

RESEARCH PAPER

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An investigation of phytochemical constituents and pharmacological activities of *Strobilanthes andamanensis* leaf extractDeepika¹, V. Ambikapathy^{*1}, S. Babu¹, A. Panneerselvam²

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Key words: *Strobilanthes andamanensis* leaf, Solvents, Phytochemical, Antioxidant and anti-inflammatory activity

DOI: <https://dx.doi.org/10.12692/jbes/27.4.86-94>

[Published: October 15, 2025]

ABSTRACT

In the present investigation, *Strobilanthes andamanensis* leaf samples were collected from Andaman Nicobar Island. The leaf samples were powdered and worked out in phytochemicals, *in vitro* antioxidant and anti-inflammatory activity analyzed. Four different solvent extracts (aqueous, chloroform, ethanol and hexane) were analyzed for phytochemicals, the ethanol extract found in Amino acids, Alkaloids, Coumarins, Flavonoids, Glycosides, Phenols, Saponins, Steroids, Tannins, Terpenoids & Triterpenoids and absence in Phlobatannins & Quinones than compared to other solvents. Quantitative phytochemicals recorded ranges in between 03.55 ± 0.28 to 11.80 ± 0.03 $\mu\text{g}/100\text{ mg}$ in ethanol extract. In antioxidant activity, reducing power assay recorded in maximum percentage of activity in ethanol extract (25.96 ± 0.12 %) in $300\text{ }\mu\text{g}/100\text{ ml}$ concentration followed by other solvents as well as DPPH assay. *In vitro* anti-inflammatory activity measured in regression coefficient value (R^2) 0.9998 in standard, 0.3355 in aqueous and 0.1199 in ethanol leaf extract of *S. andamanensis*. The results were recorded in future work.

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INTRODUCTION

Plants are vital part of biodiversity and very rich source of medicinal agents for treating various diseases including infections and inflammatory diseases (Nunes *et al.*, 2020). Plants are act as medicinal agents is attributed to the various secondary metabolites. Phytomedicines are essential components of primary health care around the world (Srivastava *et al.*, 2019).

Otherwise, phytochemicals are bioactive non-nutrient compounds produced by plants that provide health benefits, acting as antioxidants, anti-inflammatory and antimicrobials. They are originated abundantly in fruits, vegetables and grains; categorized in primary and secondary compounds. Chlorophyll, carotenoids, proteins and common sugars are included in primary constituents and secondary compounds have terpenoid, alkaloids and phenolic compounds (Krishnaiah *et al.*, 2007). Secondary metabolites are chemically and taxonomically extremely diverse compounds with obscure function. They are widely used in human therapy, veterinary, agriculture, scientific research and countless other areas observed by the Mahato and Sen (1997). Medicinal plants containing bioactive compounds used in herbal medicine for their therapeutic properties, with applications in traditional and modern healthcare systems worldwide. They possess natural compounds, called phytochemicals which provide antibacterial, antiviral, antifungal, and other pharmacological effects to treat diseases, improve health, or serve as precursors for conventional drugs.

The Andaman and Nicobar Islands by virtue of unique climatic factors and location are considered as one of the hotspots of the world's biodiversity. *Strobilanthes andamanensis*, known as the Andaman Coneflower, is a unique shrub from the Andaman Islands characterized by its bright yellow flowers *Strobilanthes andamanensis* is used as an ornamental plant in gardens and as a houseplant, and in traditional medicine by local tribes for fever, skin diseases, and to address issues like blood in urine and coughs. *S. andamanensis* specifically is limited in the provided snippets, the broader *Strobilanthes* genus has shown potential for various therapeutic

properties, including antioxidant, anti-inflammatory and antimicrobial activities.

MATERIALS AND METHODS

Plant material collection

The leaves of *Strobilanthes andamanensis* was collected from several tropical rainforest areas in the Andaman Islands.

Preparation of extract

S. andamanensis leaves samples are dried in shadow sunlight and powdered in electrical machine. Fifty gram of powdered *S. andamanensis* leaf was extracted for 72 hrs with different solvents aqueous, chloroform, ethanol and hexane in a Soxhlet extractor. Whatman filter paper No. 1 was used to filter the extract. A vacuum rotary evaporator (40–45°C) was used to evaporate the filtrate (Jayakar *et al.*, 2020).

Qualitative phytochemical analysis of *Semecarous andamanensis* leaf

Table 1 provides a clear overview of methods, reactions, and characteristic outcomes used for the preliminary screening of secondary metabolites in plant samples.

Quantitative phytochemcial analysis of *S. andamanensis* leaf

Alkaloids

Five gram of the sample was weighted into a 250 ml beaker. 200 ml of 10% acetic acid in ethanol was added and allowed to stand for 4 hours. This was filtered and extract was concentrated on a water-bath to one quarter of the original volume. Concentrated ammonium hydroxide was added drop by drop to the extract to get precipitation. The whole solution was allowed to settle down and the precipitate was collected and washed with diluted ammonium hydroxide and filtered. The residue was may be alkaloid that was dried and weighed. From this alkaloid content was determined (Harborne, 1998).

$$\text{Alkaloids Content (\%)} = B - A \times 100 / S$$

Where, B = Weight of Whatmann filter paper.

A = Weight of Whatmann filter paper, after drying.

S = Sample weight.

Aminoacids

Table 1. Qualitative analysis (Harbone, 1989)

Test name	Solution	Inference
Amino acids	1ml extracts + added few drops of ninhydrin reagent and vortex. Place the test tube in a boiling water bath for 5 minutes and cool to room temperature	Blue colour formation
Alkaloids	3 ml extract + 3 ml of 1% HCl on steam bath + few drops of Dragendorff's reagent	Orange red precipitated
Coumarins	2 ml extract + few drops of NH ₃ solution	Fluorescence observed
Flavonoids	5 ml of the dil. NH ₃ solution + conc. H ₂ SO ₄	Appearance of yellow color
Glycosides	4 mL extract + 2 mL + NH ₃ OH	Appearance of cherish red color
Phenols	2ml extract + few drops of 10% ferric chloride	Formation of blue or green color
Phlobatannins	1 ml extract + 2 ml of conc. H ₂ SO ₄	Formation of red color, particularly at the junction between the layers
Quinones	1 ml extract + conc. H ₂ SO ₄	Appearance of the colour formation
Saponins	2 gm powder was boiled in 20 ml of distilled water in a water-bath and filtered. The filtrate was mixed with 5 ml of distilled water and shaken vigorously + 3 drops of olive oil and shaken vigorously	Formation of emulsion
Steroids	1 ml extract + 2 ml of acetic anhydride + two ml sulphuric acid	Colour changes from violet to green
Tannins	0.5 gm of dried powder was boiled in 20 ml of water in a test tube and then filtered + few drops of 0.1% Ferric chloride	Appearances of brownish green colour
Terpenoids	5 ml extract + 2 ml of chloroform + 3 ml of concentrated H ₂ SO ₄	Formation of reddish brown color
Triterpenoids	Extract + 1ml of Libermann-Buchard reagent	Appearance of bluish-green color

Pipette out 1ml of *S. andamanensis* leaf extract and now added 1ml of ninhydrin reagent to all the test tubes. Mix the contents of the tubes by vortexing /shaking the tubes. Put a few marble chips in each tube. Cover the mouth of the tubes with aluminium foil. Place all the test tubes in boiling water bath for 15 minutes. Cool the test tubes in cold water and add 1ml of ethanol to each test tube and mix well. Now record the absorbance at 570 nm of each solution using a colorimeter (Meyer, 1957).

Coumarins

The Aluminum Chloride (AlCl₃) colorimetric method for quantifying coumarins is based on the principle that coumarins form a complex with AlCl₃, which exhibits maximum absorbance at around 415 nm. In this method, a 2% AlCl₃ solution in ethanol is used as the reagent, and a known coumarin standard is employed to prepare a calibration curve. The procedure involves mixing the plant extract with the AlCl₃ solution and allowing the mixture to incubate at room temperature for 10–15 minutes to ensure complete complex formation (Sethna and Shah, 1945).

After incubation, the absorbance of the solution is measured at 415 nm, and the coumarin content in the sample is determined by comparison with the standard

curve, providing a simple and effective means for quantitative analysis of coumarins in plant extracts

Flavonoids

About 100 mg of tannic acid was dissolved in distilled water and the volume was made up to 100 ml. Different concentrations of the standard was obtained by appropriate dilution with distilled water, read at 510 nm and the values were plotted to made standard graph. In a test tube, 0.5 ml of *S. andamanensis* leaf extract of sample was diluted with 3.5 ml of distilled water at zero time. 0.3 ml of 5% sodium nitrate was added to the tube. After five minutes, 0.3 ml of 10% aluminium chloride was added. Then 2 ml of 1M sodium hydroxide was added to the mixture. Immediately, the content of the reaction mixture was diluted with 2.4 ml of distilled water and mixed thoroughly. Tannic acid was used as standard compound for quantification of total flavonoids as mg / 100g of edible portion (Min and Chun, 2005).

Glycosides

10 gram of dried plant powder was extracted with 250 ml methyl alcohol in soxhlet extractor. Another wash was also carried out with same solvent, filtered and Alcoholic extract was then treated with lead acetate solution to precipitate tannins, proteins, coloring matter

and other non-glycosidal parts. The precipitate formed was filtered and to the filtrate H₂S gas (HCl + ferrous sulphide) was passed to precipitate excess lead as lead sulphide and removed by filtration and Filtrate was evaporated to dryness on water bath. The residue was dried, collected and weighed to get total glycoside content (Solich *et al.*, 1992).

Phenolic compounds

The 0.5 ml/g of extract was taken in test tubes. Eight ml of distilled water and 0.5 ml of Folin's Ciocalteu reagent were added to all tubes. The tubes were kept in BOD incubator at 40°C for 10 minutes. Then, 1 ml of sodium carbonate solution was added and the tubes were kept in dark for incubation for an hour. The colour development was read spectrophotometrically at 660 nm. Standard graph was drawn using tannic acid as standard (Ainsworth *et al.*, 2007).

Saponins

About one ml of test samples were mixed with 80% methanol in 2ml, then add 2ml of 72% sulphuric acid solution was added, mixed well and heated on a water bath at 60°C for 10 minutes, absorbance was measured at 544 nm against reagent blank. Diosgenin is used as a standard material and compared the assay with Diosgenin (concentration 20 µg) equivalents. The results were expressed as mg/100g of saponin content, calculated using the following equation (Trease and Evans, 1989).

Steroids

About one ml of extract of different solvents acetone, ethanol was transferred into 10 ml volumetric flasks. Sulphuric acid (4N, 2ml) and iron (III) chloride (0.5% w/v, 2 ml), were added, followed by potassium hexacyanoferrate (III) solution (0.5% w/v, 0.5 ml). The mixture was heated in a water-bath maintained at 70±20°C for 30 minutes with occasional shaking and made up to the mark with distilled water. The absorbance was measured at 780 nm against the reagent blank. β-Estradiol is used as a standard material and compared the assay with β-Estradiol (concentration 20 µg) equivalents (Chanwitheesuk *et al.*, 2005).

Tannins

Powdered sample weight 0.5 gm was transferred to 250 ml conical flask and 75 ml water was added. The flask was heated gently and boiled for 30 min. The samples run at 2,000 rpm for 20 min. The supernatant was collected in 100 ml volumetric flask and made up the volume (Fagbemi *et al.*, 2005).

One ml of the sample was added to 100 ml volumetric flask containing 75 ml water. 5 ml of folins reagent and 10 ml of sodium carbonate solution was added and diluted to 100 ml with water. The mixture was shaking well. Absorbance was read at 700 nm after 30 min.

Terpenoids

The different plant extracts was extracted with 10mL of petroleum ether using separating funnel. The ether extract was separated in pre-weighed glass vials and waited for its complete drying (wf). Ether was evaporated and the yield (%) of total terpenoids contents was measured by the formula (wi-wf/wi×100) (Indumathi *et al.*, 2014).

Triterpenoids

A quantitative assay for triterpenoids uses the vanillin–perchloric acid colorimetric reaction: triterpenoids in an extract react with vanillin (in glacial acetic acid) in the presence of perchloric acid to give a pink–red chromogen. Prepare your plant extract in methanol or ethanol, take a measured aliquot, add an equal volume of 5% vanillin in glacial acetic acid, then carefully add perchloric acid, incubate the mixture in a 60 °C water bath for 10–15 minutes, cool to room temperature and measure absorbance against a reagent blank at 548–550 nm. Construct a standard curve using a known triterpenoid standard (e.g., ursolic or oleanolic acid) processed the same way, and calculate total triterpenoid content from the curve (expressed as mg standard equivalents per g sample). Handle perchloric acid and heated reagents with appropriate PPE and in a fume hood (Hiai *et al.*, 1976).

Antioxidant activity of *Strobilanthes andamanensis*

DPPH assay

The DPPH (2, 2-diphenyl-1-picrylhydrazyl) is a stable free radical, due to the delocalization of the spare electron on the whole molecule. Thus, DPPH does not dimerize, as happens with most free radicals. A solution of 0.1 mM DPPH in methanol was prepared and 2.4 mL of this solution was mixed with 1.6 mL of different plant extracts at different concentrations (100-500 µg/ml) (Brand *et al.*, 1995). The reaction mixture was vortexed thoroughly and left in the dark at RT for 30 min. The absorbance of the mixture was measured spectrophotometrically at 517 nm. Ascorbic acid was used as reference. Percentage DPPH radical scavenging activity was calculated by the following equation:

$$\% \text{ DPPH radical scavenging activity} = \{(A_0 - A_1)/A_0\} \times 100\%$$

Where A_0 is the absorbance of the control, and A_1 is the absorbance of the extractives/standard. Then % of inhibition was plotted against concentration, and from the graph. The experiment was repeated three times at each concentration.

Hydrogen peroxide scavenging (H_2O_2) assay

The ability of the aqueous and methanol extracts to scavenge hydrogen peroxide was determined according to the method of solution of hydrogen peroxide (40 mM) was prepared in phosphate buffer (pH 7.4). Different concentrations of extract of *S. andamanensis* leaf extract (100, 200, 300, 400 and 500 µg/mL) were chosen for *in-vitro* antioxidant activity (Zhu *et al.*, 2025).

Ascorbic acid was used as the standard. The different concentrations were added to a hydrogen peroxide solution (0.6 mL, 40mM). Absorbance of peroxide at 230 nm decided ten minutes later against a blank answer containing the phosphate buffer while not peroxide. The percentage of hydrogen peroxide scavenging of *S. andamanensis* leaf extracts and standard compounds were calculated.

$$\% \text{ Scavenged } [H_2O_2] = [(AC - AS)/AC] \times 100$$

Anti-inflammatory activity

This Bovine serum albumin suspension was used for the estimation of anti-inflammatory property. BSA solution (0.4%, w/v) was prepared in Tris Buffered Saline (one tablet is dissolved in 15 mL of deionized water to yield 0.05M Tris and 0.15M sodium chloride, pH 7.6 at 25° C). The pH was adjusted to 6.4 with glacial acetic acid. Respective aliquots of 100 – 500 µg/ml concentration of different extract of *S. andamanensis* were added to test tubes containing 1 mL of 0.4%, w/v BSA buffer solution. Both negative and positive (Diclofenac Sodium) controls were assayed in a similar manner. The solutions were then heated in a water bath for 10 minutes and cooled for 20 minutes under laboratory conditions. The turbidity of the solutions (level of protein precipitation) was measured at 660 nm in a Hach Spectrophotometer against blank (Williams *et al.*, 2008).

$$\% \text{ Percentage inhibition} = \frac{100 - \text{Optical Density of sample}}{\text{Optical Density of Control suspension}} \times 100$$

Statistical analysis

All the tests were done in 3 replicates. The data was determined as an average of 3 experiments ($n=3$) and calculated mean $\pm$ standard deviation (SD) and linear regression coefficient analysis using Microsoft Excel (Dewan *et al.*, 2025).

RESULTS AND DISCUSSION

In the present investigation, total thirteen phytochemical compounds analyzed in *S. andamanensis* leaf with different solvent extracts (aqueous, chloroform, ethanol and hexane).

Aminoacids, alkaloids, coumarins, flavonoids, phenols, steroids, tannins and terpenoids are present, if phlobatannins and quinines as absent recorded in aqueous, chloroform, ethanol and hexane solvent extraction of *S. andamanensis* leaf extract. The results tabulated in Table 2.

Singh *et al.* (2007) and Satote *et al.* (2025) analyzed the plant extracts revealed the presence of phytochemicals such as phenols, tannins, flavonoids, saponins, glycosides, steroids, terpenoids and

alkaloids. The phenolic compounds are one of the largest and most ubiquitous groups of plant metabolites.

Table 2. Qualitative phytochemical analysis of *Strobilanthes andamanensis* with different solvents

Name of the phytochemical compounds	Aqueous	Chloroform	Ethanol	Hexane
Amino acids	+	+	+	+
Alkaloids	+	+	+	+
Coumarins	+	+	+	+
Flavonoids	+	+	+	+
Glycosides	-	-	+	-
Phenols	+	+	+	+
Phlobatannins	-	-	-	-
Quinones	-	-	-	-
Saponins	-	-	+	-
Steroids	+	+	+	+
Tannins	+	+	+	+
Terpenoids	+	+	+	+
Triterpenoids	-	-	+	-

(+) – Present; (-) – Absent

The quantitative phytochemical analyses of *S. andamanensis* leaf with different solvents were

examined. The maximum quantity results recorded in ethanol extract of *S. andamanensis* leaf have alkaloids (05.86 ± 0.07 $\mu\text{g}/100\text{mg}$), aminoacids (08.45 ± 0.95 $\mu\text{g}/100\text{mg}$), coumarins (08.78 ± 0.00 $\mu\text{g}/100\text{mg}$), flavonoids (11.80 ± 0.03 $\mu\text{g}/100\text{mg}$), glycosides (03.55 ± 0.28 $\mu\text{g}/100\text{mg}$), phenols (04.91 ± 0.03 $\mu\text{g}/100\text{mg}$), saponin (10.37 ± 0.05 $\mu\text{g}/100\text{mg}$), steroids (04.89 ± 0.00 $\mu\text{g}/100\text{mg}$), tannins (08.54 ± 0.00 $\mu\text{g}/100\text{mg}$), terpenoids (08.63 ± 0.00 $\mu\text{g}/100\text{mg}$) and triterpenoids (05.24 ± 0.58 $\mu\text{g}/100\text{mg}$) than compared by aqueous, chloroform and hexane extract of *S. andamanensis* leaf (Table 3). Several workers studied the phytocompounds are, alkaloids are the basic natural products which occur in plants (Eleazu *et al.*, 2012). Tannins, saponin, glycosides (Karunyadevi *et al.*, 2009), flavonoids, terpenoids (Harborne *et al.*, 2000), phenol content (Nobori *et al.*, 1994) used to anti-inflammatory activity, analgesic and anti-bacterial properties etc.

Table 3. Quantitative phytochemical analysis of *S. andamanensis* leaf with different solvents

Name of the phytochemical compounds	Quantity ($\mu\text{g}/100\text{mg}$)			
	Aqueous	Chloroform	Ethanol	Hexane
Alkaloids	05.87 ± 0.04	04.76 ± 0.03	05.86 ± 0.07	03.78 ± 0.02
Amino acids	08.32 ± 0.13	08.64 ± 0.87	08.45 ± 0.95	7.55 ± 0.32
Coumarins	08.62 ± 0.00	07.40 ± 0.00	08.78 ± 0.00	07.09 ± 0.00
Flavonoids	11.75 ± 0.02	10.70 ± 0.04	11.80 ± 0.03	10.00 ± 0.00
Glycosides	-	-	03.55 ± 0.28	-
Phenols	04.82 ± 0.05	04.20 ± 0.00	04.91 ± 0.03	04.97 ± 0.06
Saponins	-	-	10.37 ± 0.05	-
Steroids	04.75 ± 0.00	03.85 ± 0.03	04.89 ± 0.00	03.98 ± 0.02
Tannins	08.37 ± 0.00	07.99 ± 0.09	08.54 ± 0.00	07.62 ± 0.05
Terpenoids	07.81 ± 0.08	08.55 ± 0.00	08.63 ± 0.00	07.80 ± 0.00
Triterpenoids	-	-	05.24 ± 0.58	-

These values are expressed with standard deviation $\pm$ error

Table 4. Antioxidant activity of *S. andamanensis* leaf extract by different methods

Different conc. ($\mu\text{g}/100\text{ml}$)	Percentage of activity (%)					
	DPPH Assay			Reducing Power Assay		
	Standard (Vitamin C)	Aqueous	Ethanol	Standard (Ascorbic acid)	Aqueous	Ethanol
100	25.01 ± 0.03	18.33 ± 0.05	19.56 ± 0.04	27.15 ± 0.10	21.68 ± 0.03	22.02 ± 0.02
200	25.24 ± 0.04	19.99 ± 0.10	20.73 ± 0.09	27.17 ± 0.10	22.98 ± 0.09	23.19 ± 0.03
300	26.66 ± 0.05	21.11 ± 0.11	21.96 ± 0.10	28.18 ± 0.11	23.87 ± 0.14	25.96 ± 0.12
400	27.87 ± 0.09	19.78 ± 0.09	20.87 ± 0.08	29.23 ± 0.13	22.67 ± 0.13	23.80 ± 0.11
500	27.98 ± 0.10	18.56 ± 0.06	19.58 ± 0.07	29.55 ± 0.15	21.94 ± 0.07	22.45 ± 0.04

These values are expressed with standard deviation $\pm$ error

In the present study, DPPH and reducing power assay free radical scavenging activity were analyzed in aqueous and ethanol extract of *S. andamanensis* leaf into different concentrations of 100, 200, 300, 400 and 500 µg/100ml. In DPPH assay, the percentage of activity recorded ranges from 18.33 ± 0.05 to 21.11 ± 0.11 % for aqueous extract and 19.56 ± 0.04 - 21.96 ± 0.10 % of activity in ethanol extract in 100 – 500 µg/100ml concentrations. In the same way, reducing power assay, 21.68 ± 0.03 , 22.98 ± 0.09 , 23.87 ± 0.14 , 22.67 ± 0.13 and 21.94 ± 0.07 % of activity in aqueous extract and 22.02 ± 0.02 , 23.19 ± 0.03 , 25.96 ± 0.12 , 23.80 ± 0.11 and 22.45 ± 0.04 % of activity in ethanol extract of *S. andamanensis* leaf in 100 – 500 µg/100ml concentrations (Table 4). Report by free radicals resulting from imbalance in natural antioxidant in the body leads to tissue damage and consequent inflammatory diseases.

Natural antioxidant compounds are phenolic compounds such as flavonoid, phenolic acids, tocopherols etc. (Ali *et al.*, 2008). They act as anti-inflammatory agents with additional antioxidant activity (Campoare *et al.*, 2016; Anokwaha *et al.*, 2023).

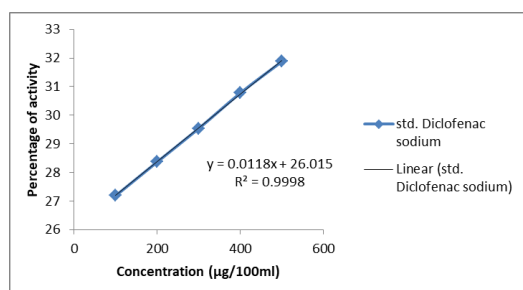


Fig. 1. Diclofenac sodium standard graph of anti-inflammatory activity

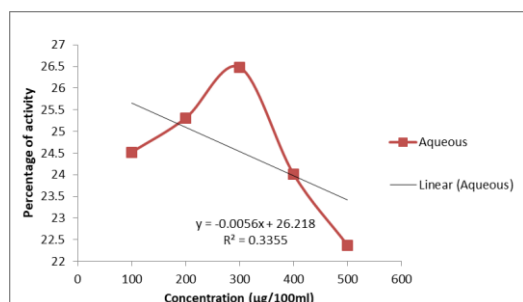


Fig. 2. Aqueous leaf extract of *S. andamanensis* graph of anti-inflammatory activity

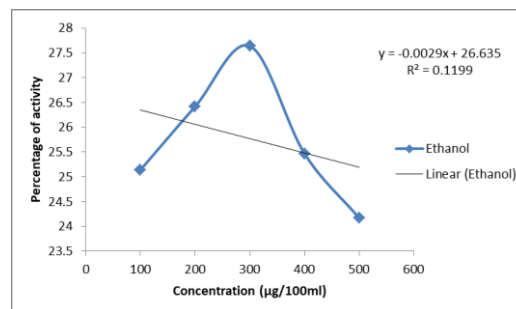


Fig. 3. Ethanol leaf extract of *S. andamanensis* graph of anti-inflammatory activity

In the current study, *in-vitro* anti-inflammatory activity of aqueous and ethanol leaf extract of *S. andamanensis* compared with standard. The maximum percentage of activity recorded in 300 µg/100ml of 26.48 ± 0.25 % in aqueous extract and 27.64 ± 0.85 % in ethanol leaf extract of *S. andamanensis* followed by 31.88 ± 0.02 % in 500 µg/100ml in standard. The regression coefficient value (R^2) 0.9998 in standard, 0.3355 in aqueous and 0.1199 in ethanol leaf extract of *S. andamanensis*. The graph mentioned in Fig. 1, 2 and 3. Presence of phytoconstituents like flavonoids, alkaloids, triterpenoids and tannins are known to as anti-inflammatory agents (Ficarra *et al.*, 1995; Singh *et al.*, 2002; Puntero *et al.*, 1997). The membrane stabilizing activity of two ethanolic extracts (*Strobilanthes kunthianus* and *Strobilanthes cuspidatus*) at concentration of 50 µg/ml shown highest protection in 50.16% and 55.24%, respectively (Brahma Srinivasa Rao *et al.*, 2011).

CONCLUSION

The ethanol and aqueous *S. andamanensis* leaf extracts have *in vitro* anti-oxidant and anti-inflammatory activities which may be due to the presence of many different phytoconstituents such as flavonoids, phytosterols, triterpenoids and tannins etc.

REFERENCES

- Ali SS, Kasoju N, Luthra A, Singh A, Sharanabasava H, Sahu A, Bora U. 2008. Medicinal herbs as sources of antioxidants. Food Research International **41**, 1–15.

- Anokwaha D, Asante KE, Yakubu J, Kingsley AI, Samuel K, Pinkrah G, Benjamin A, Ernest O, Ofori AE, Robert PB, Yeboah MA.** 2023. Pharmacognostic study and anti-inflammatory and antioxidant activities of *Loeseneriella africana*. South African Journal of Botany **157**, 174188.
- Brahma Srinivasa Rao D, Elango K, Satish Kumar MN, Suresh B, Manimaran S, Nanjan MJ.** 2011. *In vitro* anti-inflammatory and anti-osteoarthritic activities of *Strobilanthes kunthianus* and *Strobilanthes cuspidatus*. International Journal of Research in Pharmacy and Chemistry **1**(4), 1265–1268.
- Brand W, Cuvelier ME, Berset C.** 1995. Use of a free radical method to evaluate antioxidant activity. Food Science and Technology **28**(10), 25–30.
- Compaore M, Meda RNT, Bakasso S, Vlase L, Kiendrebeogo M.** 2016. Antioxidative, anti-inflammatory potentials and phytochemical profile of *Commiphora africana* (A. Rich.) Engl. (Burseraceae) and *Loeseneriella africana* (Willd.) (Celastraceae) stem leaf extracts. Asian Pacific Journal of Tropical Biomedicine **6**(8), 665–670.
- Dewan MF, Islam MN, Ali MA, Rahman MM, Shams SNU, Ahiduzzaman M.** 2025. Phytochemical and antioxidant properties of traditional and modern aromatic rice: A comparative study. Food and Humanity, 100752.
- Eleazu CO, Eleazu KC, Awa E, Chukwum SC.** 2012. Comparative study of the phytochemical composition of the leaves of five Nigerian medicinal plants. Journal of Biotechnology and Pharmaceutical Research **3**(2), 42–46.
- Ficarra R, Ficarra P, Tommasini S, Calabrò ML, Ragusa S, Barbera R.** 1995. Leaf extracts of some *Cordia* species: Analgesic and anti-inflammatory activities as well as their chromatographic analysis. Farmaco **50**(4), 245–256.
- Gao M, Liu CZ.** 2005. Comparison of techniques for the extraction of flavonoids from cultured cells of *Saussurea medusa* Maxim. World Journal of Microbiology and Biotechnology **21**(8), 1461–1463.
- Harborne JB, Williams CA.** 2000. Advances in flavonoid research. Phytochemistry **55**, 481–504.
- Harborne JB.** 1989. General procedures and measurement of total phenolics. Methods in Plant Biochemistry **1**, 1–28.
- Harborne JB.** 1998. Phytochemical methods. Chapman & Hall, London, 60–66.
- Hiai S, Oura H, Nakajima T.** 1976. Color reaction of some sapogenins and saponins with vanillin and sulfuric acid. Planta Medica **29**(2), 116–122.
- Karunyadevi S, Arun N, Surekha V.** 2009. Screening of phytochemical compounds, antioxidant and antimicrobial activity of *Aloe vera* and *Arkaa*. Advanced Biotech **9**, 38–43.
- Krishnaiah D, Sarbatly R, Bono A.** 2007. Phytochemical antioxidants for health and medicine: A move towards nature. Biotechnology and Molecular Biology Reviews **1**, 97–104.
- Mahato SB, Sen S.** 1997. Advances in triterpenoid research, 1990–1994. Phytochemistry **44**, 1185–1236.
- Meyer H.** 1957. Experimental biochemistry. Biochemical Journal **67**, 333–340.
- Nobori T, Miurak K, Wu DJ, Takabayashik LA, Carson DA.** 1994. Deletion of cyclin-dependent kinase-4 inhibitor gene in multiple human cancers. Nature **46**, 753–756.
- Nunes CDR, Barreto Arantes M, Menezes de Faria Pereira S, Leandro da Cruz L, de Souza Passos M, Pereira de Moraes L, Vieira IJC, Barros de Oliveira D.** 2020. Plants as sources of anti-inflammatory agents. Molecules **25**(16), 3726.

- Puntero BF, Peinado II, Fresno AMVD.** 1997. Anti-inflammatory and anti-ulcer activity of *Teucrium buxifolium*. *Journal of Ethnopharmacology* **55**(2), 93–98.
- Satote AR, Davange SB, Shinde SS, Khilari YP.** 2025. Phytochemical analysis of some important medicinal plants from Kopergaon Tahsil, District-Ahilyanagar (M.S.), India. *International Journal of Biology Sciences* **7**(6), 88–90.
- Sethna SM, Shah NM.** 1945. The chemistry of coumarins. *Chemical Reviews* **36**(1), 1–62.
- Singh B, Sahu PM, Sharma MK.** 2002. Anti-inflammatory and antimicrobial activities of triterpenoids from *Strobilanthes callosus* Nees. *Phytomedicine* **9**(4), 355–359.
- Singh R, Singh SK, Arora S.** 2007. Evaluation of antioxidant potential of ethyl acetate extract/fractions of *Acacia auriculiformis* A. Cunn. *Food and Chemical Toxicology* **45**, 1216–1223.
- Srivastava A, Srivastava P, Pandey A, Khanna V, Pant A.** 2019. A potential alternative medicine in controlling neurological disorders. In: *New look to phytomedicine*. *Phytomedicine* **6**, 625–655.
- Williams LAD, Connar AO, Latore L, Dennis O, Ringer S, Whittaker JA, Conrad J, Vogler B, Rosner H, Kraus W.** 2008. The *in vitro* anti-denaturation effects induced by natural products and non-steroidal compounds in heat-treated (immunogenic) bovine serum albumin (BSA) as a screening assay for detection of anti-inflammatory compounds. *West Indian Medical Journal* **57**(4), 327–331.
- Zhu F, He J, Kong L, Guo Z, Liang P, Zhang J, Liang M.** 2025. H-ferritin: A new cytoprotective antioxidant strategy via detoxification of hydrogen peroxide to oxygen. *Nano Research* **18**(2), 9490–7189.