. Additionally, individuals with allergies to the Asteraceae family (e.g., ragweed, marigolds) may experience allergic reactions, though this is rare.

Further research is required to establish safe dosage levels for concentrated extracts used in a therapeutic context.

8. Biotechnological and Agricultural Importance

The perception of *S. arvensis* in agriculture is shifting from a simple pest to a plant with unique biotechnological applications.

- **Cultivation and Propagation:** While it grows rampantly in the wild, cultivating *S. arvensis* for medicinal or nutraceutical use would require standardized practices. Propagation is easily achieved via seeds or, more reliably, through rhizome cuttings. Cultivation would allow for control over growing conditions to maximize the yield of specific bioactive compounds.
- **Potential in Soil Remediation:** The deep, extensive root system of *S. arvensis* makes it a potential candidate for phytoremediation. It has been studied for its ability to grow in soils contaminated with heavy metals (e.g., cadmium, lead) and potentially accumulate them in its tissues, thereby helping to clean the soil.
- **Genetic and Tissue Culture Studies:** As a "problem weed," *S. arvensis* has been the subject of genetic studies to understand its herbicide resistance. From a biotechnological perspective, *in vitro* plant tissue culture (micropropagation and callus cultures) offers a promising method for producing large quantities of biomass and specific, high-value secondary metabolites (like sesquiterpene lactones) in a controlled lab environment, independent of climate and season.

9. Future Prospects and Industrial Applications

The body of evidence supporting the biological activity of *Sonchus arvensis* points to significant potential for its development into commercial products.

- **Pharmaceutical and Nutraceutical Development:** The most promising application lies in the development of standardized extracts for the nutraceutical market. These could be formulated into capsules, tinctures, or functional food ingredients marketed for antioxidant support, digestive health, or as a natural anti-inflammatory. Further research could lead to the isolation of novel pharmaceutical leads, particularly from its unique sesquiterpene lactones, for drug development.
- **Challenges in Standardization:** The primary hurdle is the natural variability of phytochemicals. Commercialization would require the development of standardized extracts, quantified for key marker compounds (e.g., cichoric acid or luteolin-7-O-glucoside). This requires optimized extraction techniques and robust quality control protocols.
- **Scope for Clinical Research:** To date, research is almost exclusively preclinical. The clear gap and next logical step is to move into human clinical trials to validate the safety and efficacy of *S. arvensis* extracts for specific conditions, such as metabolic syndrome, inflammatory joint disorders, or liver support.

10. Conclusion

Sonchus arvensis exemplifies the hidden value within plants often dismissed as "weeds." Its history as a traditional food and medicine is now being substantiated by modern pharmacological studies, revealing it to be a potent natural pharmacy. The plant possesses a rich profile of bioactive compounds notably phenolic acids, flavonoids, and sesquiterpene lactones that are responsible for its significant antioxidant, anti-inflammatory, hepatoprotective, and potential antidiabetic and anticancer properties.

While its aggressive, invasive nature presents real challenges in agriculture, it also offers opportunities in phytoremediation and biotechnology. The journey of *S. arvensis* from a problematic weed to a plant of interest for nutraceuticals and pharmaceuticals is well underway. Future interdisciplinary research, focusing on sustainable cultivation, extract standardization, and, most importantly, human clinical trials, is essential to unlock the full therapeutic and economic potential of this remarkable and resilient plant.

Ghosal et. al (2023) concluded that *Sonchus arvensis* extracts exhibit significant antioxidant activity, particularly the leaves extract in petroleum ether and contain various phytochemicals like phenolic compounds, tannins, and terpenoids.

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