International Journal of Botany Studies
ISSN: 2455-541X
Impact Factor: RJIF 5.12
www.botanyjournals.com
Volume 3; Issue 2; March 2018; Page No. 21-28

Evaluation of bioactive compounds of *Solanum trilobatum* L.: A native medicinal plant

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Abstract
In this study, phytochemical analysis in different solvent system of native medicinal plant *Solanum trilobatum* have revealed the presence of varying quantities of alkaloids, carbohydrate, cardiac glycosides, flavonoids, saponins, polyphenols, tannins, terpenoids with absence of anthraquinones and steroids. These bioactive compounds together with the high antioxidant activities obtained in some species and the nutrient contents in all species may be responsible for their nutritional and therapeutic uses. The extract of this plant showed a significantly higher total phenol and flavonoid content. Phytochemical composition analysis yielded (g/100g) alkaloid, flavonoids and oligosaccharides. Thin layer chromatographic profiles yielded the different pattern of compound and as well as different Rf values. The thin layer chromatographic chromatogram was developed based on the compounds presence of each extracts. The number of bands and Rf values of each extracts and in suitable solvent systems. The ethanol extract of leaf showed four compounds (Rf = 0.31, 0.45, 0.67, 0.82) in Benzene: Ethanol: Acetone (8:1:1), (0.25, 0.51, 0.72, 0.86) in Benzene: Ethanol: Acetone (6:2:2), and (0.22, 0.45, 0.66, 0.79) in Benzene: Ethanol: Acetone (5:4:1) solvent systems respectively. Only three compounds were present In same solvent system, the ethyl acetate extract yielded three (Rf = 0.24, 0.43, 0.70), (0.31, 0.48, 0.78), (0.18, 0.37, 0.45) and two compounds (0.34, 0.56) respectively. The ethanol extract of fruit showed four compounds (0.31, 0.46, 0.65, 0.80) and (0.25, 0.48, 0.71, 0.91) respectively. Only three compounds were present (0.32, 0.49, 0.75) in ethanol extract analyzed with Benzene: Ethanol: Acetone (7:2:1) and (0.25, 0.48, 0.63) in ethanol extract analyzed with Benzene: Ethanol: Acetone (5:4:1). Similarly, two compounds (0.32, 0.69), (0.34, 0.58), (0.43, 0.70) and (0.45, 0.68) were yielded in chloroform extract of all four solvent systems and only one compound yielded in hexane extract (0.72), (0.60) (0.65) (0.70) respectively. The present findings support to the traditional knowledge of the medicinal plants to the local users and plants used as therapeutic agents for treat several diseases caused by the pathogenic bacterial populations. The aim of the present study is to determine the bioactive compounds presents in *S. trilobatum*.

Keywords: medicinal plants, *Solanum trilobatum*, bioactive compounds, thin layer chromatography

Introduction
Natures become a great source of medicinal treatment for millions of years. Much of the world's biological diversity remains unexplored as a source of novel biological compounds and the search for new bioactive agents from natural sources, including extreme environmental niches is expanding [1]. Unique bioactive compounds have many pharmacological activities. Drug from these compounds used to treat deadly diseases like cancer, AIDS, diabetes, arthritis, etc [2]. Plants are playing an important role in the health of millions of people's life in India. Ethnobotanical and traditional uses of natural compounds, especially of plant origin received much attention in recent years as they are well tested for their efficacy and general believed to be safe for human use. Traditionally, plants are used in the treatment of many infections and systemic disorders. More than hundreds of chemical compounds are derived from plants and used as therapeutic agents to treat various disorders. The plants which have medicinal values due to their health-enhancing and therapeutic properties are referred as herbs. Various pharmacologically active compounds which are derived from different parts of plants directly or indirectly can act as life-saving drugs [3, 4].

Plant derived substances have recently become of great interest owing to their versatile applications. Medicinal plants are the local heritage with global importance and world is endowed with a rich wealth of medicinal plants [5]. Medicinal plants are used by 80% of the world population as the only available medicines especially in developing countries [6]. Medicinal plants from a large group of economically important plants that provide the basic raw materials for indigenous pharmaceuticals. Medicinal plants are the richest bio-resource of drugs of traditional systems of medicine, modern medicines, nutraceuticals, food supplements folk medicines, pharmaceutical intermediates and chemical entities for synthetic drugs [7]. Currently, WHO has urged its member countries to provide financial support for traditional practitioners to develop the traditional medical systems. It is imminent to utilize both the traditional and modern medical systems to fulfill the primary healthcare of the world [8]. Phytopharmaceuticals are an inexhaustible reservoir of chemotherapeutics to treat many ailments such as cold, fever, diarrhoea, psychic problems, birth control and dental hygiene throughout the world [9]. It is estimated that there are 2,50,000 to 5,00,000 species of plant species are believed to exist on earth. India, owing to its vast green forests, rivers and hills, with its richness of biodiversity can be considered as the paradise of medicinal plants. Medicinal plants are very

important source of life saving drugs for the ever increasing world population. The developing countries greatly depend on plants, where a major role in health care is played by traditional medicine [10]. In addition, phenolic compounds and flavonoids are also widely distributed in plants which have been reported to exert multiple biological effects, including antioxidant, free radical scavenging abilities, antiinflammatory, anti-carcinogenic etc [11]. The crude extracts of herbs, spices and other plant materials, rich in phenolics and flavonoids are of increasing interest in the food industry because they retard oxidative degradation of lipids and thereby improve the quality and nutritional value of food [12].

Solanum trilobatum L., is a rare, perennial, medicinal herb belongs to the family of Solanaceae and its' parts such as berries and flowers are used in the treatment of respiratory illness such as cough and chronic bronchitis [13]. The genus *Solanum* is comprised of about 1500 species and well represented all over the world. It is rich in alkaloids which are distributed in all parts of the plant [14]. It is a important medicinal plant available in southern India. The plant well known in ayurveda and siddh systems [15]. The active principles such as solinidine and other steroids extracted from the roots and leaves of the genus *Solanum*, which has tremendous impact on utilization of this genus economically and medicinally all over the world [16 - 18]. The leaves contain rich amount of calcium, iron, phosphorus, carbohydrates, protein, fat, crude fibre and minerals. This plant is used as medicine for asthma, respiratory disorders, rheumatism and in reducing blood glucose level. It also possesses antibacterial, antifungal, antioxidant and antitumouours properties [19]. *Solanum trilobatum* is used as herbal remedy for asthma, blood vomiting, reducing blood glucose level and bilious matter phlegmatic rheumatism and different types of leprosy [20]. This herbal plant is used as medicine for asthma, vomiting of blood and bilious matter, phlegmatic rheumatism, several kinds of leprosy. It is also antibacterial, antifungal, antimitotic and antitumourous [21, 22]. The decoction of entire *Solanum trilobatum* plant is used to treat acute and chronic bronchitis. It has been widely used to treat respiratory disorders [23]. The constituents of this plant include sobatum, solamarine, solanine, solasodine, glycoalkaloid, diosogenin and tomatidine [24]. This herbal medicine used to treat more diseases like tuberculosis, bronchial asthma and respiratory problems. The plant roots, berries and flowers are used for cough [25].

Solanum trilobatum is reported to treat many diseases viz., respiratory problems and bronchial asthma. Many pharmacological activities are found in *S. trilobatum* like hepatoprotective activity, antimicrobial activity, larvicidal activity, antidiabetic activity, cytotoxic activity and anticancer activity. The leaves and stem of *S. trilobatum* are reported to possess antimitotic, anti-inflammatory and anti-ulcerogenic properties. The leaf extracts are used to increase male fertility and to cure snake poison [26]. Various chemical compounds are identified in *Solanum* species they are flavanoides, sterols, saponins alkaloids, phenolics, and their glycosides. The secondary compound of alkaloids from soladunalinidine and tomatidine were isolated from leaf and stem of *Solanum* species [27]. *Solanum trilobatum* is used as herbal remedy for asthma, blood vomiting, reducing blood glucose level and bilious matter phlegmatic rheumatism and different types of leprosy. This plant also showed significant hepatoprotective activity against carbon tetrachloride induced hepatic damage in rats, antimicrobial activity against *Escherichia coli* and, *Staphylococcus aureus* and antifungal activity against *Aspergillus flavus* and *A. niger* [28]. The phytochemical and biological importance of the different parts of *S. trilobatum* was not explored completely. Hence, the objective of the present investigation was aimed at evaluation of phytochemical constituents of the leaves, stem and fruits of valuable medicinal plant *Solanum trilobatum*.

2. Materials and Methods

2.1 Collection of sample

The plant samples such as leaves, stem and fruits of *Solanum trilobatum* L. were collected from Vathal Hills of Dharmapuri district Tamilnadu, India during August-December 2016 and identified the voucher specimen has been deposited in departmental herbarium, PG and Research Department of Botany, Government Arts College, Dharmapuri, Tamil Nadu, India for future reference.

2.2 Preparation of extractions

Fresh leaves, stem and fruits were collected and washed thoroughly under running tap water followed by sterile distilled water and dried under shade. They were ground into coarse powder by using mechanical pulveriser. These powdered materials were used for further analysis. All the samples, about 100g of the powder were repeatedly extracted with different solvents in a 500 ml round bottom flask with 250 ml solvents hexane, chloroform, ethyl acetate and ethanol separately. The reflux time for each solvent wash 25 cycles for complete extraction using soxhlet apparatus [29].

The extraction was done in soxhlet apparatus at 60°C for 6 hour. After the completion of extraction, the supernatant was filtered through Whatman No. 1 filter paper. All solvent extracted fractions were evaporated to dryness to obtain residues. The extracts were stored at 4°C in air tight containers and used for preliminary phytochemical screening of secondary metabolites. The presence of different chemical constituents in crude drugs can be detected by subjecting them to successive extraction using solvents in the order of increasing polarity. In the present study were therefore, subjected to extraction followed by qualitative chemical tests in order to know the phyto profiles on a preliminary basis.

2.3 Phytochemical Screenings [30, 31]

Phytochemical screening were performed to assess the qualitative chemical composition of different samples of crude extracts using commonly employed precipitation and coloration reactions to identify the major secondary metabolites like alkaloids, glycosides, steroids, tannins and terpenoides. To identify the chemical constituents of sample extracts by standard producers have been followed. The crude extract was qualitatively tested for the presence of chemical constituents using the following reagents and chemicals. The extracts obtained in the successive extraction process were subjected to various qualitative tests using reported methods, subjected to preliminary phytochemical screening for the identification of various phytoconstituents such as alkaloids, carbohydrates, steroids, cardiac glycosides, flavonoides,

carbohydrates, amino acids, phenols, naphthoquinones and tannins according to standard methods.

2.4 Tests for alkaloides

Dragendroff's test: Little amount of the sample was treated with the Dragendroff's reagent; the appearance of reddish brown precipitate indicated the presence of alkaloids.

Mayer's test: Sample (2-3ml) was treated with few drops of Mayer's reagent. Appearance of white precipitate indicated the presence of alkaloids.

Wagner's test: Sample (2-3ml) was mixed with few drops of Wagner's reagent. Appearance of reddish brown precipitate indicated the presence of alkaloids.

2.5 Test for flavonoides [32]

Alkaline test: To 3 ml of the extract few magnesium ribbons are dipped and concentrated Hydrochloric acid was added over them and observed for the formation of magenta (brick red) colour indicating the presence of flavonoides.

Shinoda test: Sample extract was treated with 5 ml of 95% ethanol; few drops of concentrated Hydrochloric acid and 0.5g of magnesium turnings were also added. Pink colour was observed. Addition of increasing amount of sodium hydroxide to the residue shown yellow coloration, which decolorizes after addition of acid.

2.6 Determination of flavonoides as quecetin equivalent

Flavonoids contents in the extracts were determined by standard colorimetric method with minor modifications. To 1 ml leaf extract was added 0.3 ml 5% sodium nitrite; 4 ml distilled water and held for 5 minutes. To the mixture 0.3 ml of 10% aluminium chloride was and held for 6 minutes. Finally 2 ml of 1M sodium.

2.7 Test for amino acids [33]

Ninhydrin test: Test sample (3ml) and 3 drops of 5% ninhydrin solution were heated in boiling water for 10 min. Purple color appeared.

2.8 Test for Proteins [33]

Million's test: Test sample (3ml) was mixed with 5ml of Million's reagent. White precipitate is formed. On warming precipitate turn's brick red or the precipitate dissolves giving red colored solution.

Biuret test: Test sample (3 ml) was mixed with 4% NaOH and few drops of 1% CuSO solution were added. Violet or pink color not appeared. To 3 ml of the extract few drops of 10% sodium chloride and 1% copper sulphate was added for the formation of violet or purple colour. On addition of alkali, it becomes dark violet.

2.9 Tests for Carbohydrates [33]

Molisch's test: To a small amount of the extract few drops of Molish's reagent was added followed by the addition of conc. H_2SO_4 along the sides of the test tube. The mixture was then allowed to stand for 2 min and then diluted with 5 ml of distilled water. Formation of red or dull violet colour at the inter phase of two layers indicates the presence of carbohydrates. First yellow then brick red precipitate was observed.

Fehling's test: The extract was treated with 5 ml of Fehling's solution (A and B) and kept in boiling water bath for 5-10 min. The formation of yellow or red colour precipitate indicates the presence of reducing sugar.

Benedict's test: Sample solution and equal volume of Benedict's reagent were mixed in the test tube. Heated in boiling water bath for 5 min solution appears green, yellow colour appeared based on the amount of reducing sugar present in test solution.

2.10 Test for Tannins [36]

A fraction of the extract was dissolved in water and then it was subjected to water bath 37°C for 1 h and treated with ferric chloride solution and observed for the formation of dark green colour.

Lead acetate test: The sample was treated with 10% lead acetate solution; appearance of white precipitate indicated the presence of tannins. When the extract was treated with aqueous bromine solution, appearance of white precipitate indicated the presence of tannins.

Ferric chloride test: To 1 ml of extract, 2 ml of 5% ferric chloride was added. Formation of greenish black colour indicated the presence of tannins. A fraction of the extract was dissolved in water and then it was subjected to water bath 37°C for 1hr and treated with ferric chloride solution and observed and for the formation of dark green colour.

2.11 Test for steroids [33]

Salkowski's test: Sample (2 ml) was mixed with 2 ml of concentrated Sulphuric acid, it was well shaken then chloroform layer appeared red and acid layer shown greenish yellow fluorescene.

Liberman-Buchard reaction: Sample (2 ml) was mixed with chloroform. 1-2 ml of acetic anhydride was added and 2 drops concentration sulphuric acid was added from the sides of the tube. First red then blue and finally green colour appeared.

2.12 Test for Glycosides: [33]

Free content of the sugar extract was determined. The sample was hydrolysed with mineral acid (dilute hydrochloric or dilute sulphuric acid). Again the total sugar content of the hydrolysed extract was determined. Increase in the sugar content indicated the presence of glycoside in the extract.

Glycoside -----H_2O--→Aglycon (genin) + Glycon (sugar)

Baljet's Test: To 5 ml of the extract few drops of sodium picrate was added to observe yellow to orange colour.

Keller-killiani test: To 5 ml of the extract few drops of ferric chloride solution was added and mixed, then sulphuric acid containing ferric chloride solution was added, it forms two layer showed reddish brown while upper layer turns bluish green indicates the presence of glycosides.

Legal's test: Aqueous or alcoholic sample extract was mixed with 1 ml of pyridine sodium nitroprusside was added. Pink to red color appeared.

2.13 Test for phenols [33]

Ferric chloride test: A fraction of the extract was treated with 5% ferric chloride solution and observed for the

formation of deep blue or black colour.
To 1 ml of the extract, 2 ml of distilled water, 3 drops of 10% aqueous ferric chloride (FeCl) and 3 drops of potassium ferrocyanide were added. Formation of blue or green color showed the presence of polyphenols.

2.14 Test for Total Polyphenols
Phenolic compounds in the leaf extracts were estimated by a colorimetric assay, based on standard procedures described by Harbone (1998) with minor modifications. To 5 ml distilled water was added 0.5 ml Folin Ciocalteu's reagent. After 3 min, 1 ml 7.5% sodium carbonate solution, 1 ml extract were added to the mixture and made to 10 ml with distilled water. The mixture was kept in water bath maintained at 50°c for 16 minutes. UV Visible spectrophotometer (UV-Vis Shimadzu) was used to read the absorbance at 765 nm. Gallic acid was prepared in different concentrations and the absorbance equally read at 765 nm. The values obtained were used to generate the standard curve against which polyphenols in the leaves, stem bark, fruit pulp and seeds were calculated and expressed as Gallic acid equivalents (GAEs) per 100 g dwb.

2.15 Test for reducing sugars
The residue was dissolved in water and kept in the water bath. Two ml of the solution in a test tube was added with 1 ml each of Fehling's reagent A and B. The mixture was shaken and heated in a water bath for 10 min. A brick red precipitate indicates a reducing sugar.

2.16 Test for Saponin [33]
Foam test: To 1 ml of the extracts 5 ml distilled water was added and shaken vigorously. Formation of foam indicated presence of saponins.

2.17 Test for terpenoides [33]
Chloroform test: To 5 ml of the extract few drops of chloroform and concentrated H was added carefully along the sides of the test tube. Formation of brown color at interface was a positive indicator.
Test for anthraquinones: Weighted leaf powder, 0.5g, was boiled in 10% hydrochloride acid and filtered hot. To this, 2 ml chloroform and 10% ammonia solution each were added. Formation of pink color in the aqueous layer indicated presence of anthraquinones.

2.18 Identification of Compound by Thin Layer Chromatography (TLC)
In 1958 Stahl [36] demonstrated application of TLC in analysis. It is at present an important analytical tool for qualitative analysis of a number of natural products. The plates were visualized for spot identification under iodine chamber and sprayed with spray reagent of the category given in table. The Rf value was calculated by using formula.

$$\text{Rf value} = \frac{\text{Distance travelled by solute from the base line}}{\text{Distance travelled by solvent from the base line}}$$

10 mg/ml of *Solanum trilobatum* in different extract was dissolved in ethanol solvent used for TLC examination. TLC plates were prepared by using Silica Gel-G as adsorbent. 100g Silica Gel-G was mixed with sufficient quantity of distilled water to makes Slurry. The slurry was immediately poured into a spreads and plates were prepared by spreading the slurry on glass plates of required size. Plates were allowed to air dry for one hour.

2.19 Statistical analysis
Phytochemical estimation and quantification were performed in five replicates under standard procedures to ensure consistency of all conclusions. Data of all experiments were statistically analysed and expressed as Mean ± Standard Deviation.

3. Results
In this study, the results of preliminary phytochemical screening of leaf, stem and fruit extracts of *Solanum trilobatum* are presented in Table 1. Investigations on the phytochemical screening of *S. trilobatum* ethanol extract revealed the presence of alkaloids, amino acids, tannins, phenols, terpenoids, flavonoids, glycosides, carbohydrates, and saponins. Whereas the metabolites like steroids, and anthraquinones were found to be absent in the ethanolic extracts. In ethyl acetate extracts have showed the presence of flavonoids, terpenoides, anthraquinones, phenol, saponins and steroids. Very few numbers of phytochemicals were found in hexane extract like flavonoides and terpenoids. Fruit ethanol extract showed more amounts of alkaloids, glycosides, steroids, proteins, tannins, saponins and terpenoides. No new phytochemicals was observed in stem extracts. The quantitative screening of phytochemicals in all the extracts revealed the presence of saponins and tannins in leaves, stem and fruits. Flavonoides, phenols and glycosides were present in all extracts except leaves. Similarly carbohydrates were present only in leaves and stem.
Thin layer chromatographic analysis was carried out for leaves and fruit extracts. The chromatogram was developed based on the compounds presence of each extracts. Further individual bands and its colour and Rf value were calculated based on corresponding authentic samples of each bioactive compounds will be visualized under iodine vapour and UV illumination and identified. The extracted bioactive compounds were tested followed by calculate their Rf value by analyzing thin layer chromatographic techniques with four different kinds of solvent systems in different combination of benzene, ethanol and acetone. The number of bands and Rf values of each extracts and in suitable solvent systems were presented in Table 2. The ethanol extract of leaf showed four compounds (Rf = 0.31, 0.45, 0.67, 0.82) in Benzene: Ethanol: Acetone (8:1:1), (0.25, 0.51, 0.72, 0.86) in Benzene: Ethanol: Acetone (6:2:2), and (0.22, 0.45, 0.66, 0.79) in Benzene: Ethanol: Acetone (5:4:1) solvent systems respectively. Only three compounds were present (Rf = 0.36, 0.51, 0.78) in ethanol extract analyzed with Benzene: Ethanol: Acetone (7:2:1). In same solvent system, the ethyl acetate extract yielded three (Rf = 0.24, 0.43, 0.70), (0.31, 0.48, 0.78), (0.18, 0.37, 0.45) and two compounds (0.34, 0.56) respectively. Similarly, two compounds (Rf = 0.32, 0.68), (0.34, 0.61), (0.47, 0.72) and (0.41, 0.66) were yielded in chloroform extract of all four solvent systems and only one compound

yielded in hexane extract (0.74), (0.63) (0.67) and (0.71) respectively. The ethanol extract of fruit showed four compounds (0.31, 0.46, 0.65, 0.80) in Benzene: Ethanol: Acetone (8:1:1) and (0.25, 0.48, 0.71, 0.91) in Benzene: Ethanol: Acetone (6:2:2) solvent systems respectively. Only three compounds were present (0.32, 0.49, 0.75) in ethanol extract analyzed with Benzene: Ethanol: Acetone (7:2:1) and (0.25, 0.48, 0.63) in ethanol extract analyzed with Benzene: Ethanol: Acetone (5:4:1). In same solvent system, the ethyl acetate extract yielded three (Rf = 0.30, 0.54, 0.70), (0.31, 0.47, 0.77) and two compounds (0.37, 0.58) and (0.28, 0.42) respectively. Similarly, two compounds (0.32, 0.69), (0.34, 0.58), (0.43, 0.70) and (0.45, 0.68) were yielded in chloroform extract of all four solvent systems and only one compound yielded in hexane extract (0.72), (0.60) (0.65) (0.70) respectively.

Table 1: Preliminary phytochemical analysis of leaf, stem and fruit extracts of *Solanum trilobatum* L.

Biochemical tests	Leaf				Stem				Fruit			
	H	C	EA	ET	H	C	EA	ET	H	C	EA	ET
Alkaloids Mayer's Test	-	-	+	+	+	+	+	+	+	+	+	+
Wagner's Test	-	-	+	+	+	+	+	+	+	+	+	+
Dragendroff's Test	-	-	-	+	+	+	+	+	+	+	+	+
Carbohydrates Molisch's Test	-	-	-	-	-	-	-	-	-	-	-	-
Fehling's test	-	-	-	-	-	-	-	-	-	-	-	-
Benedict's Test	-	-	-	-	-	-	-	-	-	+	-	-
Glycosides Baljet's Test	-	+	-	-	-	-	-	+	-	+	-	+
Keller-Killiani test	-	+	-	-	-	-	-	+	-	+	-	+
Legal's test	-	+	-	-	-	-	-	+	-	+	-	+
Steroids Liebermann-Buchard Test	-	-	+	-	-	-	+	+	+	+	+	+
Salkowskis Test	-	+	+	-	-	-	-	+	+	+	+	+
Proteins Biruet test	-	-	+	+	-	-	+	+	-	-	-	-
Millions test	-	-	+	+	-	-	+	+	-	-	-	-
Flavonoides Alkaline Test	+	+	+	+	-	-	-	+	-	-	-	-
Shinoda Test	+	+	+	+	-	-	-	+	-	-	-	-
Tannins Lead acetate Test	-	+	+	+	-	-	+	+	-	-	+	+
Ferric chloride Test	-	+	+	+	-	-	+	+	-	-	+	+
Saponins Foam Test	+	+	+	+	+	+	+	+	+	+	+	+
Anthraquinones NH_4OH Test	-	-	-	-	-	-	+	+	-	-	+	+
Amino acid Ninhydrin test	-	-	-	+	-	-	+	+	-	-	-	+
Phenols Ferric chloride	-	-	+	+	-	-	+	+	-	-	+	+
Terpenoids Chloroform Test	+	-	+	+	-	-	-	-	+	-	+	+
Reducing sugars Fehling's Test	-	+	+	+	-	-	-	+	-	-	+	+

Note: H=Hexane; C=Chloroform; EA=Ethyl Acetate; ET=Ethanol; (+) = Present; (-) = Absent

Table 2: Thin Layer Chromatographic analysis of *Solanum trilobatum* L. leaves and fruit extracts with their Rf values in different solvent systems.

Solvent System	Leaf extract	No. of Bands	Rf values	Fruit extract	No. of Bands	Rf values
Benzene : Ethanol : Acetone (8:1:1)	Hexane	1	0.74	Hexane	1	0.72
	Chloroform	2	0.32	Chloroform	2	0.32
			0.68			0.69
	Ethyl acetate	3	0.24	Ethyl acetate	2	0.30
			0.43			0.54
			0.70			0.70
	Ethanol	4	0.31	Ethanol	4	0.31
			0.45			0.46
			0.67			0.65
			0.82			0.80
Benzene : Ethanol : Acetone (7:2:1)	Hexane	1	0.63	Hexane	1	0.60
	Chloroform	2	0.34	Chloroform	2	0.34
			0.61			0.58
	Ethyl acetate	2	0.34	Ethyl acetate	2	0.37
			0.56			0.58
	Ethanol	3	0.36	Ethanol	3	0.32
			0.51			0.49
			0.78			0.75
Benzene : Ethanol : Acetone (6:2:2)	Hexane	1	0.67	Hexane	1	0.65
	Chloroform	2	0.47	Chloroform	2	0.43
			0.72			0.70
	Ethyl acetate	3	0.31	Ethyl acetate	3	0.31

			0.48			0.47
			0.78			0.77
	Ethanol	4	0.25	Ethanol	4	0.25
			0.51			0.48
			0.72			0.71
			0.86			0.91
Benzene : Ethanol : Acetone (5:4:1)	Hexane	1	0.71	Hexane	1	0.70
	Chloroform	2	0.41	Chloroform	2	0.45
			0.66			0.68
	Ethyl acetate	3	0.18	Ethyl acetate	2	0.28
			0.37			0.42
			0.45			-
	Ethanol	4	0.22	Ethanol	3	0.25
			0.45			0.48
			0.66			0.63
			0.79			-

4. Discussions

Phytochemical screening of various extracts such as hexane, chloroform, ethyl acetate and ethanol of *S. trilobatum* revealed the presence of secondary metabolites such as steroids, triterpenoids, sugars, phenolic compounds, tannins, anthroquinone, amino acids, saponins [37, 38]. Phytochemical analysis of dried powder of *S. trilobatum* leaves showed the presence of carbohydrates, saponins, phytosterols and tannins, where as the stem portion possess carbohydrates, saponins, phytosterols, tannins, flavonoids and cardiac glycosides. Alkaloides such as soladunalinidine and tomatidine were isolated from the leaf and stem of Solanum species. *S. trilobatum* contains chemical compounds like Sobatum, ß-solamarine, solasodine, solaine, glycoalkaloid and diosogenin [39]. *Solanum trilobatum* leaf samples were used for antioxidant studies. Analysis on different extraction of methanol (80%), ethanol (75%), petroleum ether, ethyl acetate and aqueous extract showed the presence of antioxidants. 50µl of leaf extracts (methanol, ethanol, petroleum ether, ethyl acetate and aqueous extracts of *Solanum trilobatum* were estimated for free radical scavenging activity using Diphenyl-2-picryl hydrazyl (DPPH) assay [40]. *Solanum trilobatum* gave maximum crude protein content in its aqueous extract of fruit, maximum free phenol was found out in methanolic leaf extract. *S. trilobatum* seed extract by using acetone, petroleum ether and chloroform were calculated. The result showed that the acetone extract has highest extractive value of 10.5 (%w/w) and the extractive values of petroleum ether and chloroform are 8.7and 9.2 (%w/w).Tannins have stringent hasten the healing of wounds and inflamed mucous membranes. Apart from tannin and phenolic compounds, other secondary metabolite constituents of all the five plants detected include the alkaloids, saponin and flavonoids. Flavonoids on the other hand are potent water-soluble antioxidants and free radical scavengers, which prevent oxidative cell damage, have strong anticancer activity [41-43]. Saponin has the property of precipitating and coagulating red blood cells [44, 45].

The results indicate that the plant material may become an important source of compounds with health protective potential. Plants are important source of potentially useful structures for the development of new chemotherapeutic agents. The increased frequency of resistance to commonly used antibiotics led to search for newer, effective, cheap and easily affordable drugs in the management of infectious diseases and plants belonging to the *Solanum* genus have been reported to have remarkable pharmacological activity [46]. A phytochemical compound from plant material is depending on the type of solvent used in the extraction method. The solubility of the active constituents in solution showed some degree of antibacterial activity [47]. It was remarkable that abundance of phytochemicals such as trepenoid, alkaloid, flavonoid, saponin, anthroquinone and tannin in *Solanum trilobatum* constitutes the main antibacterial principle as suggested by many workers [48, 49].

5. Conclusion

The results of present investigation clearly show that the hexane, chloroform, ethyl acetate and ethanol extracts have showed the presence of some active constituents in the extracts. These active principles may have acted alone or in combination to inhibit the growth of the bacterial organisms. The medicinal uses of these plants to heal diseases including infectious one has been extensively applied by people. Thus, the present study concluded that both leaf and fruit extract of *Solanum trilobatum* shows presence of Phenols, Tannins, saponin, flavonoids, Terepenoids and Steroids. The existence of phytoconstituents make the plant valuable for treating different ailments and have a potential of providing useful drugs of human use. In the present study, we have found that most of the biologically active phytochemicals were present in the ethanol extracts. The medicinal value of the title plant can be correlated due to the presence of various bioactive chemical constituents. Natural products from folk remedies have contributed significantly in the discovery of modern drugs and can be an alternative source for the discovery of novel structures with better safety and efficacy profiles. Ethno-botanical and traditional uses of natural compounds, especially of plant origin received much attention in recent years as they are well tested for their efficacy and generally believed to be safe for human use.

6. Acknowledgments

The author is greatly thankful to the Principal and Head of the Department, PG and Research Department of Botany, Government Arts College, Dharmapuri, for providing the

laboratory facilities.

7. References

1. Cragg GM, Newman DJ. Medicines for the millennia. Ann NY Acad Sci. 2001; 953:3-25.
2. Amutha R, Ramesh K, Sudha A, Rathika S, Pandiselvi P. Preclinical Assessment of *Solanum trilobatum* Leaf Extracts as DNA Damaging Anti Cancer Agent in the Management of Breast Cancer. International Journal of Latest Engineering and Management Research. 2017; 2(9):23-27.
3. Lahlou M. The success of natural products in drug discovery. Pharmacology and Pharmacy. 2013; 4:1731.
4. Parasuraman S, Thing GS, Dhanaraj SA. Polyherbal formulation: Concept of ayurveda. Pharmacognosy Review. 2014; 8:73-80.
5. Suriyavathana M, Usha V, Shanthanayaki M. Studies on phytochemical analysis and antioxidant activity of selected medicinal plants from Kolli hills. J Pharm Res. 2010; 2:260-262.
6. Hasim H, Kamali EL, Mohammed Y. Antibacterial activity and phytochemical screening of ethanolic extracts obtained from selected Sudanese medicinal plants Curr Res J Biol. 2010; 2(2):143-146.
7. Ncube NS, Afolayan AJ, Okoh AL. Assessment techniques of antimicrobial properties of natural compounds of plant origin: current methods and future trends. Afr J Biotechnology. 2008; 7(12):1797-1806.
8. Oliver SJ. The role of traditional medicine practice in primary health care within Aboriginal Australia: A review of the literature. Journal of Ethnobiology and Ethnomedicine. 2013; 9:46.
9. Mitscher LA, Drake S, Goliapudi SR, Okwute SK. A modern look at folklore use of anti-infective agents. J Nat. Prod. 1987; 50:1025-1040.
10. Zakaria M. Isolation and characterization of active compounds from medicinal plants. Asia Pac. J Pharmacol. 1991; 6:15-20.
11. Miller AL. Antioxidant flavonoids: structure, function and clinical usage. Altern Med Rev. 1996; 1:103-111.
12. Chu YH, Chang CL, Hsu HF. Flavonoid content of several vegetables and their antioxidant activity. Journal of the Science of Food and Agriculture. 2000; 80:561-566.
13. Nee M. Synopsis of *Solanum* in the New World. In: Nee M, Symon DE, Laster RN, Jessop JP. Solanaceae IV: Advamces in Biology and utilization. Royal Botanical Gardens, Kew, 1999; 285-333.
14. Cornquist A. An integrated system of classification of flowering plants. Columbia University Press, New York. 1981; 1262.
15. Nirmala Devi N, Ramachandramurthy B. Priliminary Pytochemical Screening of *Solanum Trilobatum* Young Leaves. Int. Res. J. Pharm. 2014; 5(2):80-82.
16. Silva TMS, Costa RA, Oliveria EJ, Barbosa-Filho JM, Agra MF, Camara CA. Complete ^{1}H and ^{13}C NMR assignments of isojuripidine from *Solanum asterophorum* Mart. J Braz Chem Soc. 2005a; 16(6B):1467-1471.
17. Silva TMS, Agra MF, Bhattacharyya J. Studies on the alkaloids of *Solanum* of Notheastern Brazil. Rev Bras Farmacogn. 2005b; 15:292-293.
18. Barbosa-Filho JM, Agra MF, Oliveira RAG Paulo MQ, Troling G, Cunha EVL, Ataide JR, Bhattacharyya J. Chemical and Pharmacological investigation of *Solanum* species of Brazil – a search for solasodine and other potentially useful therapeutic agents. Mem I Oswaldo Cruz. 1991; 86:189-191.
19. Govindan S, Viswanathan S, Vijayasekaran V, Alagappan R. Further studies on the clinical efficacy of *Solanum trilobatum* in bronchial asthma. Phytotherapy Res. 2004; 18:805-809.
20. Doss A, Dhanabalan R. Preliminary phytochemical screening and antibacterial studies of leaf extract of *Solanum trilobatum* Linn. Ethnobotanical Leaflets, 2008; 12:638-642.
21. Subramanian SV, Madhavan VR. Heritage of the Tamil siddha medicine. International Institute of Tamil Studies, Madras, 1983.
22. Purushothaman KK, Saradambal S, Nararanaswamy V. Chemical estimation of *Solanum trilobatum* L. Aust. J. Chem. 1969; 22(7):1569-1570.
23. Jawhar M, Amalan Rabert G, Jayaseelan M. Rapid proliferation of multiple shoots in *Solanum trilobatum* L. Plant Tissue Culture, 2004; 14(2):107-112.
24. Guilietti AM. *Solanum elaeagnifolium* Cav. Silver leaf night shade *in vitro* culture and production of solasodine. In: Biotechnology in Agriculture Forestry, Medicinal and Aromatic Plants. YPS Bajaj (Ed.) Vol. XIV Springer-Verlag, Berlin, Germany. 1991; 432-450.
25. Sai Durga Prasad S, Mallikarjuna K. Venumadhav R. Screening of Anti-Bacterial Activity of *Solanum trilobatum* Linn. Seed Extract against Dental Pathogens. Asian Journal of Plant Science and Research, 2015; 5(2):34-37.
26. Priya G, Chellaram C. Evaluation of Antibacterial Activity and Phytochemical Analysis of Medicinal Plant *Solanum trilobatum*. Int J Pharm Bio Sci, 2014; 5(3):354-359.
27. Amir M, Kumar S. Possible Industrial Application of Genus *Solanum* In Twentyfirst Century - A Review. J. Sci. Ind. Res, 2004; 63:116-124.
28. Nagarajan SM, Kandasamy S, Chinnappa R. Comparative antimicrobial activity of callus and natural plant extracts of *Solanum trilobatum* L. Ancient Science of Life, 2009; 28:3-5.
29. Harborne J.B. Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis. 3rd Edition. Chapman and Hall Co. New York. 1998, 1-302.
30. Raaman N. Phytochemical Techniques. New India Publishing Agency; 2008.
31. Trease GE, Evans WC. Textbook of pharmacognosy. 12th ed. Balliere-Tindal, London. 1979; 343.
32. Boham BA, Kocipai-Abyazan R. Flavonoids and condensed tannins from leaves of Hawaiian *Vaccinium vaticulatum* and *Vaccinium calycinium*. Pacific Sci, 1974; 48:458-463.
33. Kokate P, Purohit AP, Gokhale SB. Pharmacognosy, 20th Ed, Nirali Publication, India. 2002.
34. Adebayo EA, Ishola OR. Phytochemical and antimicrobial screening of crude extracts of *Terminalia*

gaucescens; African Journal of Pharmacy and Pharmacology, 2009; 3(5):217-221.
35. Van- Burden TP, Robinson WC. Formation of complexes between protein and Tannin acid. J. Agric. Food Chem., 1981; 1:77.
36. Stahl E. Thin-layer chromatography. II: standardization, visualization, documentation, and application. Chem Ztg, 1958; 82:323-329.
37. Annamalai P, Khosa RL, Hemalatha S. Evaluation of Analgesic Potential of *Solanum trilobatum* Roots. Iranian Journal of Pharmaceutical Research, 2009; 8(4):269-273.
38. Sahu J, Rathi B, Koul S, Khosa RL. *Solanum trilobatum* (Solanaceae) - An overview. Journal of Natural Remedies, 2013; 13:76-80.
39. Chinthana P, Ananthi T. Protective Effect of *Solanum nigrum* and *Solanum trilobatum* Aqueous Leaf Extract on Lead Induced Neurotoxicity in Albino mice Journal of Chemical and Pharmaceutical Research, 2012; 4(1):72-74.
40. Govindarajan P, Chinnachamy C. Studies on antioxidant activity and phenol and flavonoid content of *Solanum trilaobatum* L. Life Sciences International Research Journal, 2014; 1(1):131-136.
41. Salah N, Miller NJ, Pagange G, Tij burg L, Bolwell GP, Rice E, Evans C. Polyphenolic flavonoils as seavenger of aqueous phase radicals as chain breaking antioxidant. Arch Biochem. Broph. 1997; 2:339-346.
42. Del-Rio A, Obdululio BG, Casfillo J, Marin FG,Ortuno A. Uses and properties of citrus flavonoides. J.Agric Food Chem. 1997; 45:4505-4517.
43. Okwn DE. Phytochemical and vitamin content of indigenous spices of southeastern Nigeria. J. Sustain. Agric. Enuiron. 2004; 6(1):30-37.
44. Sadipo OA, Akiniyi JA, Ogunbamosu JU. Studies on certain Characteristics of extracts of bark of pansinystalia macruceras (K Schemp) pierre Exbelle. Global J.Pure Appl. Sci. 2000; 6:83-87.
45. Senthilkumar M. Phytochemical Screening of *Gloriosa superba L.*- from different Geographical Positions. International Journal of Scientific and Research Publications, 2013; 3(1):1-5.
46. Mahadev R, Hanumanthaiah R, Venkatarangaiah K, Paranthaman DA. Phytochemical screening and antimicrobial activity of *Solanum erianthum* D. Don. Int. J. Pharma. Sci., 2014; 4:507-511.
47. Romero CD, Chopin SF, Buck G, Martinez E, Garcia M, Bixby L. Antibacterial properties of common herbal remedies of the southwest. J Ethnopharmacol., 2005; 99:253-257.
48. Tambekar DH, Khante BS. Evaluation of antibacterial properties of ethnomedicinal herbs used by Korkus in Melghat of India against enteric pathogens. Int J Pharm Bio Sci. 2010; 6:31-34.
49. Thambiraj J, Paulsamy S. Evaluation of antimicrobial efficacy of the folklore medicinal plant, Acacia caesia. Asian J Pharm. Clin. Res. 2011; 4:103-105.