



**International Journal of Biology, Pharmacy  
and Allied Sciences (IJBPAS)**

*'A Bridge Between Laboratory and Reader'*

[www.ijbpas.com](http://www.ijbpas.com)

---

**PHARMACOGNOSTIC, PHYTOCHEMICAL, ANTIOXIDANT ANALYSIS AND  
ISOLATION OF SOLASODINE ALKALOID FORM OF *SOLANUM GIGANTEUM*  
LEAF**

**VIKAS S. SHENDE<sup>\*1,2</sup>, JAGDISH L. KAKADIYA<sup>1</sup>**

**1:** Parul Institute of Pharmacy and Research, Parul University, Vadodara. Gujarat, India  
391760

**2:** Satara College of Pharmacy, Satara, [MS], India 415004

**\*Corresponding Author: Vikas s. Shende: E Mail: [vikas\\_shende2003@yahoo.co.in](mailto:vikas_shende2003@yahoo.co.in)**

Received 3<sup>rd</sup> Oct. 2021; Revised 11<sup>th</sup> Nov. 2021; Accepted 20<sup>th</sup> Dec. 2021; Available online 25<sup>th</sup> Jan. 2022

<https://doi.org/10.31032/ijbpas/2022/11.1.2066>

**ABSTRACT**

**Objective:** To analyze pharmacognostic, phytochemical and evaluate in vitro antioxidant properties and to assess the alkaloids present in the *Solanum giganteum* leaf.

**Methods:** It includes a study of leaf macroscopic features, microscopic features and physicochemical parameters evaluated using standard procedures as per WHO guidelines. In vitro antioxidant DPPH, H<sub>2</sub>O<sub>2</sub> and NO radical scavenging estimated standard methods. Alkaloid solasodine is isolated from *Solanum giganteum* leaf and performed various characterization tests.

**Result:** In microscopy of *Solanum giganteum* leaf are having Upper epidermis, trichomes, vascular bundle, collenchyma, the lower epidermis. In powdered characteristics, Lignified trichomes, Brownish matter, Non-lignified fibre, Starch grain and Calcium oxalate crystal is observed. A low amount of total ash acid insoluble ash and water-soluble ash indicate that the inorganic matter and non-physiological matter such as silica is less in *Solanum giganteum Jacq* leaves. The estimation of total phenolic content in the examined extracts showed SG-Chloro extracts contain high phenolic content than SG-Alcohol and SG-Pet ether. The results of antioxidant evaluation based on the three models (DPPH, H<sub>2</sub>O<sub>2</sub> & NO) used in this study revealed that Chloroform and Alcohol extract of *Solanum giganteum* leaf possess interesting antioxidant activity. Alkaloid solasodine is isolated from *Solanum giganteum* and performed various

---

characterization tests like melting point, optical rotation, solubility, TLC, IR characterization test results of standard solasodine and isolated solasodine same was found.

**Conclusion:** The pharmacognostic, phytochemical analysis can contribute to the development of the quality control norms for this species. This plant may possess considerable antioxidant activities.

**Keywords:** - *Solanum giganteum*, Pharmacognostic, antioxidant activities, Solasodine

## INTRODUCTION

Plants are the main resources for medicine, and consequently, their Pharmacognostical, pharmacological and safety parameters require to be assessed. Pharmacognosy principally deals with the standardization, authentication and study of natural drugs. It is directly involved with allied fields, viz. photochemistry and toxicological screening of natural products. Much of the investigation in pharmacognosy has been done in identifying notorious species of plants, authentication of normally used traditional medicinal plants through morphological, histological, physicochemical and toxicological parameters, especially heavy metal estimation and radiobiological contagion in plants, prescribed by an authoritative source. The significance of pharmacognosy has been widely felt in recent times. To ensure the reproducible superiority of herbal medicines, the correct organisation of starting material is essential. The first step towards ensuring the value of the initial material is authentication followed

by creating numerical values of standards for comparison [1].

Ancient Indian literature incorporates an outstandingly broad description of the control. There is a requirement for documentation of examining work carried out on traditional medicines. With this backdrop, it becomes enormously significant to make an effort towards the reliability of the plant material to be used as medicine. The process of reliability can be achieved by stepwise pharmacognostic studies [2, 3].

So numerous varieties in the plant of the genus Solanaceae. There may be up to around 1,500 species worldwide. With a few 800 conventional specific and infraspecific taxa of the more than 4,000 described, the genus Solanum contains more species than any other genus in the *Solanaceae* family and it is one of the largest between the angiosperms.

*Solanum giganteum* (SG) is a recognized medicinal plant; the leaves were previously used as a dressing for festering, open sores: the woolly undersurface being applied to cleanse the lesion and the smooth upper

surface to heal it. Hence, in the existing work, the pharmacognostic standardization has been performed for the leaves, of *Solanum giganteum*. This present work helps establish the proper identification of plant material. It will be a diagnostic tool for the standardization and characterization of *Solanum giganteum* Jacq. It will also be supportive of other researchers to retain the standard of this plant for their research project [4-6].

## MATERIALS AND METHODS

### Collection of the Plant Material and Identification

The plant *Solanum giganteum* Jacq was collected in November 2019, from the area of Satara Maharashtra, India, the specimen was authenticated by comparing it with the voucher specimen deposited in the Department of Botany by Y.C. Institute of Science, Satara, Maharashtra, India.

### Pharmacognostic standardization:

It includes the study of leaf macroscopic features, microscopic features and physicochemical parameters. Macroscopic features include a study of colour, odour, size, shape, taste and special features including touch and texture etc of drugs with help of sensory organs. Microscopic features tell about tissue arrangement in the transverse section of leaf and type of

stomata, trichomes, vascular bundle and different cells. Along with this we also get to know about cell content and crystalline structures. With help of a photomicroscope, we can check various leaf constants. In physicochemical parameters, we have studied various Ash values, extractive values, loss on drying, foreign organic matter, swelling index and foaming index. These all were performed using standard procedures as per WHO guidelines [7-11].

### Extraction

Freshly collected leaves of the plant *Solanum giganteum* Jacq. were dried at room temperature for three weeks. The dried plant material was made a coarse powder and weighed the quantity of the powder (500g) was subjected to hot extraction in a soxhlet apparatus using petroleum ether, chloroform, ethanol, at a temperature range of 40-80<sup>0</sup> c. The marc was completely dried and weighed, before and after every extraction. At room temperature, the extract was concentrated by evaporation of solvent [12].

### Phytochemical screening

Preliminary phytochemical investigations for secondary metabolites were carried out on the extracts sample of the plant of *Solanum giganteum* using standard procedures. The metabolites tested for were carbohydrates, balsams, resins, saponins, sterols, terpenes,

tannins, flavonoids, cardiac glycosides, glycosides, alkaloids and phlorotannins [13].

### **In-Vitro Antioxidant Studies.**

#### **Determination of total phenolic content.**

Total phenol contents in the extracts were determined. 100 mg of extract was dissolved into 4.5 ml of distilled water with 0.5 ml of tween 80. Pipette out 0.5 ml (500  $\mu$ l) of extracts (SG-chloro, SG-alcohol, SG-pet ether.), and Gallic acid (Standard) solutions are of strength (100-600  $\mu$ g/ml). Then mixed with 5 ml Folin-Ciocalteu reagent (previously diluted with water 1:10 v/v) and 5 ml (7.5 g/L) of sodium carbonate. The tubes were vortexed for 15 seconds and at 40 °C, permitted to stand for 30 minutes for colour development. Absorbance was read at 765 nm using a spectrophotometer by putting 4 ml of the prepared mixture into a cuvette [14, 15].

The percentage of total phenolic content (TPC) was calculated from the calibration curve of gallic acid plotted and total phenolic content was expressed as mg gallic acid equivalent per g extract (mg GAE/g extract)

#### **DPPH (1, 1-diphenyl-2-picrylhydrazyl) radical scavenging activity.**

DPPH radical scavenging assay was performed using 1, 1 diphenyl-2-picrylhydrazyl (DPPH). Ascorbic acid and extracts (SG-Pet ether SG-Chloro, SG-

Alcohol) of plants prepared solutions are of strength (50 -500  $\mu$ g/ml). Then 3 ml from each extract was mixed with 1 ml of freshly prepared 0.1 mmol/L DPPH (1, 1-diphenyl-2-picrylhydrazyl) solution. The mixture was shaken vigorously and incubated at room temperature for 30 min in dark. The reduction of the DPPH free radical was measured by reading the absorbance at 517 nm by a spectrophotometer [16, 17].

Inhibition of DPPH free radical in percentage was calculated by the formula:

$$\text{DPPH radical scavenging activity (\%)} = [(A_{\text{control}} - A_{\text{sample}}) / (A_{\text{control}})] \times 100$$

Where,

$A_{\text{control}}$  is the absorbance of DPPH radical + methanol;

$A_{\text{sample}}$  is the absorbance of DPPH radical + sample extract /standard.

#### **Hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) scavenging activity.**

Various concentrations (20-100  $\mu$ g/ml) of the ascorbic acid and *Solanum Giganteum* extracts (SG-Chloro, SG-Pet ether, SG-Alcohol.) were prepared in distilled water. 1 ml of each solution of different concentrations of extracts and standard was mixed with 2 ml of 0.1 M phosphate buffer solution and 600  $\mu$ l of 100 mM H<sub>2</sub>O<sub>2</sub> solution. After 10 minutes (approximately) absorbance of different concentrations of

ascorbic acid and *Solanum giganteum* extract solutions were taken at 230 nm [18].

The percentage of inhibition was calculated by comparing the absorbance values of the control and test samples using Equation. IC<sub>50</sub> values were estimated from the % inhibition versus concentration plot, using a non-linear regression algorithm [19].

$$I\% = \frac{Ac - Ab}{Ac} \times 100$$

Where,

I% = Percentage inhibition.      Ac = Absorbance of control (0.1 M phosphate buffer solution and H<sub>2</sub>O<sub>2</sub>).

At = Absorbance of ascorbic acid/plant extract with H<sub>2</sub>O<sub>2</sub> after 10 minutes.

Ab = Absorbance of ascorbic acid/plant extract without H<sub>2</sub>O<sub>2</sub>.

### Extraction and Isolation of Solasodine

Fresh green leaves of *Solanum giganteum* (Solanaceae) were collected. Leaves portion next to dried at room temperature and then reduced to a coarse powder were transferred to 5 litres round bottom flask. The powder was defatted with petroleum ether to give up greenish-yellow oil, which is discarded as it is devoid of glycoalkaloid. Defatted material was then refluxed with 32% v/v conc. HCl, water and toluene in 1:2:3 ratios for 5 hours and pH were recorded 3-4. After reflux two phases were found- one is superior pale yellow toluene layer and the other was

inferior dark brown aq. layer. The upper toluene layer was siphoned out and the lower aqueous layer was extracted with toluene 3 times. The toluene extract was acidified with 25% v/v acetic acid and stirred well for one hr. On standing two phases were formed, the upper pale yellow toluene layer and lower acetic acid layer. The process was repeated for the second time too. The pH was recorded was 3.5. Finally, the acetic acid layer was alkalinized with 25% v/v NH<sub>4</sub>OH slowly, pH was checked 10. The mixture was briefly heated and then cooled at room temperature. The colourless solasodine was precipitated. The reaction mixture was subsequently alkalinized with 40% w/v NaOH, pH was recorded 9-10 and again refluxed under stirring for 2 hrs. The colourless solasodine was precipitated and filtered off and washed with cold water and also finally dried in air (colourless crystalline powder, 20 mg) [20, 21].

### Physical properties of Solasodine

To determine the various physical characteristic of isolated solasodine alkaloids like melting point, solubility, Optical rotation, TLC, IR carried out the standard method [22, 23].

### RESULT

*Solanum giganteum Jacq* was also known as a healing tree found in Satara Maharashtra

India. Thus the Pharmacognostic study is carried out and the result obtained as follow macroscopy of leaves are shown in table 1 and fig.1.



Figure 1: Leaf

Table 1 Macroscopy of Leaf		
Sr. No.	Properties	Leaf
1	Colour	Green
2	Odour	None
3	Test	Bitter
4	Size	9-11cm.
5	Shape	Irregular

### Microscopy:

The transverse section of a leaf through midrib, epidermis in surface view, lamina in surface view and lamina in transverse view show the following characteristic. The leaf is Dorsi-ventral in nature. The upper epidermis is covered by a thin cuticle. Both the epidermis shows diacytic stomata. Multicellular covering trichomes are ardently present on both epidermises. The transverse view of the lamina shows a single layer of closely packed palisade cells below the upper epidermis. Midrib shows 5-7 layered thick wall closely packed collenchymas on both surfaces. Spongy parenchymas, lignified as well as non-lignified vascular bundles are shown in fig. 2.

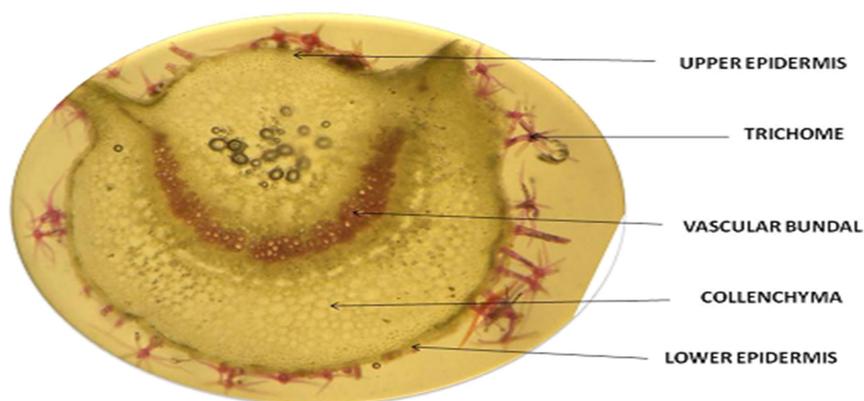


Figure 2. T.S. of Leaf

**Physicochemical Analysis:****Determination of Ash Values of Crude Drug (Table 2) P****reliminary Phytochemical Test:**

The results of preliminary phytochemical analysis of Pet ether, Chloroform, Ethanol extract *Solanum giganteum* of are shown in Table 3.

**Total phenolic content (TPC).**

The phenolic content of all the extracts was considerably high which could be a major contributing factor to the strong antioxidant activity of these plant extracts are shown in table 4.

**DPPH radical scavenging activity.**

The antioxidant effect of various extracts of *Solanum giganteum* leaf by DPPH % scavenging is shown in Table 5.

**Hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) scavenging activity.**

The antioxidant effect of various extracts of *Solanum giganteum* leaf by H<sub>2</sub>O<sub>2</sub> % scavenging is shown in Table 6.

**Isolation of Solasodine**

Alkaloid solasodine is isolated from *Solanum giganteum* yield obtained 0.9 mg.

**Physical properties**

The physical properties like melting point, solubility, optical rotation are carried out on the isolated product.

**Melting Point:** - Melting Point of isolated product is 198-200 °C is similar to the reported melting Point

**Solubility:** Solubility determines the polarity of the drug. By performing a solubility test on isolated products confirmed that they are soluble in benzene, chloroform, and methanol.

**Optical rotation:** Optical rotation of isolated product is  $[\alpha]_D^{25} = -980$ ,  $[\alpha]_D = -1130$  (c 0.14 in MeOH) and similar with reported standard product.

**TLC:** TLC of standard and test are performed by using Ethyl acetate: toluene: triethylamine (5:5:1, v/v/v) as a solvent system and anisaldehyde sulfuric acid reagent (ASR) as a spraying agent and it is calculated by RF value are shown in Table 7 and Fig. 5 and 6.

**IR**

IR of isolated product carried out showing the near about same stretching like slandered and confirmed by comparing graphical representation and interpretation of IR spectrum of isolated solasodine with reported solasodine standard shown in Table 8 and Fig. 7.

Table 2: Ash values

Sr. No	Parameter	% Ash Value
1	Total Ash	0.2%
2	Acid insoluble ash	0.06%
3	Water-soluble	0.17%

Table 3: Preliminary Phytochemical Screening of Various Extracts Of *Solanum Giganteum*

Sr. No	Phytochemical Test	SG -Pet ether.	SG -Chloro	SG -Alcohol
1.	Alkaloids	-	+	-
2.	Saponin glycoside	-	-	-
3.	Anthraquinone glycoside	-	+	+
4.	Cardiac glycoside	-	+	+
5.	Flavonoids	-	+	+
6.	Amino acid	-	-	-
7.	Carbohydrate	-	-	-
8.	Proteins	-	-	-
9.	Starch	-	-	-
10.	Tannins	+	+	-

Table 4: Total phenolic content of *Solanum giganteum* plant extracts.

Sr.No	Plant Extracts	Total phenolic content (GA equivalent)
1	SG-Alcohol	294.8
2	SG-Chloro	323.4
3	SG-Pet. ether	271.4

Table 5: IC<sub>50</sub> values and % inhibition of *Solanum giganteum* leaf extracts and standard ascorbic acid obtained for DPPH radical scavenging activity.

Conc. µg/ml	Ascorbic Acid	SG-Pet ether	SG-Chloro	SG-Alcohol
	% Inhibition	% Inhibition	% Inhibition	% Inhibition
50	6.565 ± 2.74	-28.787 ± 7.5	46.96 ± 10.74	-28.78 ± 4.00
100	19.191 ± 2.67	-28.78 ± 4.62	30.80 ± 18.80	-3.030 ± 3.15
200	29.797 ± 4.13	-9.090 ± 3.15	37.87 ± 16.20	3.03 ± 1.74
300	47.979 ± 4.48	6.565 ± 1.01	76.666 ± 6.74	10.60 ± 2.31
400	56.565 ± 2.02	6.565 ± 1.82	3.535 ± 7.01	27.777 ± 7.84
500	59.595 ± 6.23	18.181 ± 3.49	3.535 ± 8.26	35.353 ± 9.43
IC <sub>50</sub>	274.985 µg/ml	160.72 µg/ml	363.81 µg/ml	351.71 µg/ml

Table 6: IC<sub>50</sub> values and % inhibition of *Solanum giganteum* leaf extracts and standard ascorbic acid obtained for Hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) scavenging activity

Conc. µg/ml	Ascorbic acid	SG - Pet ether	SG - Chloro	SG - Alcohol
	% Inhibition	% Inhibition	% Inhibition	% Inhibition
20	20.947 ± 0.38	-1.309 ± 2.33	11.468 ± 5.52	12.516 ± 1.17
40	22.627 ± 0.96	-0.583 ± 3.09	16.279 ± 7.12	17.875 ± 2.66
60	27.307 ± 2.78	-0.940 ± 2.06	17.065 ± 6.19	20.423 ± 3.43
80	36.072 ± 3.09	-6.049 ± 1.03	16.397 ± 1.14	21.043 ± 2.80
100	62.176 ± 0.62	-13.61 ± 5.92	23.745 ± 2.41	15.410 ± 2.06
IC <sub>50</sub>	193.011 µg/ml	0	440.523 µg/ml	36.229 µg/ml

Table 7: RF Value

Sr. no	Sample	Solvent system	Spraying agent	RF value
1	Standard	Ethyl acetate: toluene: triethylamine (5:5:1, v/v/v)	Anisaldehyde sulfuric acid reagent (ASR)	0.56
2	Test	Ethyl acetate: toluene: triethylamine (5:5:1, v/v/v)	Anisaldehyde sulfuric acid reagent (ASR)	0.58



Figure 5: TLC of standard



Figure 6: TLC of Test (Isolated product)

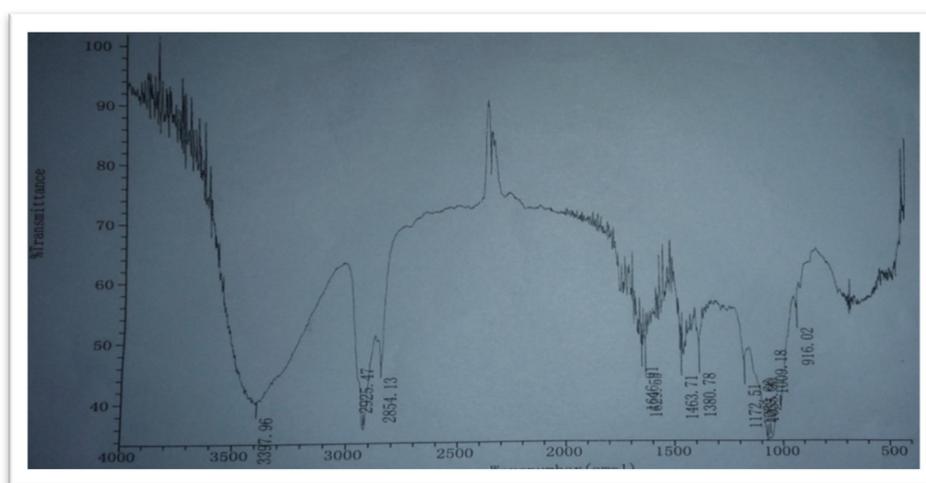


Figure 7: IR Spectra of isolated product

Table 8: Interpretation of IR spectrum of isolated solasodine

Wavelength(cm <sup>-1</sup> )	Inference
2854.13, 2925.47	C-H Stretching
1629.59	C=C Stretching
1172.51, 1069	C-N Symmetric stretching
1009.18, 1172.51	C-O Stretching

---

## DISCUSSIONS

The pharmacognostic study is the most imperative and reliable criterion of recognition of plant drugs. The pharmacognostic parameters are essential for confirmation of the individuality and rationale of the quality and purity of a crude drug. According to the World Health Organization (WHO), the macroscopic and microscopic explanation of a medicinal plant is the first step towards establishing its uniqueness and purity and should be carried out before any tests are undertaken<sup>05</sup>. In recent years, there has been great interest in the health effects of various natural products and the In-vivo protective function of natural antioxidants contained in dietary food against oxidative damage caused by ROS. In vitro-antioxidant studies are widely carried to screen various plants containing phenolic and flavonoids constituents. They have received considerable attention because of their physiological effect like antioxidant, anti-inflammatory, antitumor activities<sup>16</sup>. Microscopy of the leaf is carried out. In microscopy of a leaf are having an upper epidermis, trichomes, vascular bundle, collenchyma, the lower epidermis. Ash value of a crude drug is used to determine the quality of the drug. A low amount of total ash acid insoluble ash and water-soluble ash

indicate that the inorganic matter and non-physiological matter such as silica is less in *Solanum giganteum* Jacq leaves.

Spectrophotometric analytical methods applied for the estimation of total phenolic content and determination of phenolic acids in the examined extracts showed that these constituents are present in a valuable amount in the leaf extract of *Solanum giganteum* in the current study. The SG-Chloro extracts contain high phenolic content than SG-Alcohol and SG-Pet ether. This can absorb and neutralize free radicals, decompose peroxide and relative oxygen species, and help to prevent cell damage caused by oxidative stress. Our results strongly suggest that phenolic compounds are important components of *Solanum giganteum* and some of their pharmacological effects could be attributed to the presence of these compounds. The result of the DPPH scavenging activity assay in this study indicated that the plant extract SG-Chloro, SG-Alcohol, was more potently active than SG-Pet ether and show high % inhibition. This suggested that the extracts did contain a compound that could be capable of donating hydrogen to a free radical to remove the odd electron which is responsible for the radical's reactivity.

H<sub>2</sub>O<sub>2</sub> scavenging activity was detected and compared with ascorbic acid. Hydrogen peroxide is a weak oxidizing agent and can inactivate a few enzymes directly, usually by oxidation of essential thiol (-SH) groups. It rapidly Transverses cell membrane and once inside the cell interior. H<sub>2</sub>O<sub>2</sub> can probably react with Fe<sup>2+</sup> and possibly Cu<sup>2+</sup> ions to form hydroxyl radical and this may be the origin of many of its toxic effects. It is therefore biologically advantageous for cells to control the amount of hydrogen peroxide that is allowed to accumulate. (35) So current study provide evidence that our plant *Solanum giganteum* leaf extracts SG-Chloro and SG-Alcohol show the hydrogen peroxide scavenging activity.

In the present investigation, SG-Chloro and SG-Alcohol extract of *Solanum giganteum* exhibited an outstanding scavenging effect on DPPH and H<sub>2</sub>O<sub>2</sub> radicals. So It was observed that the SG-Chloro and SG-Alcohol extract contained a high level of phenolic content that might have accounted for the strong activity observed against the free radical. Results revealed that leaves of *Solanum giganteum* have many phytochemical constituents which may be responsible for many pharmacological activities.

Alkaloid solasodine is isolated from *Solanum giganteum* yield were obtained 0.9 mg. Performed various characterization tests like melting point, optical rotation, solubility, TLC, IR characterization test results of standard solasodine and isolated solasodine same was found. Melting was found of isolated sample 198-200 °C standard solasodine was the same reported. The isolated solasodine is soluble in benzene chloroform-methanol same as standard. TLC of isolated sample and standard solasodine near same RF value (RF value of standard - 0.56, RF value and isolated product- 0.58). Optical rotation isolated product found ( $[\alpha]_D^{25} = -98^{\circ}$ ,  $[\alpha]_D = -113^{\circ}$  (c 0.14 in MeOH). The IR Spectra of the isolated product shows-H Stretching, C=C Stretching, C-O Stretching and C-N show Symmetric stretching similar to solasodine.

#### ACKNOWLEDGEMENTS

The authors are thankful for the financial support provided by Shivaji University, Kolhapur, Maharashtra, India.

#### REFERENCES

- [1] Chanda S, Nagani K, Parekh J. Assessment of quality of *Manilkara hexandra* (Roxb.) Dubard leaf (Sapotaceae): pharmacognostical and physicochemical profile. Pharmacognosy Journal. 2010 Sep 1;

- 2(13):520-4. doi.org/10.1016/S0975-3575(10)80054-9
- [2] Deore SL, Khadabadi SS, Baviskar BA. Pharmacognosy and phytochemistry, a comprehensive approach, Pharmamed Pres a unit of BSP books Pvt. Ltd. printed on. 2014; 483.
- [3] Jayakumar K, Murugan K. Solanum alkaloids and their pharmaceutical roles: a review. J Anal Pharm Res. 2016; 3(6):00075. doi: 10.15406/japlr.2016.03.00075
- [4] Shende VS and Kakadiya JL. "Screening of Medicinal Plants Used For Prevention and Treatment Neurodegenerative Diseases: A Review. IJPSR.2021 May 19; 12(8): 4073-4085. doi: 10.13040/IJPSR.0975-8232.12(8).4073-85
- [5] Patel K, Singh BR, and Patel KD. "Medicinal significance, pharmacological activities, and analytical aspects of solasodine: A concise report of current scientific literature." Journal of Acute Disease 2.2013; 2: 92-98. doi.org/10.1016/S2221-6189(13)60106-7
- [6] Manasa S, Raju AB. Antiamnesic activity of *Solanum melongena* L. extract. Postępy Fitoterapii. 2014 Jan 21.
- [7] Sharma T, Airao V, Panara N, Vaishnav D, Ranpariya V, Sheth N, Parmar S. Solasodine protects rat brain against ischemia/reperfusion injury through its antioxidant activity. European Journal of Pharmacology. 2014 Feb 15; 725:40-6. doi.org/10.1016/j.ejphar.2014.01.005.
- [8] Shende VS, Jadhav SD, Aloorkar NH, Kulkarni AS, Suryavanshi SV. Pharmacognostic and phytochemical evaluation of *Strobilanthes sessilis* Nees. Leaves. Int J Pharmacogn. 2015; 2:310-4. doi: 10.13040/ijpsr.0975-8232.ijp.2(6).310-14.
- [9] Rajisha K, Fernanades J. Pharmacognostic and Preliminary Phytochemical Investigation of *Exacum bicolor* Roxb. Research Journal of Pharmacy and Technology. 2020. Dec; 13(4):1752-6. doi : 10.5958/0974-360x.2020.00316.9.
- [10] Odoh UE, Ezugwu CO, Ezejiofor M. Pharmacognostic Studies on the Leaves of *Dyschoriste Perottetii* Nees. Pharmacognosy Journal. 2011

- Aug 1; 3(24):11-4.  
doi.org/10.5530/pj.2011.24.3.
- [11] Gupta PC, Sharma N, Rao CV. Pharmacognostic studies of the leaves and stem of *Careya arborea* Roxb. Asian Pacific journal of tropical biomedicine. 2012 May 1; 2(5):404-8. doi.org/10.1016/S2221-1691(12)60065-3
- [12] World Health Organization Quality control methods for medicinal plant materials. Geneva. (1998).
- [13] Alam F, Najum us Saqib Q. Pharmacognostic standardization and preliminary phytochemical studies of *Gaultheria trichophylla*. Pharmaceutical biology. 2015 Dec 2; 53(12):1711-8. doi.org/10.3109/13880209.2014.1003355
- [14] Blainski A, Lopes GC, De Mello JC. Application and analysis of the folin ciocalteu method for the determination of the total phenolic content from *Limonium brasiliense* L. Molecules. 2013 Jun; 18(6):6852-65. doi.org/10.3390/molecules18066852
- [15] Kumar A, Mahajan A, Begum Z. Phytochemical screening and in vitro study of free radical scavenging activity of flavonoids of aloe vera. Research Journal of Pharmacy and Technology. 2020. Apr 9; 13(2):593-8. doi : 10.5958/0974-360x.2020.00112.2
- [16] Saumya SM, Mahaboob BP, Basha P. In vitro evaluation of free radical scavenging activities of *Panax ginseng* and *Lagerstroemia speciosa*: a comparative analysis. Int J Pharm Pharm Sci. 2011;3(1):165-9. doi: 10.5958/0974-360x.2018.00894.6
- [17] Shankar S, Thiripura Salini S. Evaluation of in vitro Antioxidant Activity of *Canthium coromandelicum*. RJ Med Plant. 2014;8(2):149-55.doi: 10.3923/rjmp.2014.149.155
- [18] Sreejayan N, Rao MN. Free radical scavenging activity of curcuminoids. Arzneimittel-forschung. 1996 Feb 1; 46(2):169-71. PMID: 8720307
- [19] Yadav SS, Sangwan P, Ganie SA, Gulia SS. Studies on free radical Scavenging activity and total phenolic content of *Foeniculum vulgare* Mill. Research Journal of Pharmacy and Technology. 2020.

- 
- Aug 10; 13(7):3394-8. doi : 10.5958/0974-360x.2020.00603.4
- [20] Christiya CR, Radhika J. Screening of Physicochemical properties and In Vitro free radical scavenging activity of *Delonix elata* L. leaf extracts. Research Journal of Pharmacy and Technology. 2020; 13(6):2727-32. doi : 10.5958/0974-360x.2020.00485.0
- [21] Bhattacharya S, Kohli S, Chaudhary AS. Isolation of solasodine from the unripe fruits of *Solanum xanthocarpum* Schrad and Wendl. Solanaceae) and it's anti cancer activity against HeLa and U937 cell lines. Austral-Asian J Cancer. 2013; 12:199-213.
- [22] Chauhan K, Sheth N, Ranpariya V, Parmar S. Anticonvulsant activity of solasodine isolated from *Solanum sisymbriifolium* fruits in rodents. Pharmaceutical biology. 2011 Feb 1; 49(2):194-9.  
doi.org/10.3109/13880209.2010.508499
- [23] Devi RK, Radha R, Jayshree N. Formulation and Evaluation of Solasodine Transdermal Patches for Anti-Inflammatory Activity. Int J Pharm Res & Rev. 2014; 3(4):36-42. Corpus ID: 55908566
-