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Phytochemical Profiling and *In Vitro* Assessment of Antioxidant and Anti-Inflammatory Activities of *Sonchus arvensis* L.

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KEYWORDS

Sonchus arvensis, phytochemicals, antioxidant activity, anti-inflammatory, HR-LCMS.

ABSTRACT:

Sonchus arvensis L., a traditionally used medicinal plant, was investigated for its phytochemical composition and in vitro antioxidant and anti-inflammatory activities. Sequential extracts (petroleum ether, chloroform, ethanol, and aqueous) were screened qualitatively and quantitatively; the ethanolic extract (SEE) showed the highest levels of flavonoids (941.67 µg/g) and phenolics (74.77 µg/g). High-resolution Liquid Chromatography-Mass Spectroscopy (HR-LCMS) profiling of the petroleum ether and ethanolic extracts identified a variety of bioactive compounds, including 7(14)- bisabolene-2,3,10,11-tetrol, Nigakilactone B, tocopherol, ganoderiol H, liquiritic acid, and delta-maslinic acid. In vitro antioxidant assays (DPPH, ABTS, hydroxyl radical, metal chelation, total antioxidant capacity, and reducing power) demonstrated that SEE exhibited the strongest scavenging and reducing activities, with ICso values ranging from ~240 to -320 µg/mL. Anti-inflammatory potential was confirmed via inhibition of albumin denaturation, human red blood cell membrane stabilization, and protease inhibitory assays; SEE showed up to -80% inhibition in membrane stabilization and ICso values between ~245 and ~251 µg/mL. These findings suggest that the mid-polar constituents of S. arvensis L. particularly in the ethanolic extract, contribute to its potent antioxidant and anti-inflammatory effects. Further in vivo studies and mechanistic analyses are warranted to assess its therapeutic potential.

Introduction:

Nature provides a wealth of herbs that have been used for the treatment of the human body. Medicinal plants have been associated with traditional medicine for hundreds of years and have been appreciated for their relative low toxicity and cost. Many modern pharmaceuticals, including cancer and antimicrobial drugs are derived from plant-derived compounds. The traditional knowledge of medicinal plants is being adopted and reinvented by modern health systems, uniting conventional and complementary/alternative medicinal practices. (Dutta et al., 2021). Medicinal plants are the source of bioactive compounds, and are the foundational component of phytomedicine (Kancherla et al., 2019), as they are frequently used to treat chronic and infectious disease states (Duraipandiyan et al., 2006). Medicinal plants are a promising source of safe, environmentally sustainable, and renewable medicines. Although many of their traditional uses have yet to be scientifically validated, testing in an appropriate scientific manner is crucial to investigate medicinal plant bioactivity and bioactive compounds (Samy et al., 2000).

Antioxidants and free radicals neutralize toxicity caused by radicals and in so doing, are also effective for the prevention and treatment of complex diseases. Plant-derived flavonoids and phenolic compounds also possess antioxidant, radical scavenging, anti-inflammatory and anticarcinogenic potential (Priya et al., 2011). Plants supply the antioxidant, anti-inflammatory agents. Oxidative stress occurs when production of radicals overwhelms antioxidant defenses leading to lipid peroxidation and inflammation (Bahramikia et al., 2009). Inflammation is a multifaceted process related to tissue repair but the phagocyte and free radical response of chronic inflammation as well as increased vascular permeabilization due to free radicals, results in more damage to the tissue (Umapathy et al.,

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2010). Therefore, antioxidants and anti-inflammatory agents derived from plants are important for protecting from oxidant damage and inflammatory states (Joseph et al., 2012).

Sonchus arvensis is a medicinal plant that is useful in treating many diseases including gout arthritis, inflammatory conditions, and various diseases associated with oxidative stress. When used as an extract, it decreases uric acid crystal-induced inflammation by blocking immune cells, like neutrophils, resulting in a decreased severity of joint damage in gout9 (Poudel et al., 2015) and (Lobo et al., 2010). In terms of active ingredient analysis, S. arvensis contains several flavonoids like luteolin and apigenin, which are known to help with antioxidant and anti-inflammatory activities and have strong demonstrated free radical quenching and anti-inflammatory effects. This makes S. arvensis effective in the treatment of oxidative stress and chronic inflammation seen in symptoms of arthritis, cardiovascular disease, and neurodegenerative diseases (Suwartiny et al., 2002). *S. arvensis* also demonstrated hepatoprotective activity through its ability to protect the liver against toxins and oxidative stress. It has demonstrated antimicrobial activity inhibiting bacterial growth as well. Traditionally, S. arvensis was used to treat digestive ailments, like ulcers and indigestion, and this is attributed to its healing and anti-inflammatory effects (Li et al., 2018). Overall, *Sonchus arvensis* offers a natural, and sustainable, and cost-effective way to provide treatment for disease in both a modern and traditional medicine sense.

Materials and Methods

Sample collection and authentication:

The medicinal plant *Sonchus arvensis* L. was collected from the Bhadra Wildlife Sanctuary in the Western Ghats, located approximately 1 km from Kuvempu University, Karnataka, India. The plant was taxonomically authenticated by Prof. V. Krishna, a taxonomist and Professor in the Department of Biotechnology, Kuvempu University, and the voucher specimen was deposited at the same institute.

Phytochemical Screening:

The phytochemical analysis was conducted to identify the major classes of compounds present in the extracts using standard qualitative tests. The tests were carried out by the modified method of Kokate et al., (2002).

Quantitative analysis of phytochemicals

Determination of total flavonoid content (TFC)

Total flavonoid content (TFC) in petroleum ether, chloroform, ethanol, and aqueous extracts of *Sonchus arvensis* L. was measured using a modified method from Ojha et al. (2018). Different concentrations of each extract were mixed with 6 µl of 5% sodium nitrite and incubated for 5 minutes at room temperature. Then, 6 µl of 10% aluminium chloride was added, followed by a 5-minute incubation. Next, 40 µl of 1 M sodium hydroxide and 48 µl of distilled water were added to the reaction mixture. Absorbance was recorded at 510 nm against a blank, and TFC was expressed as quercetin equivalents.

Equivalent (QE, mg/g of dry mass).

Determination of total phenol content (TPC)

Total phenolic content (TPC) in petroleum ether, chloroform, ethanol, and aqueous extracts of *Sonchus arvensis* L. was determined using the method of Waterhouse et al. (2002). Briefly, 50 µg of each 1 mg/ml extract was mixed with 50 µl of Folin–Ciocalteu reagent (1:10 dilution) and incubated for 5 minutes at room temperature. Then, 40 µl of 7.5% sodium carbonate was added, and the mixture was incubated for 10 minutes at 50ºC. Absorbance was measured at 750 nm against a blank using a double-beam spectrophotometer. Total phenolic content was expressed as gallic acid equivalents (GAE, mg/g dry mass).

HRLC-MS analysis of extracts

High-resolution liquid chromatography-mass spectrometry (HR-LCMS) analysis of the bioactive components in sequential solvent extracts of *Sonchus arvensis* L. was performed using an Agilent Technologies G6550A system. Chromatographic separation employed a 30-minute ± ESI 10032014_MSMS.m method at the Sophisticated Analytical Instrument Facility (SAIF), Indian Institute of Technology (IIT), Mumbai, India. A 5 µL aliquot of petroleum ether and ethanolic extracts was injected with needle wash into an Agilent ultra-high-performance liquid chromatography (UHPLC) system equipped with a Hypersil Gold C18 column (100 × 2.1 mm, 3 µm). The

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mobile phase consisted of 0.1% formic acid in water (solvent A) and acetonitrile (solvent B), delivered at 0.3 mL/min. The gradient program shifted from 95% A and 5% B to 5% A and 95% B over 50 minutes, then returned to the initial composition in 10 minutes and was held for 5 minutes to re-equilibrate the column.

Mass spectrometric detection was conducted in both positive and negative electrospray ionization (ESI) modes under the following source conditions: capillary voltage at 3500 V, nebulizer pressure of 35 psi, gas temperature of 250°C, and drying gas flow rate of 13 L/min. Compounds were identified by comparing retention times, mass-to-charge (m/z) ratios, abundance areas, and other spectral features with entries from the Metlin Library available at IIT Bombay. Data processing and analysis were performed using Agilent MassHunter software.

***In vitro* antioxidant activity**

2, 2-Diphenyl-l-picrylhydrazyl (DPPH) radical scavenging activity

Extracts of *Sonchus arvensis* L. using petroleum ether, chloroform, ethanol, and aqueous solvents were screened for free radical scavenging activity using the modified DPPH method of (Kim et al., 2001) and (Karthik et al., 2025). Different concentrations of each extract (100, 200, 300 µg/ml) at 2 mg/ml stock were mixed with 100 µl of 0.004% DPPH in ethanol and incubated in the dark at room temperature for 30 minutes. The scavenging activity was measured by absorbance at 517 nm. Butylated hydroxytoluene (BHT) was used as a standard for comparison.

DPPH Radical scavenging activity was calculated using the formula:

$$\% \text{ of inhibition} = [(A_{control} - A_{test})/A_{control}] \times 100$$

Where $A_{control}$ is the absorbance of the control and A_{test} is the absorbance of the extract reaction. IC_{50} value was calculated using the formula: $IC_{50} = [(\Sigma C/\Sigma I) \times 50]$, where ΣC is the sum of extracts and pure compounds used to test and ΣI is the sum of the percentage of inhibition at different concentrations.

ABTS radical scavenging assay

The ABTS radical scavenging activity was measured using a method of Re et al. (1999), based on the reduction of the ABTS radical cation ($ABTS^{\bullet+}$) to its colorless form. The $ABTS^{\bullet+}$ radical was generated by reacting 7 mM ABTS with 2.45 mM potassium persulfate (1:1) and incubating in the dark at 27°C for 16 hours until reaching an absorbance of ~0.700 at 734 nm. This solution was then diluted with ethanol to maintain this absorbance. Plant extracts at concentrations of 50, 100, 150, and 200 µg/ml were mixed with 160 µl of the diluted $ABTS^{\bullet+}$ solution and absorbance was recorded at 734 nm after 30 minutes. To confirm reliability, all samples were tested in triplicate with appropriate solvent blanks.

Percent inhibition of absorbance at 734 nm was calculated using the formula, ABTS•+ scavenging effect (%) = ((AB –AA)/AB) ×100 (2), where AB is absorbance of ABTS radical + methanol; AA is absorbance of ABTS radical + sample extract/standard

Hydroxyl radical scavenging activity

The hydroxyl radical scavenging activity of petroleum ether, chloroform, ethanol, and aqueous extracts of *Sonchus arvensis* L. was measured using a modified method based on Hussien et al. (2011). Extracts at 2 mg/ml were prepared at concentrations of 100–500 µg/ml. To each sample, iron-EDTA solution, 15 µl of 0.018% EDTA, and 30 µl of 0.85% DMSO in phosphate buffer (pH 7.4) were added. The reaction was initiated with 15 µl of 0.22% ascorbic acid, and tubes were incubated at 80–90°C in a water bath. After 15 minutes at room temperature, the reaction was stopped with 30 µl of 17.5% trichloroacetic acid (TCA). Then, 100 µl of Nash reagent was added and incubated for 15 minutes at room temperature to develop a yellow complex. Hydroxyl radical scavenging activity was measured by absorbance at 412 nm against a blank.

The percentage hydroxyl radical scavenging was calculated by the formula, % of inhibition = 1 - $[A_{sample}/A_{blank}]$ x 100, where A sample is the extract containing the reaction mixture absorbance; Ablank is the blank absorbance. The IC50 value was calculated using the formula: $IC_{50} = [(\Sigma C/\Sigma I) \times 50]$, where ΣC is the sum of the test samples concentrations used to test and ΣI is the sum of the percentage of inhibition at different concentrations.

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Metal chelating activity

Metal chelating activity was determined using the method of Islam et al. (2016). Plant extracts at 2 mg/ml were prepared at concentrations of 100–500 µg/ml and added to separate wells. To each well, 10 µl of 2 mM ferrous chloride and 40 µl of 5 mM ferrozine were added. The mixtures were incubated in the dark at room temperature for 10 minutes. Absorbance was measured at 562 nm against a blank. Ascorbic acid served as the standard. Metal chelating activity (%) was calculated using the formula:

% inhibition = t($A_{control}$ - A_{test})/$A_{control}$] x 100, where $A_{control}$ is the control reaction absorbance and A_{test} is the test sample reaction absorbance. IC_{50} value was calculated using the formula: IC_{50} = [(ΣC/ΣI) x 50], where ΣC is the sum of the extracts/isolated constituents concentration used to test and ΣI is the sum of the percentage of inhibition at different concentrations.

Total reductive power Assay:

The reducing power of petroleum ether, chloroform, ethanol, and aqueous extracts of *Sonchus arvensis* L. was measured using the method of Apak et al. (2018). Extracts at concentrations from 10 to 50 µg/ml were mixed with 50 µl of 20 mM phosphate buffer (pH 6.6) and 50 µl of 1% potassium ferrocyanide. The mixture was incubated at 50°C for 30 minutes. Then, 50 µl of 10% trichloroacetic acid and 10 µl of 0.1% ferric chloride were added, followed by a 10-minute incubation at room temperature. Absorbance was recorded at 700 nm, with higher absorbance indicating greater reducing power. Ascorbic acid was used as a standard, and phosphate buffer as the blank.

Determination of total antioxidant capacity:

The total antioxidant activity of methanol extracts was evaluated using the phosphomolybdenum method (Prieto et al., 1999). This assay measures the reduction of Mo(VI) to Mo(V) by antioxidants, forming a green phosphate/Mo(V) complex at acidic pH. Briefly, 100 µL of plant extract was mixed with 50 µL of reagent solution (0.6 M sulfuric acid, 28 mM sodium phosphate, and 4 mM ammonium molybdate) and incubated at 95°C for 90 minutes. After cooling to room temperature, absorbance was measured at 695 nm against a methanol blank. Ascorbic acid was used as a standard, and results are expressed as milligrams of ascorbic acid equivalent per gram of dry extract.

***In vitro* anti-inflammatory activity:**

Inhibition of albumin denaturation:

The anti-inflammatory activity of *Sonchus arvensis* L. was evaluated using the inhibition of albumin denaturation method, based on Chandra et al. (2012). with slight modifications. Test extracts were mixed with 1% bovine serum albumin (BSA) solution, and the pH was adjusted with 1N HCl. Samples were incubated at 37°C for 20 minutes, then heated at 51°C for 20 minutes to induce denaturation. After cooling, turbidity was measured at 660 nm to determine the inhibition of albumin denaturation, indicating the anti-inflammatory potential.

The Percentage inhibition of protein denaturation was calculated as follows: Percentage inhibition = ($Abs_{Control}$ – Abs_{Sample}) X 100/ $Abs_{control}$.

Human red blood cell (HRBC) membrane stabilization assay:

The *in vitro* anti-inflammatory activity of plant extracts was evaluated using the human red blood cell (HRBC) membrane stabilization method (Sharma et al., 2018). Blood from healthy volunteers (free from NSAIDs for two weeks) was collected and, mixed with an equal volume of sterilized Alsever solution, and centrifuged to isolate RBCs. The cells were washed three times with isosaline and prepared as a 10% suspension. The assay mixture contained 50 µl phosphate buffer (0.15 M, pH 7.4), 100 µl hypo saline, 25 µl HRBC suspension, and 50 µl plant extract or standard drug diclofenac sodium at various concentrations. Distilled water was used as a control to induce 100% hemolysis. After incubation at 37°C for 30 minutes and centrifugation at 3000 rpm for 20 minutes, hemoglobin release was measured at 560 nm to assess membrane stabilization.

Proteinase Inhibitory Activity

Proteinase inhibitory activity was assessed following a modified Leelaprakash et al. (2011) protocol. The reaction mixture (2 mL) contained 0.06 mg trypsin, 1 mL of 20 mM Tris-HCl buffer (pH 7.4), and 1 mL test sample (0.02 mL extract in 0.98 mL methanol). After incubation at 37 °C for 5 min, 1 mL of 0.8% casein

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was added, followed by a 20 min incubation. The reaction was terminated with 2 mL 70% perchloric acid, centrifuged, and absorbance of the supernatant measured at 210 nm against buffer blank. Phosphate buffer served as control.

Results and Discussions:

Table 1: Phytochemical analysis:-

Tests	**Qualitative analysis**				**Quantitative analysis**			
Extracts	**SPE**	**SCE**	**SEE**	**SAE**	**SPE**	**SCE**	**SEE**	**SAE**
Alkaloids	-	-	-	-				
Flavonoids	+	+	+	+	528.332 µg/g	408.74 µg/g	**941.666 µg/g**	515 µg/g
Tannins	+	-	+	-				
Saponins	-	-	-	-				
Phenolics	+	-	+	+	52.19 µg/g	45.03 µg/g	**74.77 µg/g**	63.51 µg/g
Cardiac Glycosides	+	-	+	-				
Terpenoids	+	+	+	+				

SPE-petroleum ether extract, SCE- Chloroform extract, SEE- Ethanol extract, SAE- Aqueous extract.

The findings reveal that the ethanolic extract of *Sonchus arvensis* L. (SEE) exhibits the highest phytochemical richness, both in terms of qualitative diversity and quantitative concentration. Qualitative screening indicated the presence of flavonoids and terpenoids across all extracts, while alkaloids and saponins were absent. Tannins and cardiac glycosides were exclusively detected in the petroleum ether (SPE) and ethanolic (SEE) extracts, whereas phenolics were identified in SPE, SEE, and the aqueous extract (SAE). Quantitative analysis further confirmed that SEE contained the highest concentrations of flavonoids (941.67 µg/g) and phenolics (74.77 µg/g) among the tested extracts.

HR-LCMS analysis:

HR-LCMS Profiling of ethanol and petroleum ether extracts of *Sonchus arvensis* L. The yield of petroleum ether and ethanol Soxhlet extracts of S. arvensis. was higher compared to chloroform and aqueous extracts. Therefore, ethanol extracts and petroleum ether extracts were subjected to HR-LCMS phytochemical profiling. The compounds analyzed by HR-LCMS were identified by comparison with their retention time (RT), mass, abundance area and m/z cloud best match with the stored Metlin Library available with IIT, Bombay. The mass spectrometric analysis was done using Agilent Mass Hunter software. Phytoconstituents of S. arvensis petroleum ether and ethanolic extract obtained from HR-LCMS.

Fig 1: HR-LCMS profiling of *Sonchus arvensis* plant extract showing positive ion mode chromatogram

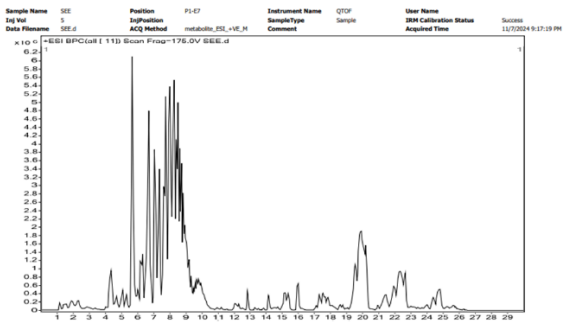

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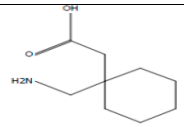
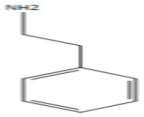
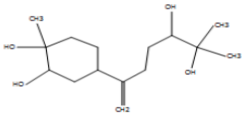
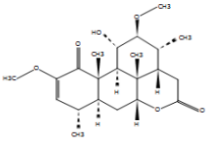
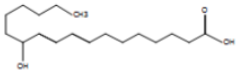
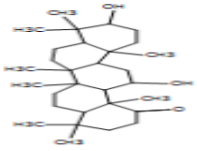
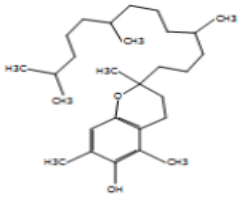
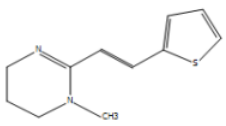
Table.2: Phytochemicals of *S. arvensis* extract obtained from HR-LCMS mode

Compounds	Formula	RT	Mass (DB)	DB Hits	Structure
Gabapentin	$C_9H_{17}NO_2$	1.531	171.1268	10	
Phenyl ethylamine;	$C_8H_{11}N$	4.229	121.0796	10	
7(14) Bisabolene-2,3,10,11tetrol	$C_{15}H_{28}O_4$	14.527	272.195	8	
Nigakilactone B	$C_{22}H_{32}O_6$	16.082	329.2191	10	
12-Hydroxy 8,10-octadecadienoic acid	$C_{18}H_{32}O_8$	20.001	296.2324	10	
Coriandrinonediol	$C_{30}H_{50}O_3$	21.79	458.3712	10	
z2-Tocopherol	$C_{28}H_{48}O_2$	22.602	412.3615	10	
Pyrantel	$C_{11}H_{14}N_2S$	9.438	206.0885	10	

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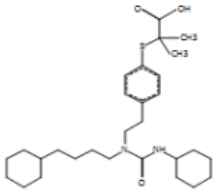
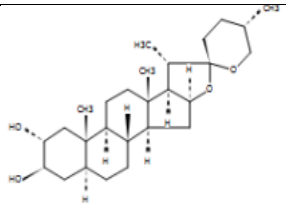
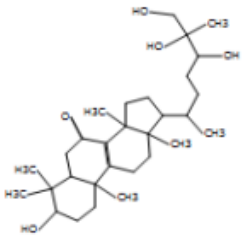
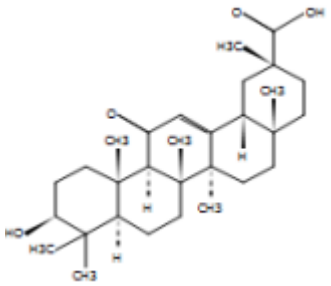
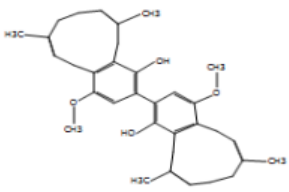
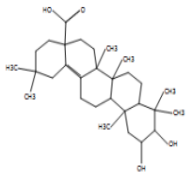
GW 7647	C_{29} H_{46} N_2 O_3 S	16.688	502.3258	10	
Neogitogenin	C_{27} H_{44} O_4	17.76	432.3205	9	
Ganoderiol H	C_{30} H_{50} O_5	17.34	490.3698	10	
Liquiritic acid	$C_{30}H_{46}$ O_4	18.73	470.3364	10	
Ganodermatriol;	C_{30} H_{48} O_3	22.146	456.3576	**9**	
delta-Maslinic acid	C_{30} H_{48} O	22.308	472.3522	**10**	

The HRLCMS analysis of the *Sonchus arvensis* L. plant extract identified a diverse range of bioactive compounds with substantial therapeutic potential as mentioned in Table 2. Among these, gabapentin, a widely used drug for managing neuropathic pain syndromes, was noted (Nicholson, 2000).

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Phenylethylamine, another identified compound, has been linked to enhancing athletic performance and addressing conditions like depression and obesity (Kaur et al., 2016).7(14)-bisabolene-2,3,10,11-tetrol, known for its anti-inflammatory, antibacterial, antiviral, antitumor, and anti-obesity properties, was found to be a significant bioactive agent with anti-inflammatory properties and neuroprotective properties (Jiang et al., 2021). Other compounds like Nigakilactone B have demonstrated insecticidal activity, appetite stimulation, and gastric acid secretion inhibition, alongside anti-inflammatory and blood pressure-lowering effects (Jamil et al., 2020). 12-Hydroxy-8,10-octadecadienoic acid serves as an antineoplastic, anti-inflammatory, and bacterial xenobiotic metabolite. (Vangaveti et al., 2010). Tocopherol, a natural antioxidant and vital component in vegetable oils, was also identified, supporting its role as a dietary supplement for treating vitamin E deficiency and reducing oxidative stress and acting as an antioxidant agent (DrugBank). Pyrantel treats pinworms and helps detect anthelmintic resistance (Kopp et al., 2008). GW 7647 is a lipid-lowering and anti-inflammatory agent that supports mitochondrial enzyme expression and aids in Alzheimer's treatment (Nandhikonda et al., 2013). Neogitogenin from shows potential as a COVID-19 therapeutic with antiherpes, antioxidant and anticancer properties (Elasbali et al., 2024). Ganoderiol H exhibits cytotoxic, antitumor, and anti-inflammatory effects (Lin et al., 2019). Liquiritic acid addresses gastrointestinal issues, dermatitis, hepatitis, and pain, and serves as a flavouring agent, with glycyrrhizic acid providing anti-inflammatory and liver-protective benefits (Wang et al., 2019). Ganodermatriol acts as an antioxidant, antimicrobial, immune activator, and tumour suppressor. (jedinak et al., 2011). Delta-Maslinic acid offers anti-inflammatory, antioxidant, liver-protective, muscle-building, neuroprotective, antitumor, antidiabetic, antiparasitic, and cardioprotective properties (Hey et al., 2022)

***In vitro* antioxidant activity:**

The antioxidant activity of the extracts (SPE, SCE, SEE, SAE) was evaluated using DPPH, Metal Chelating, ABTS, and Hydroxyl Radical Scavenging Assays. The percentage of inhibition and IC_{50} values for each extract were determined and compared with the standard.

Sonchus arvensis extracts showed notable antioxidant activity across multiple assays. The ethanolic extract (SEE) exhibited the highest activity, with IC_{50} values of 248.86 µg/mL (DPPH), 244.21 µg/mL (metal chelating), 241.92 µg/mL (ABTS), and 317.41 µg/mL (hydroxyl radical scavenging). SAE showed moderate activity (IC_{50} ranging from 333.96 to 382.51 µg/mL), while SPE and SCE had higher IC_{50} values, indicating lower antioxidant potential. Although the standard antioxidants demonstrated superior activity, the strong performance of SEE is attributed to its rich phenolic and flavonoid content, which are crucial for free radical scavenging. Studies have demonstrated notable antioxidant activities in various Sonchus species. Similarly, in *Sonchus oleraceus*, the ethanol extract showed significant DPPH radical scavenging activity with an IC_{50} value of 56.5 µg/mL. (Yin et al.,2007), The standard exhibited a potent activity with an IC_{50} value of 282.7 µg/mL, These findings underscore the potential of Sonchus species as natural sources of antioxidants. These results support the therapeutic potential of *Sonchus arvensis* as a natural antioxidant source useful in combating oxidative stress-related diseases as mentioned in table 3.

Table 3: In vitro anti-oxidant activity of *Sonchus arvensis* L. extracts:

Activity	Conc	% of Inhibition				IC50 of Extracts				Standard IC50
		SPE	SCE	SEE	SAE	SPE	SCE	SEE	SAE	
DPPH	100	23.47	23.15	37.29	32.15	344.30	356.36	248.858	338.055	124.87
	200	37.29	36.91	49.833	44.69					
	300	47.58	48.87	54.66	48.25					

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	400	55.94	55.62	58.84	54.98					
	500	64.30	59.48	66.55	58.06					
Metal Chelating	100	24.05	7.046	37.54	17.98	353.88	387.04	244.21	360.87	109.21
	200	42.52	22.35	39.85	37.54					
	300	50.49	32.07	57.10	44.22					
	400	55.40	50.19	67.31	55.28					
	500	60.87	65.96	79.22	61.60					
ABTS Assay	100	17.56	14.07	21.19	10.88	345.26	394.89	241.92	333.96	111.9
	200	27.283	24.87	33.67	24.23					
	300	41.21	38.89	45.57	40.20					
	400	56.45	54.71	56.74	67.34					
	500	74.74	61.28	82.87	77.64					
Hydroxyl radical scavenging assay	100	10.74	7.43	21.48	9.91	377.05	401.874	317.41	382.51	282.7
	200	26.44	19.00	35.53	21.48					
	300	38.84	38.01	48.76	42.97					
	400	52.06	49.56	59.503	52.06					
	500	67.76	60.33	73.551	65.28					

SPE- petroleum ether extract; **SCE**- Chloroform extract; **SEE**- Ethanol extract; **SAE**- Aqueous extract

Table 4: total antioxidant and total reducing power assay of different extracts of *Sonchus arvensis:*

Tests	**SPE**	**SCE**	**SEE**	**SAE**
Total antioxidant	474 mg AAE/g	407.3334 mg AAE/g	1680.666 mg AAE/g	600.666 mg AAE/g
Total reducing power assay	646.8 mg QE/g	422.9 mg QE/g	962.5 mg QE/g	653.8 mg QE/g

SPE- petroleum ether extract; **SCE**- Chloroform extract; **SEE**- Ethanol extract; **SAE**- Aqueous. The The total antioxidant and reducing power activities of *Sonchus arvensis* L. extracts were evaluated using standard *in vitro* assays. Among the four extracts, the ethanol extract (SEE) showed the highest antioxidant capacity **(**1680.67 mg AAE/g**)** and reducing power **(**962.5 mg QE/g**),** significantly surpassing SPE, SCE, and SAE as mentioned in table 4. These results suggest that the ethanol extract contains the highest levels of antioxidant constituents and may serve as a potent natural source of antioxidant activity. *Sonchus arvensis* L. exhibits strong antioxidant and anti-inflammatory properties, attributed to its diverse and rich phytochemical composition. High-Resolution Liquid Chromatography-Mass Spectrometry (HR-LCMS) analysis revealed the presence of key bioactive compounds, including 7(14)-bisabolene-2,3,10,11-tetrol, Nigakilactone, Tocopherol, Ganoderiol H, Glycyrrhizic acid, Ganodermatriol, and Delta-Maslinic acid. These constituents are known for their potent free radical scavenging activity and ability to modulate inflammatory pathways, thus supporting the ethnomedicinal use of the plant.

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Table 5: *In vitro* anti-inflammatory activity of *Sonchus* arvensis L. extracts:

Activity	Conc	% OF Inhibition				IC50 of Extracts				
		SPE	SCE	SEE	SAE	SPE	SCE	SEE	SAE	Standard IC50
Inhibition of albumin denaturation	100	21.25	22.45	27.12	24.48	376.98	397.16	248.85	335.2	124.87
	200	35.15	34.24	37.15	32.27					
	300	42.84	43.21	48.66	41.21					
	400	49.54	52.36	56.75	50.16					
	500	56.87	54.32	68.45	55.62					
HRBC) membrane stabilization assay	100	24.05	7.046	37.54	17.96	353.88	387.04	244.21	309.8	109.21
	200	32.52	22.35	39.85	34.35					
	300	50.49	32.07	57.10	42.98					
	400	55.40	50.19	67.31	55.93					
	500	60.87	65.96	79.22	67.94					
Protease inhibitory assay	100	17.56	14.07	21.19	15.23	378.23	408.89	250.92	302.7	160.9
	200	27.283	24.87	33.67	26.87					
	300	41.21	38.89	45.57	40.85					
	400	56.45	54.71	56.74	50.71					
	500	74.74	61.28	82.87	65.58					

SPE- petroleum ether extract, SCE- Chloroform extract, SEE- Ethanol extract , SAE- Aqueous extract.

The anti-inflammatory activity of four *Sonchus arvensis* extracts petroleum ether (SPE), chloroform (SCE), ethanol (SEE), and aqueous (SAE) was assessed using three in vitro models: inhibition of albumin denaturation, HRBC membrane stabilization, and protease inhibition assays. All extracts showed concentration-dependent activity, with the ethanol extract (SEE) demonstrating the greatest efficacy. SEE achieved maximum inhibition of 68.45% in albumin denaturation at 500 µg/mL and had the lowest IC_{50} value (248.85 µg/mL) compared to SPE, SCE, and SAE. Similarly, in the HRBC membrane stabilization assay, SEE showed 79.22% inhibition with an IC_{50} of 244.21 µg/mL, outperforming other extracts. Protease inhibition results further confirmed SEE's superior activity with 82.87% inhibition and an IC_{50} of 250.92 µg/mL. Although the standard anti-inflammatory drug exhibited lower IC_{50} values (109.21–160.9 µg/mL), SEE was the most potent among the plant extracts tested. Previous comparative Studies have demonstrated notable anti-inflammatory activities in *Sonchus arvensis* and in other species of Sonchus.

Similarly, The *Sonchus oleraceus* displays considerable anti-inflammatory action by alleviating paw edema, reducing peritonitis and febrile response induced by lipo polysaccharide, and decreasing granulomatous tissue growth. The mechanism of the effect may be due to the presence anti-inflammatory substances such as flavonoids and sesquiterpenes. which are present in *Sonchus oleraceus*. (Vilela et al., 2010)

These findings indicate that the *Sonchus*

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arvensis L. contains bioactive compounds with strong anti-inflammatory potential, meriting further phytochemical and pharmacological studies.

Conclusion:-

The present study establishes the significant antioxidant and anti-inflammatory potential of *Sonchus arvensis* L. ethanolic extract (SEE), as demonstrated by its pronounced activity in DPPH and FRAP antioxidant assays, as well as in protein denaturation, albumin denaturation, and HRBC membrane stabilization anti-inflammatory models. This bioactivity is likely attributed to the presence of mid-polar phytochemicals such as flavonoids, phenolics, tannins, and saponin compounds, well-recognised for their free radical scavenging and inflammation-modulating properties. Phytochemical screening confirmed the abundance of these secondary metabolites, supporting the extract's ability to inhibit oxidative stress and inflammatory processes. Although the standard drug exhibited slightly greater efficacy in anti-inflammatory assays, SEE consistently showed dose-dependent inhibitory effects with low IC_{50} values, underscoring its pharmacological relevance. Collectively, the phytochemical and pharmacological findings highlight *Sonchus arvensis* L. plant as a promising natural candidate for the development of antioxidant and anti-inflammatory therapeutics. However, further *in vivo* studies and mechanistic investigations are essential to validate its efficacy and assess its clinical safety and therapeutic potential.

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