



Research Article

www.ijrap.net



PHYTOCHEMICAL EVALUATION OF THREE SPECIES OF SOLANUM L.

S. Gnana Sundari, S. Rekha and A. Parvathi*

Herbal Study Centre, Department of Botany, Holy Cross College (Autonomous), Tiruchirappalli, Tamil Nadu, India

Received on: 12/01/13 Revised on: 10/02/13 Accepted on: 17/03/13

*Corresponding author

E-mail: parvathi.adapa@gmail.com

DOI: 10.7897/2277-4343.04323

Published by Moksha Publishing House. Website www.mokshaph.com

All rights reserved.

ABSTRACT

The identification of primary and secondary constituents has become the utmost important tool to know the active principles of various medicinal plants. The present study was aimed at identification and evaluation of certain phytochemicals of therapeutic importance in *Solanum torvum*, *Solanum trilobatum* and *Solanum xanthocarpum* of the genus *Solanum* L., used in folk and traditional medicine to cure respiratory disorders especially bronchial asthma. The five different aqueous and organic (chloroform, dimethyl sulfoxide, ethanol and methanol) extracts of the leaves, flowers and fruits were used for identification of phytochemical constituents. The analysis revealed the presence of phytochemicals like alkaloids, flavonoids, saponins, steroids, tannins, terpenoids and phenolic compounds. Further, some of these phytochemicals were quantitatively estimated.

Key words: *Solanum torvum*, Swartz., *Solanum trilobatum*, L., *Solanum xanthocarpum*, Schrad. & Wendl., Qualitative analysis, Quantitative estimation, Therapeutic value.

INTRODUCTION

The genus *Solanum* L., belongs to the family Solanaceae is considered to be one of the largest among the angiosperms with great potential for food security in the developing world^{1,2}. 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 plant³. The active principles such as solanidine and other steroids extracted from the roots and leaves of some species are of potent and effective pharmaceuticals⁴. Majority of the *Solanum* species are widely used in folk medicine⁵. The presence of the steroidal alkaloid solasodine, an important starting material for the synthesis of steroid hormones, is characteristic active principle of the genus *Solanum* L., which has tremendous impact on utilization of this genus economically and medicinally all over the world^{6,7,8}. The lack of immediate known use for certain members of this group has led to their neglect and subsequent genetic erosion. Depletion of such potentially useful plant resources should be taken care of by paying attention to germplasm exploration and conservation studies. The present study was focused on phytochemical analysis of *S. torvum*, *S. trilobatum* and *S. xanthocarpum* that are largely used worldwide in traditional and folk medicine to cure respiratory disorders especially bronchial asthma.

Solanum torvum Swartz., is a hairy shrub and commonly known as turkey berry. In Tamil it is called sundaikai. The fruits are employed in traditional medicine to cure cough, bronchial asthma, liver and spleen enlargement⁹. Fruits and leaves are reported to be used in controlling various microbial infections¹⁰. It is also reported that the plant possesses antioxidant properties and intensively used worldwide in traditional medicine to cure fever, wounds, tooth decay and hypertension^{11,12}.

S. trilobatum L., is commonly called purple-fruited pea eggplant widely distributed in India. In Tamil it is called Tuduvulai. It is a climbing shrub with sharp recurved and

short compressed spines. The leaves contain rich amount of calcium, iron, phosphorus, carbohydrates, protein, fat, crude fibre, and minerals¹³. This plant is used as medicine for asthma, respiratory disorders, rheumatism and in reducing blood glucose level. It also possesses antibacterial, antifungal, antioxidant and antitumourous properties¹⁴⁻¹⁷.

S. xanthocarpum Schrad. & Wendl., is a perennial spiny under shrub commonly known as yellow-berried nightshade plant. In Tamil it is called kandankattiri. This plant is known for its medicinal benefits from time immemorial. The roots, stems, leaves, flowers and fruits of the plant are used in ayurvedic medicine^{18,19}. Different parts of the plant have been utilised traditionally for curing various ailments such as fever, cough, asthma and diabetes. The hot aqueous extract of dried fruits is used for treating cough, fever and heart diseases²⁰. The plant is extensively studied for the various pharmacological activities like antiasthmatic, hepatoprotective, cardiovascular, hypoglycemic and antiulcer properties²¹⁻²⁵. Scientific evidence has been reported in favor of the traditional use of the fruits of *S. xanthocarpum* in the treatment of diabetes mellitus²⁶.

The present investigation was aimed at evaluation of phytochemical constituents of the leaves, flowers and fruits of three valuable medicinal species of the genus *Solanum* L.

MATERIALS AND METHODS

The leaves, flowers and fruits used in the present study were collected from Pachamalai hills and Tiruchirappalli Town during November, 2011- February, 2012. Voucher specimens (401, 402, 403) were deposited at Herbal Study Centre, Department of Botany, Holy Cross College (Autonomous) Tiruchirappalli, India. The plants were taxonomically identified with the aid of "Flora of the Presidency of Madras"²⁷ and "Flora of Tamil Nadu Carnatic"²⁸.

Extraction of plant material

Leaves, flowers and fruits of selected plants were cleaned, shade dried and powdered in an electric grinder. Fifteen grams of powdered plant materials were soaked in 100 ml of aqueous and 80% of selected organic solvents (chloroform, ethanol, methanol and dimethyl sulfoxide (DMSO) and incubated for 24 h. Using the different extracts various tests were performed for alkaloids, flavonoids, indoles, phenols, polyphenolases, saponins, steroids, tannins and triterpenoids^{29,30,31}.

Qualitative detection of Phytochemicals

Qualitative phytochemical analysis was carried out with different organic extracts of leaves, flowers and fruits of the selected plants for identification of their bioactive components. The extracts were treated with various chemical reagents and their colour reactions were observed to identify the presence of phyto-constituents such as alkaloids, steroids, flavonoids, polyphenolases, triterpenoids, saponins and tannins.

Quantitative detection of Phytochemicals

After the confirmation of the presence of various phytoconstituents by qualitative phytochemical analysis, the coarse powder of the plant material was taken up for the quantitative estimation of alkaloids, flavonoids, phenols, saponins and tannins.

Determination of total Alkaloids

Five gram of the sample was weighed into a 250 ml beaker and 200 ml of 10% acetic acid in ethanol was added and covered and allowed to stand for 4 hr. This was filtered and the extract was concentrated on a water bath to one – quarter of the original volume. Concentrated ammonium hydroxide was added drop wise to the extract until the precipitation was completed. The whole solution was allowed to settle and the precipitate was collected and washed with dilute ammonium hydroxide and then filtered. The residue is the alkaloid, which was dried and weighed³⁰.

Determination of total Flavonoids

Two gram of the plant sample was extracted repeatedly with 100 ml of 80% aqueous methanol at room temperature. The whole solution was filtered through whatman filter paper No. 42 (125 mm). The filtrate was later transferred into a crucible and evaporated to dryness over a water bath and weighed to a constant weight³².

Determination of total Phenols

100 mg of the sample was extracted with 5 ml of 80% ethyl alcohol and centrifuged at 2000 rpm. The supernatant was taken for assay. One ml of folin-ciocalteu reagent was added to 0.5 ml of the alcoholic extract of the sample. 2 ml of 20 % sodium carbonate was added and heated for one minute. After cooling, the solution was made up to 10 ml with distilled water. A blank was prepared by adding all the reagents except the sample. The absorbance was read at 650 nm in spectrophotometer³³.

Determination of Saponins

The ground sample of 2 g of each was placed in a conical flask and 100 ml of 20 % aqueous ethanol were added. The samples were heated over a hot water bath for 4 h with continuous stirring at about 55°C. The mixture was filtered and the residue was re-extracted with another 200 ml of 20% ethanol. The combined extracts were reduced to 40 ml over water bath at about 90°C. The concentrate was transferred in to a 250 ml separation funnel and 10 ml of dimethyl ether was added and shaken vigorously. The aqueous layer was recovered and the ether layer was discarded. The purification process was repeated. 10 ml of n-butanol was added to it. The combined n-butanol extracts were washed twice with 10 ml of 5% aqueous sodium chloride. The remaining solution was heated in a water bath. After evaporation, the samples were dried in the hot air oven to a constant weight and the saponin content was calculated³⁴.

Determination of Tannins

500 mg powdered sample material was transferred to 250 ml conical flask containing 75 ml of distilled water. The contents in the flask were boiled for 30 min, centrifuged for 2000 rpm for 20 min. The supernatant was collected in 100 ml volumetric flask and made up to a known volume. One ml of the sample extract was transferred to a 100 ml volumetric flask containing 75 ml of distilled water. To this, 5 ml of Folin-Denis reagent and 10 ml of sodium carbonate solution were added and diluted to 100 ml. It was shaken well and left for 30 min. and the absorbance was read at 700 nm against a reagent blank water³⁵.

RESULTS AND DISCUSSION

Qualitative analysis of the aqueous, ethanol, methanol, DMSO and chloroform extracts of the selected plants exhibited presence of different phytochemicals. The results are presented in Tables 1-5. From the Table 1, ethanolic extracts clearly indicated the presence of alkaloids, flavonoids, saponins, steroids and polyphenolases (Hot water test) in all the parts of the plants tested. However, the test for HCN was uniformly negative. The fruits of all the tested plants contained tannins and terpenoids. All parts of the plants showed the presence of indoles except in leaves of *S. trilobatum* and *S. xanthocarpum*. The fruits of *S. trilobatum*, alone showed the absence of phenols. The results are in line with the reports of Swapna Latha and Kannabiran (2006)³⁶.

The methanolic extracts (Table 2) of the plant parts showed the presence of flavonoids, saponins, alkaloids and steroids. However, alkaloids are absent in the leaves of *S. xanthocarpum*³⁷. All parts of *S. torvum* and leaves of *S. trilobatum* and *S. xanthocarpum* showed the presence of terpenoids. Except the flowers of *S. xanthocarpum* all parts of the plants showed presence of indoles and phenols. Tannins are recorded in flowers and fruits of *S. torvum* and *S. trilobatum*.

Table 1: Test with fresh and 80% ethanolic extracts

Name of the plants	Plant Parts tested	Alkaloids	Flavonoids	HCN	Hot Water	Indoles	Phenols	Saponins	Steroids	Tannins	Terpenoids
<i>Solanum torvum</i> Swartz	Leaves	+++	+++	--	+++	+	+	+++	+++	--	--
	Flowers	++	+++	--	*	+++	+++	+	+++	--	--
	fruits	+++	+++	--	*	+++	+++	+	+++	++	+
<i>Solanum trilobatum</i> Linn.	Leaves	+++	+	--	+++	--	+	+++	+	--	--
	Flowers	+++	+++	--	*	+++	++	++	+++	--	--
	fruits	+++	+++	--	*	+++	--	+	+++	+	+
<i>Solanum xanthocarpum</i> Schrad & Wendl.	Leaves	+	+	--	+++	--	+++	++	+	--	--
	Flowers	+	+	--	*	++	++	+	+++	--	--
	Fruits	+++	+++	--	*	+++	+++	+	+++	+	+

+++ = High intensive; ++ = Medium intensive; + = Low intensive; - = Negative; * = Not tested

Table 2: Test with 80% methanolic extracts

Name of the plants	Plant Parts tested	Alkaloids	Flavonoids	Indoles	Phenols	Saponins	Steroids	Tannins	Terpenoids
<i>Solanum torvum</i> Swartz.	Leaves	++	+++	+	+++	+++	++	--	+
	Flowers	+	+++	+	++	+	+	+	+
	fruits	+	+++	+	+++	+	+	+	+
<i>Solanum trilobatum</i> Linn.	Leaves	++	+++	+	+++	+++	++	--	+
	Flowers	+	+++	+	+	++	+	+	--
	fruits	+	+++	+	+	+	+	+	--
<i>Solanum xanthocarpum</i> Schrad & Wendl.	Leaves	--	+++	+	+	++	++	--	++
	Flowers	+	+++	--	--	+	+	--	--
	fruits	+	+++	+	+	+	+	--	--

+++ = High intensive; ++ = Medium intensive; + = Low intensive; - = Negative

Table 3: Test with 80% Dimethyl sulfoxide (DMSO) extracts

Name of the plants	Plant Parts tested	Alkaloids	Flavonoids	Indoles	Phenols	Saponins	Steroids	Tannins	Terpenoids
<i>Solanum torvum</i> Swartz.	Leaves	+++	+++	+	++	++	++	--	+
	Flowers	+	+++	+	+++	+	+	--	+
	fruits	+	+++	+	+++	+	++	+	+
<i>Solanum trilobatum</i> Linn.	Leaves	+	+++	--	+++	+	++	--	+
	Flowers	+	+++	++	+	++	+	--	--
	fruits	+	+++	+	+	+	+	+	+
<i>Solanum xanthocarpum</i> Schrad & Wendl.,	Leaves	+	+++	+	++	+	+	--	--
	Flowers	+	+++	++	++	+	+	--	--
	fruits	+	+++	+	+++	+	+	+	--

+++ = High intensive; ++ = Medium intensive; + = Low intensive; - = Negative

Table 4: Test with 80% Chloroform extracts

Name of the plants	Plant Parts tested	Alkaloids	Flavonoids	Indoles	Phenols	Saponins	Steroids	Tannins	Terpenoids
<i>Solanum torvum</i> Swartz.	Leaves	+	+++	+	+	+	+++	--	+
	Flowers	+	+++	+	+	++	+++	--	+
	fruits	--	+++	+	+	+	+++	--	+
<i>Solanum trilobatum</i> Linn.	Leaves	+	+++	+	+	++	+	--	--
	Flowers	+	+++	+	+	+	++	+	--
	fruits	--	+++	--	--	+	+	--	--
<i>Solanum xanthocarpum</i> Schrad &Wendl.	Leaves	+	+++	+	++	+	+	++	+
	Flowers	+	+++	--	+	+	+	--	--
	fruits	+	+++	--	--	+	+	--	--

+++ = High intensive; ++ = Medium intensive; + = Low intensive; - = Negative

Table 5: Test with aqueous extracts

Name of the plants	Plant Parts tested	Alkaloids	Flavonoids	Indoles	Phenols	Saponins	Steroids	Tannins	Terpenoids
<i>Solanum torvum</i> Swartz.	Leaves	+	+++	+	+	+	+	--	--
	Flowers	+	+++	++	--	+	--	--	--
	fruits	+	+++	+++	--	+	--	--	--
<i>Solanum trilobatum</i> Linn.	Leaves	+	+	+	--	+	+	+	--
	Flowers	+	+++	+	+	+	--	--	--
	fruits	+	+++	+	+	+	--	--	--
<i>Solanum xanthocarpum</i> Schrad &Wendl.,	Leaves	--	+	+	--	+	++	--	+
	Flowers	+	+	+	+	+	+	--	--
	fruits	+	+++	+	+	+	--	--	--

+++ = High intensive; ++ = Medium intensive; + = Low intensive; - = Negative

Table 6: Quantitative estimation of phytochemical constituents

Name of the plants	Plant parts tested	Alkaloids mg/g of dry tissue	Flavonoids mg/g of dry tissue	Phenols mg/g of dry tissue	Saponins mg/g of dry tissue	Tannins mg/g of dry tissue
<i>Solanum torvum</i> Swartz.	Leaves	5.3	25	3.5	8.4	---
	Flowers	3.5	19	10.5	0.75	0.25
	Fruits	5.03	18.0	15.25	0.31	2.7
<i>Solanum trilobatum</i> Linn.	Leaves	4.70	0.21	2.0	6.23	--
	Flowers	6.12	18.36	4.37	2.25	--
	Fruits	5.03	16.90	--	0.3	0.15
<i>Solanum xanthocarpum</i> Schrad &Wendl.,	Leaves	0.94	1.18	17	3.08	--
	Flowers	0.63	0.97	7.75	1.8	--
	Fruits	4.62	30.16	12.5	0.7	1.5

The results of DMSO extracts (Table 3) showed the presence of alkaloids, flavonoids, phenols, saponins, steroids and indoles in all parts of the plants except in the leaves of *S. trilobatum*. However, tannins are observed in fruits of all the tested plants. The presence of terpenoids is noted all the parts of the *S. torvum*, leaves and fruits of *S. trilobatum*.

The chloroform extracts (Table 4) of selected plant parts showed the presence of flavonoids, saponins, steroids and phenols except in fruits of *S. trilobatum* and *S. xanthocarpum*. The tannins are recorded in the flowers of *S. trilobatum* and leaves of *S. xanthocarpum*. The presence of indoles are observed in all the parts of the plants except in fruits of *S. trilobatum* and *S. xanthocarpum*. All parts of the *S. xanthocarpum*, leaves and fruits of *S. torvum* and *S. trilobatum* showed the presence of alkaloids. Terpenoids are contained in all the parts of *S. torvum* and leaves of *S. xanthocarpum*.

The aqueous extracts (Table 5) of all the parts of selected plants showed the presence of flavonoids, indoles, saponins and alkaloids except in leaves of *S. xanthocarpum*. However, the leaves of *S. xanthocarpum* alone contained terpenoids. The steroids are recorded in leaves of all the selected plants and flowers of *S. xanthocarpum*. Tannins are present only in the leaves of *S. trilobatum*. Leaves of *S. torvum*, flowers and fruits of *S. trilobatum* and *S. xanthocarpum* showed the presence of phenols.

The selected plant parts were quantified for metabolites such as alkaloids, flavonoids, phenols, saponins and tannins. The results are presented in Table 6. From the table, it is understood that the alkaloids content of the flowers of *S. trilobatum* was found to be highest (6.12 mg/g) followed by leaves of *S. torvum* (5.3 mg/g). Whereas, fruits of *S. torvum* and *S. trilobatum* showed the approximately same amount (5.03 mg/g) of alkaloids. The alkaloid content ranged between the 0.63 mg/g (flowers of *S. xanthocarpum*) to 4.70 mg/g (leaves of *S. trilobatum*). The tannin content ranged between 1.5 mg/g (fruits of *S. xanthocarpum*) to 2.7 mg/g (fruits of *S. torvum*).

The fruits of *S. xanthocarpum* contained high amount of flavonoids (30.16 mg/g) followed by leaves of *S. torvum* (25 mg/g). Whereas, very low amount of flavonoid content was registered in the leaves of *S. trilobatum* (0.21 mg/g). The flavonoid content ranged between 1.18 mg/g in the leaves of *S. xanthocarpum* and 19 mg/g in the flowers of *S. torvum*.

The saponin content was registered high in the leaves of *S. torvum* (8.4 mg/g) followed by the leaves of *S. trilobatum* (6.23 mg/g). The saponin content ranged between 0.3 mg/g in fruits of *S. trilobatum* and 3.08 mg/g in leaves of *S. xanthocarpum*.

High amount of phenol content was registered in the leaves of *S. xanthocarpum* (17 mg/g) followed by fruits of *S. torvum* (15.25 mg/g). The phenol content varied from 12.5 mg/g in fruits of *S. xanthocarpum* and 2.0 mg/g in leaves of *S. trilobatum*.

CONCLUSION

From the studies, it could be concluded that these three selected *Solanum* species contained considerable amount

of therapeutic phytochemicals like alkaloids, flavonoids, indoles, saponins and steroids. The results might provide scientific support to the traditional claims in using these plants in throat congestion, cough and cold. In addition, all the three plants responded negatively for the Hydrogen cyanide (HCN) test. Therefore, it is suggested that these plant parts could be consumed without any hesitation in the form of various herbal preparations like decoctions, infusions, powders and tonics to cure various respiratory ailments. The results of the study could provide the basis for further isolation and evaluation of major active principles of these plant materials to test their efficacy against respiratory diseases.

ACKNOWLEDGEMENTS

The authors thank University Grant Commission, New Delhi for financial support and principal Holy Cross College (Autonomous), Tiruchirappalli for providing research facilities to carry out present research work.

REFERENCES

- Kochhar SL. Tropical Crops: A textbook of Economic Botany. Macmillan Publ. New Delhi. 1981.
- Nee M. Synopsis of *Solanum* in the New World. In: Nee M, Symon DE, Lester RN. & Jessop JP. *Solanaceae IV: Advances in biology and utilization*. Royal Botanic Gardens, Kew, 1999.p.285-333.
- Cronquist A. An integrated system of Classification of flowering Plants. Columbia University Press, New York. 1981. p. 1262.
- Simmonds NW, Choudhury B. Egg Plant (*Solanum melongena* L.). Evolution of Crop Plants. Longman Inc. New York. 1976.
- Tania Maria S, Silva I, Roberto Jefferson B, Nascimento, Michelle M. Batista, Maria F Agra, Celso A, Camara. Brine shrimp bioassay of some species of *Solanum* from Northeastern Brazil. *Revista Brasileira de Farmacognosia Brazilian Journal of Pharmacognosy*. 2007;17(1):35-38. <http://dx.doi.org/10.1590/S0102-695X20070010100008>
- Silva TMS, Costa RA, Oliveira EJ, Barbosa-Filho JM, Agra MF, Camara CA. Complete ¹H and ¹³C NMR assignments of isojuvipidine from *Solanum asterophorum* Mart. *J Braz Chem Soc*. 2005a; 16(6B): 1467- 1471. <http://dx.doi.org/10.1590/S0103-50532005000800030>
- Silva TMS, Agra MF, Bhattacharyya J. Studies on the alkaloids of *Solanum* of northeastern Brazil. *Rev Bras Farmacogn*. 2005b; 15: 292-293. <http://dx.doi.org/10.1590/S0102-695X2005000400005>
- 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. <http://dx.doi.org/10.1590/S0074-02761991000600043>
- Siemonsma J, Piluek K. Plant Resources of South-East Asia 8 (PROSEA), Bogor, Indonesia. 1994. p. 412.
- Schippers RR. African indigenous vegetables. An overview of the cultivated species. Natural Resources Institute/ ACP-EU Technical Centre for Agricultural and Rural Cooperation, Chatham, United Kingdom. 2000. p. 214.
- Sivapriya M, and Srinivas L. Isolation and purification of a novel antioxidant protein from the water extract of Sundakai (*Solanum torvum*) seeds, *Food Chemistry*, 2007; 104: 510 – 517. <http://dx.doi.org/10.1016/j.foodchem.2006.11.060>
- Ndebia EJ, Kanga R and Nchunga-Anye Nkeh B. Analgesic and anti-inflammatory properties of aqueous extract from leaves of *Solanum torvum* (Solanaceae), *AJTCAM*, 2007;4: 240 - 244.
- Jawhar M, Amalan Rabert G and Jeyaseelan M. Rapid proliferation of multiple shoots in *Solanum trilobatum* L. *Plant Tissue Culture*. 2004; 14 (2): 107-112.
- Purushothaman, K.K., Saradambal, S. and Narayanaswamy, V. Chemical estimation of *Solanum trilobatum*, L. *Aust.J.Chem*. 1969;22 (7): 1569-1570. <http://dx.doi.org/10.1071/CH9691569>
- Subramanian SV, and Madhavan VR. Heritage of the Siddha medicine, International Institute of Tamil Studies. Madras. 1983. P. 128.
- 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. <http://dx.doi.org/10.1002/ptr.1555>

17. Shahjahan M, Vani G and Shyamaladevi CS. Effect of *Solanum trilobatum* on the antioxidant status during diethyl nitrosamine induced and phenobarbital promoted hepatocarcinogenesis in rat, *Chemico-Biological Interactions*. 2005;156,(2-3):113-123. <http://dx.doi.org/10.1016/j.cbi.2005.08.003>
18. Billore KV, Yelne MB. Data base on medicinal plants in Ayurveda. Vol. VII, C.C.R.A.S, New Delhi. 2005.
19. Hedrick UP. Sturtevant's edible plants of the World. Dover publications. 1972.
20. Parmar S, Gangwal A and Sheth N. *Solanum xanthocarpum* (Yellow Berried Night Shade): A review, *Der Pharmacia Lettre*. 2010;2(4): 373-383.
21. Parmar S, Gangwal A and Sheth N. Evaluation of antiasthmatic activity of a polyherbal formulation containing four plant extracts. *J of Cur. Pharma Res*. 2010; 2(1): 40-44.
22. Gupta AK, Ganguly P, Majumder UK, Ghosal S. Hepatoprotective and antioxidant effects of total extracts and steroidal saponins of *Solanum xanthocarpum* and *Solanum nigrum* in paracetamol induced hepatotoxicity in rats. *Pharmacologyonline*. 2009; 1(27):757-768.
23. Samuel GY, Henry W. Comparative Cardiotonic activity of *Solanum xanthocarpum* with digoxin on isolated frog heart, *IJPI's J of Pharmacog and Herbal Formul*. 2011;1(5):1-6.
24. Kar DM, Maharana L, Pattnaik S, Dash GK. Studies on hypoglycaemic activity of *S.Xanthocarpum* fruit extract in rats. *J of Ethnopharmacol*.2006;108:251–256.<http://dx.doi.org/10.1016/j.jep.2006.05.016>
25. Yogendr B, Vijay J, Kuldeep G. Pharmacological evaluation of *Solanum Surattense* leaves for antiulcer activity. *J of Pharm Res*. 2008;1(2):253- 259.
26. Gupta S, Mal M, Bhattacharya P. Evaluation of hyperglycemia potential of *S.Xanthocarpum* fruit in normal and Streptozin induced diabetic rats. *Eur.bull.Drug res*. 2005; 13, 51, 55.
27. Gamble J S. Flora of the Presidency of Madras. Botanical Survey of India, Calcutta. Vol. I and II. 1957. p. 931-941.
28. Matthew K M. In: the flora of the Tamil Nadu Carnatic. 3:289. Publishers: the Diocesan press, Chennai. 1983.p. 334-342.
29. Gibbs RD. Comparative chemistry and phylogeny of flowering plants. *Tans. Roy. Soc. canser*. 1974.p. 48.
30. Harborne JB. *Phytochemical Methods. A guide to modern techniques of plant analysis*. chapman and Hall, London. 1984.
31. Trease GE, Evans WC. *Textbook of Pharmacognosy*. W.B. Sanders, London. 1989.
32. Bohm BA and Kocipai-Abyazan R. Flavonoids and condensed tannins from leaves of Hawaiian *vaccinium vaticulatum* and *V. calycinium*. *Pacific Sci*. 1974; 48 : 458 - 463.
33. Mahadevan A and Sridhar R. *Methods in physiological plant pathology*,Sivakami publications, Madras. 1982.
34. Obadoni B O, and Ochuko P O. Phytochemical studies and comparative efficacy of the crude extracts of some Homostatic plants in Edo and delta States of Nigeria. *Global J. Pure Appl.Sci*. 2001; 8 : 203 - 208.
35. Sadasivam S. and Manickam A. *Biochemical methods for agricultural sciences*. Wiley Eastern Ltd., Madras. 1992.
36. Swapna Latha P, and Kannabiran K. Antimicrobial activity and phytochemicals of *Solanum trilobatum* Linn. *Afr.J.Biotechnol*. 2006; 5 (23):2402-2404.
37. Neelapu Neelima, Naikwadi Gajanan Devidas, Muvvala Sudhakar, Jadhav Kiran VA Preliminary phytochemical investigation on the leaves of *Solanum xanthocarpum*. *Int. J. Res. Ayurveda Pharm*. 2011; 2(3):845-850.

Cite this article as:

S. Gnana Sundari, S. Rekha and A. Parvathi. Phytochemical evaluation of three species of *Solanum* L. *Int. J. Res. Ayurveda Pharm*. 2013;4(3):420-425

Source of support: University Grant Commission, New Delhi, Conflict of interest: None Declared