An updated ethnobotany, phytochemical and pharmacological potential of *Solanum indicum* L.

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**Abstract**

*Solanum indicum* L. (Family Solanaceae), also known as poison berry in English, is a thorny, heavily branched perennial under shrub that can grow up to 1 metre in height and reach heights of up to 1 metre in height. This wonderful medicinal plant is extensively used in folk and traditional Indian systems of medicine to treat toxic affections, skin problems, ulcers, difficulties breathing, stomach aches, coughing, and dyspepsia, among other conditions. It is native to India and can be found throughout the country, primarily in warmer climates up to an elevation of 1500 metres. It is a well-known Indian medicinal plant that has been utilised extensively in the Ayurvedic system of medicine of treatment for many years in various ailments. It is a key component of the dasamoola group of plants' composition. Solasodine, Solasonine, Solamargine, Solandine, and Solanine are some of the active steroidal alkaloids/glycoalkaloids found in *S. indicum*. The presence of various phytoconstituents in the plant has been documented, including steroidal saponins, sesquiterpenoids, hydroxycoumarins, phenolic compounds, coumarins, coumarinolignoids alkaloids, saponin, fatty acids, glycerides of the oil, and triterpenes, among other substances. Various pharmacological effects of the plant, including antibacterial, antioxidant, antihelminthic, antiplasmodial, hepatoprotective, anticancer, laxative, cardiotonic activity, CNS depressant and anti-hypertensive, hepatoprotective qualities, have been discovered in the plant. So, the aim of the present review is to provide comprehensive information from recognized sources on the ethno uses, phytochemistry and pharmacological efficacy and of the medicinal plant, *S. indicum*. These reports are very encouraging and indicate that herb should be studied more extensively for its therapeutic benefits. Clinical trials using Solanum for a variety of combinations in different formulations should also be conducted.

**Keywords:** Solanum indicum, Solanaceae, ethnobotany, phytochemistry, phytopharmacology.

**INTRODUCTION**

Although modern scientific medicine has made significant advances in recent years, traditional medicine continues to be the primary method of treating diseases for the vast majority of people in developing countries, including India. Even among those who have access to western medicine, the number of those who use complementary or alternative medicine is rapidly increasing around the world. The growing understanding of metabolic processes and the effects of plants on human physiology has broadened the scope of medicinal plants’ potential use in medicine. The oldest evidence we know of human beings employing plants for medicinal purposes has been unable to be identified. Whether unintentionally or purposefully, it seems probable that man has been experimenting with nature for some time. For the most part, regular people were responsible for accumulating most of the collected information about valuable plants. However, when one is aware of the medical applications that thousands of wild plants around us have developed, the plant takes on a new significance, a new value that surpasses its aesthetic worth, its cooling shade, or its pleasant aroma. Nature has always been a first-rate medication shop, thanks to its great variety of plants that have been shown to offer medicinal properties that are effective. Traditional civilizations have amassed a wealth of information about herbal medicines via trial and error through hundreds of years of experience. Even more importantly, the most significant remedies were handed down orally from one generation to the next. Natural alternatives to synthetic chemicals, such as herbal plants and plant-derived medications, have long been practised in civilisations across the globe, and they are becoming more popular in contemporary society as natural alternatives to synthetic chemicals. Quinine, morphine, codeine, atropine, reserpine, and digoxin are all examples of plant-derived medications that are widely used today. It is an unassailable truth that plants are the world’s largest laboratory for naturally occurring components. Plant medications have had a significant resurgence in recent years. For one thing, researchers started to extract and identify the ingredients and active elements of medicinal plants, which led to the discovery of new drugs.
very long history; it is the sum total of practises based on the theories, beliefs, and experiences of different cultures and time periods, which are often inexplicable, and which are used in the maintenance of health as well as the prevention, diagnosis, improvement, and treatment of illness. Traditional medicine has a very long history; it is the sum total of practises based on the theories, beliefs, and experiences of different cultures and time periods, which are often inexplicable. The majority of people who have taken traditional medicines may not comprehend the scientific logic for the cures, but they seem to be aware from personal experience that certain medicinal herbs may be quite effective when used at therapeutic quantities. Since we have gained a greater knowledge of how the body operates over the centuries, we are in a better position to appreciate the healing properties of plants and their potential as multi-functional chemical entities for addressing complex health issues than we were before.

Solanum indicum (also known as Solanum violaceum Ortega or Solanum anguivi Lam.) is a medicinal plant that is utilised in Indian medical systems such as Ayurveda, Siddha, and Unani to treat a variety of ailments. It is a significant component of the dasamoola (a set of 10 root medications) group of plants in Ayurvedic and Siddha medicine, and it is used to treat vitiated diseases of the vata, pita, and kapha doshas, as well as a variety of other disorders. It is used to cure nausea and vomiting, heart illness, toxic affections, skin diseases, ulcers, trouble breathing, stomach discomfort, coughing, and dyspepsia, among other things. It is also used to treat other conditions. Despite their appearance, the roots have a harsh and bitter flavour. It removes the nasty taste from the mouth as well as the lack of desire for food. However, the root is the most often used medicinal component of the plant, with the fruits and leaves also being used seldom, as is the whole plant as a whole. The root is a significant component in around 68 distinct Ayurvedic formulations. It may be used either as a stand-alone herb or as a component of the dasamoola group of plants, depending on the application. In several significant formulations, such as Amritharishtam and Gandha Taila, it is used; others include Balajerakadi Kashaya, Mannasamithra Vataka, Pippalyadi Gridha, Rajanyadi Choorna, and Vidaryadi Gridha, among others. Amritharishtam is a kind of Ayurvedic medication that is used to treat various ailments. It is a perennial under shrub with numerous branches that has prickles on the tips of the leaves. The plant may be found mostly in warmer regions of the country, up to a height of 1500 metres above sea level. The plant is a densely branched, widely distributed, and exceedingly thorny under shrub that grows to a height of 0.3-1m. Its leaves are simple, big and oval, sub-entire, sinuate, or lobed, sparsely prickly on both sides, with a cordate base that is frequently uneven in size. The flowers are blue and borne in axillary cymes that are stellately hairy, and the peduncles are stellately hairy as well. The plant, according to Acharya Charaka, belongs to the Kantha group of herbs used in treating throat disorders), Hikkanigrahana (group of herbs used in treating hiccups), Shothahara (anti-inflammatory group of herbs), and Angamarda Prashamana (pain relieving group of herbs) mahakashayas, whereas the plant, according to Acharya Susuruta, belongs to the Laghupanchmula.

MATERIALS AND METHODS

This review paper included information on ethnobotanical descriptions, plant components, and biological impacts, among other things. There was additional material about M. oleifera that could be obtained in a peer-reviewed publication, which was included in the package. A comprehensive search of online databases such as ACS Publications and Elsevier was conducted in order to locate the proper material for this project. We also had a look over the books in the library with our group. Some of the terms used to obtain information on the plant were “Solanum,” “S. indicum,” “traditional uses of S. indicum,” “ethnobotany,” “phytochemistry,” “biological activities,” Indian herbal classic books, and a Ph.D. dissertation. Prior to January 2021, only English-language publications were considered for inclusion on the list. Non-English language articles, previously unpublished data, and publications that were not original were not included in the selection process. Using the The Plant List website, www.theplantlist.org, the scientific name for the plant was determined.

BOTANICAL DESCRIPTION

Distribution

This species may be found in tropical India, Sri Lanka, Malaya, China, and the Philippines, among other places. It may be found in a variety of habitats across India’s tropical areas, including waste fields, roadside ditches, and other locations, ranging from sea level to around 1500 m above sea level.

Morphological Characters S. indicum

A biennial, upright, spiky herb or small shrub with sturdy stems, huge, sharp prickles with a long compressed base that is typically somewhat recurved, and prickles that are large and sharp. Plant has leaves that are 5-15 cm long and 2.5-7.5 cm broad, oblong in form, sub-entire with a few triangular-oval lobes, sparsely prickly and hairy on both sides; the base is cordate or truncate, frequently uneven sided; the petioles are 1.3-2.5 cm long and hairy on both sides. Flowers are borne in racemose extra axillary cymes, with short, stellately hairy pedunules; the corolla is pale purple, 0.8 cm long, and covered with darker purple stellate hair on the outside; the lobes are 5 mm long; the stamens are attached to the corolla, with filaments that are short and anthers that are large. Fruits (berries) are globose, approximately 0.8 cm in diameter when ripe, and glabrous. When ripe, they are dark yellow. Seeds are 0.4 cm in diameter and have minute pits. In Central and Southern India, flowering and fruiting are often seen between August and October, with fruting occurring between November and December.
Traditional applications

Both the root and the fruit have a strong and bitter flavour. According to Ayurvedic systems of medicine, they are warming, digestive, astringent to the bowels, anthelmintic, removes foulness from the mouth, beneficial in cardiac troubles, useful in leucoderma, fever, asthma, pain bronchitis, vomiting, and pruritus. They are also beneficial in a variety of other conditions. The roots are beneficial in the treatment of vittiated vata and kapha conditions, as well as odontalgia, dyspepsia, flatulence, colic, verminosis, diarrhoea, leprosy, strangury, cough, asthma, fever, skin diseases, respiratory and cardiac disorders, ulcers, and poisonous affections, among other things. The root is used in difficult parturition as well as in the treatment of toothache. It is also used in the treatment of fevers, worm problems, and colic. It is considered an expectorant and is beneficial in the treatment of cough and catarrhal diseases. In the event of dysuria and inchiura, it is recommended to be taken \(^{15,17,27,31}\).

Classical application

In traditional systems of treatment such as Ayurveda, \textit{S. indicum} fruits are cooked and seasoned before being mixed with boiled curd and administered to patients suffering from anorexia (Vaidyamanorama). Aloepecia areata may be cured by applying the juice of fruit combined with honey to the affected area (Vrnhadhamadhava; Gadangiraha; Sargadharasamhita). The juice of brhati fruits is used to crushed the fruit and root of gunja, which is then rubbed with Datura fruit. It takes away the opacity (Vrnhadhamadhava). An inhalation of powdered \textit{S. indicum} fruit and ginger mixed together is administered via the nose. The patient sneezes and regains consciousness as a result of this (Gadanigraha). Fruit is softly streamed in water, pulverised, and cooked in ghee until soft and fragrant. This is mixed with powdered rock salt before being consumed. It helps to improve digestion while also alleviating coughing (Kalyanakaraka). Pipalyadihe has a component called brhati fruit (Gadanigraha). After removing the seeds from the maturing fruit of brhati, a paste of pipali and srotonjana is used to alleviate the symptoms of flatulence and intestinal colic, as well as in the treatment of asthma. Root of \textit{S. indicum} is employed for Aphrodisiac Potentials in Rajasthani folklore and traditional medicine \(^{42}\). Unripe fruits of the \textit{S. indicum} plant are cooked and consumed with meals in the Ariyalur District of Tamil Nadu in order to expel tapeworms. These fruits are used to make pickles and are also beneficial in the treatment of digestive disorders \(^{43}\). In Arunachal Pradesh, \textit{S. indicum} is used as a vegetable (green salad) to treat intestinal parasitic worms such as round and tape worms, and the leaves of \textit{S. indicum} are used as common growth supplements during the preparation of fermentation starter cultures containing brewer’s yeast. \textit{S. indicum} is also used to treat intestinal parasitic worms such as round and tape worms \(^{44}\). Fruits of the \textit{S. indicum} tree are used as food in Assam and Thailand \(^{45}\). Medicinal uses for \textit{S. indicum} include usage as vegetables and as a key element in anticarcinogenic formulations in Thailand \(^{46}\). Throughout Taiwan, \textit{S. indicum} L. is used as a folk medicine to treat toothache, ascites, edoema, and wound infection, among other ailments. The fruit is used to treat leukoderma, pruritus, and bronchitis, and the juice extracted from the leaves is used with fresh ginger juice to alleviate nausea and vomiting \(^{47}\). This plant, which grows in the south of China, has been used in Chinese traditional medicine as an analgesic for toothache, rhinitis, and breast cancer pain. It is also used to treat wounds and promote wound healing (Table 2) \(^{48}\).

Phytochemistry

Many phytoconstituents, including phytosterols, steroidal glycosides, steroidal glycoalkaloids, flavonoids, and fatty acids, have been extracted from plants and have been shown to be active chemicals in animal and human studies. Its crude fibre content is 8 percent wet weight, and its total carbohydrate content is 40.67 percent wet weight. Its crude protein content is 23.47 percent wet weight, and its total ash content is 2.26 percent wet weight. Its crude fat content is 5.26 percent wet weight, and its caloric content is 526 calories per 100 gm wet weight (303.9 g dry weight). This includes testing for the presence of alkaloids, polyphenols (7.02mg/g), and saponins among other things. Steroid glycosides and steroidal glycoalkaloid constituents of plants are the most often encountered of all of their constituents, and they account for the majority of their occurrences. The overall alkaloids content varies depending on the type of fruit, ranging from 0.2 to 1.8 percent, whereas the total alkaloids concentration in the leaves is 0.32 percent of the total (dry weight basis) \(^{39,40}\).
Steroidal alkaloids/glycoalkaloids

Steroidal alkaloids are a substantial family of secondary metabolites that are of great interest from both an ecological and a human health viewpoint, and they have been widely investigated in both the laboratory and the field. Throughout the Genus Solanum, these alkaloids may be found in high concentrations, with the highest concentrations being found in the flowering parts of the plant (flowering buds), sprouting leaves, unripe berries, immature leaves, and young shoots. These compounds are made up of two structural components: the first aglycone unit contains the basic steroidal 27-carbon skeleton (cyclopentanophenanthrene) of cholestane with nitrogen incorporated into the F ring, which is amphiphilic in nature; and the second aglycone unit contains the basic steroidal 27-carbon skeleton (cyclopentanophenanthrene) of cholestane with nitrogen incorporated into the For the second time, a hydrophilic glycone unit is attached to the 3-OH position of the molecule (Figure 2). This family of substances is classed as pseudoalkaloids, which is a subclass of alkaloids, owing to the introduction of nitrogen into a nonamino acid residue in the chemical structure (or isoprenoid alkaloids). Steroid glycoalkaloids are generally divided into two groups based on the presence or absence of an aglycone part of their structure. Solasodine is an example of the spirostan type; the solanidine type is an example of the solanidine type, in which N links the spirostan rings E and F rings, as is the case with solanidine. Solasodine, solanidine, solasonine, solamargine, and solanine were all discovered in S. indicum, as was solanidine. It has been discovered that the plant contains several phytoconstituents such as carotene, carpesterol, solanocarpone, diosgenin, -sitosterol, lanosterol, solavetivone, solafuranone, scopoletin N-(ptranscoumaroyl) tyramine, and indiosides (Table 1) 27, 32, 49.

![Figure 2(a): Previously isolated phytoconstituents of Solanum indicum Linn.](image-url)
Figure 2(b): Previously isolated phytoconstuents of *Solanum indicum* Linn.
Figure 2(c): Previously isolated phytoconstuents of *Solanum indicum* Linn.
Figure 2(d): Previously isolated phytoconstuents of *Solanum indicum* Linn.

Table 1: Phytochemical work reported on *Solanum indicum* Linn.

<table>
<thead>
<tr>
<th>Plant part</th>
<th>Identified Constituents</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruits</td>
<td>Indioside A</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>Indioside B</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>Fatty acids</td>
<td>74, 75</td>
</tr>
<tr>
<td>Roots</td>
<td>Solanine</td>
<td>74, 75</td>
</tr>
<tr>
<td></td>
<td>Solanidine</td>
<td>74, 75</td>
</tr>
<tr>
<td></td>
<td>Indioside C</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>Indioside D</td>
<td>74, 75</td>
</tr>
<tr>
<td></td>
<td>Indioside E</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>Solamargine</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>Solasonine</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>Isoanguivine</td>
<td>73</td>
</tr>
<tr>
<td>Leaves</td>
<td>Solanine</td>
<td>74, 75, 76</td>
</tr>
<tr>
<td></td>
<td>Solanidine</td>
<td>74, 75, 76</td>
</tr>
<tr>
<td>Whole Plant</td>
<td>Dioscin</td>
<td>63, 77</td>
</tr>
<tr>
<td></td>
<td>Methyl-protopodioscin</td>
<td>63, 77</td>
</tr>
<tr>
<td></td>
<td>β-sitosterol</td>
<td>63, 77</td>
</tr>
<tr>
<td></td>
<td>β-sitosterol glucoside</td>
<td>63, 77</td>
</tr>
<tr>
<td></td>
<td>Protodioscin</td>
<td>63, 77</td>
</tr>
<tr>
<td></td>
<td>Methyl protodioscin</td>
<td>63, 77</td>
</tr>
<tr>
<td></td>
<td>Scopoletin</td>
<td>62, 78</td>
</tr>
<tr>
<td></td>
<td>Solafurone</td>
<td>62, 78</td>
</tr>
</tbody>
</table>
PHYTOPHARMACOLOGICAL ACTIVITIES

The following are some of the folk and traditional applications of the plant; it has also been studied scientifically in animal models to see whether or not the plant has the ability to treat a number of maladies.

Table 2: Traditional Uses of Solanum indicum Linn.

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Plant parts</th>
<th>Uses quoted in Literature</th>
<th>Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Leaves</td>
<td>Juice of leaves with ginger stops vomiting.</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rubbed with sugar, used as external application to relieve itch.</td>
<td>79, 80</td>
</tr>
<tr>
<td>2.</td>
<td>Fruits/Berries</td>
<td>Fruit juice beneficial in alopecia.</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dried powder given to children to expel worms among tribes of Orissa.</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In cases of loss of appetite, bitter stomachic.</td>
<td>81</td>
</tr>
<tr>
<td>3.</td>
<td>Roots</td>
<td>Prescribed in cases of dysuria &amp; in driburia.</td>
<td>82-84</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pounded roots used for nasal ulcers.</td>
<td>82-84</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Facilitates child-birth.</td>
<td>82-84</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Employed in difficult parturition.</td>
<td>82-84</td>
</tr>
<tr>
<td>4.</td>
<td>Whole Plant</td>
<td>Antipyretic</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Beneficial in catarrhal affections, asthma, dry coughs, cardiac troubles, dropsy, relieves toothache, worm complaints, anti diarrhoeal &amp; antiulcerogenic.</td>
<td>86, 87</td>
</tr>
</tbody>
</table>

Antibacterial activity

- A leaf ethanolic extract of S. indicum exhibited antibacterial efficacy against Corynebacterium diphtheriae, Pseudomonas spp., and Salmonella typhimurium, as well as against other bacteria found that the chloroform extract was effective against Staphylococcus aureus, Bacillus cereus, and Escherichia coli, whereas the acetone extract and ethanol extract were effective against Pseudomonas aeruginosa [48, 50].

- The fruits of S. indicum are also known to have antimicrobial properties. Listeria innocua, S. aureus, E. coli and P. aeruginosa strains were tested, and it was discovered that both the aqueous and Ethanolic extracts were efficient against the bacteria. According to the findings, the activity of the Ethanolic extract was superior to that of the aqueous extract [51].

- The aqueous fraction of the ethanolic extract of S. indicum berries has been shown to have a concentration-dependent inhibitory impact on P. aeruginosa, P. fluorescens, and P. syringae strains, according to the findings. Flavonoids, carotenoids, and saponins were found in the examined aqueous fraction, according to the results [52].

Antioxidant activity

- The antioxidant activity of an ethanolic extract of berries from S. indicum was studied utilising an in vitro DPPH (1, 1-Diphenyl-2-Picolyl hydrazyl radical) radical scavenging technique in order to determine its antioxidant activity. At a concentration of 200 g/mL, the extract exhibits the greatest amount of inhibition (70.007±0.841 percent) [53].

- IC50 values for the ethanolic and aqueous extracts of berries were computed using the DPPH Scavenging Assay and the -carotene/linoleate model system, according to the results of another work. It was shown that ethanolic extract was significantly more effective (IC50 37.22±1.3) in the alpha-carotene test, while aqueous extract was discovered to be more successful in the DPPH assay (IC50 21.83 ±0.84) in both assays. This suggests that the fruit may serve as a useful source of natural antioxidants in the diet [54].

- N’Dri et al., 2010 [55] found that, when the antioxidant capacity of fruit is studied using the FRAP test and the Folin-Ciocalteau assay, it has been observed that the antioxidant potential rises as ripening occurs. It was possible that this was owing to the fact that the concentration of -carotene in red berries increased by 60 and 20 times, respectively, when compared to green and yellow berries. The amount of ascorbic acid found in green and yellow berries was found to be equal, however the amount found in red berries was found to be lower. The total polyphenol content did not change with ripening, but the concentrations of caffeoylquinic acids, caffeic acid, flavonol glycosides, and naringenin increased with maturity, while the concentrations of p-coumaric acid and feruloylquinic acids remained constant throughout the ripening process.

- The ethanolic extract of S. indicum berries also greatly reduced the generation of peroxides in a linoleic acid emulsion system in a dose-dependent manner, as shown by the results of this study [56].

- The aqueous and ethanolic extracts of the leaves of S. indicum have also been shown to have DPPH scavenging capability [57].

Anthelmintic activity

- The anthelmintic activity of butanol and aqueous extracts of S. indicum was determined utilizing a Caenorhabditis elegans bioassay. After 24 hours of incubation, the percentage of dead nematodes was determined. Based on the results of the C. elegans experiment, fractions eluted from DEAE cellulose demonstrated anthelmintic activity in four distinct peaks. Those peaks were eluted at concentrations of 0.1, 0.28, 0.48, and 0.85 M NaCl, respectively. When compared to the negative control, the highest mean death percentages found at each peak were 53, 59, 37, and 61 percent, respectively. S1 fruit seems to have at least four separate anthelmintic chemicals, according to the research [58].

- In a study conducted on the Indian earthworm (Pheretima posthuma), it was discovered that a crude methanolic extract of S. indicum berries (100 mg/mL) paralysed the worm in 9.16 ± 0.12 seconds, while the helmith died in 17.71 ± 0.21 seconds [59].
Antinflammatory Effect

In one set of experiments, oral dosages of an extract of the root of *Solanum indicum* were administered 60 minutes before the injection of carrageenin was administered. The paw volume grew by 78 percent in the negative control carrageenin group, whereas the paw volume increased by 35 percent in the normal phenylbutazone group. Paw volumes were lower in all dosages of the *Solanum indicum* extract than in the negative control group, but greater than in the phenylbutazone group when compared to the negative control. In another experiment, the fruit extract of *Solanum indicum* (Indian gooseberry) was used. There was no difference in paw volume between the negative control group and the standard phenylbutazone group when all dosages of *Solanum indicum* fruit extract were administered 59.

Antiplasmodial activity

It was determined that the antiplasmodial activity of ethanolic fruit extract against the chloroquine-resistant FcBl1 strain of Plasmodium falciparum was in vitro when it was tested. The cytotoxicity of the compound was tested on the human MRC-5 (IC50 >50μg/mL) and rat L-6 cell lines (IC50 >50μg/mL) cell lines. Plant extracts shown substantial antimalarial action (IC50 = 41.3 ± 7.0 μg/mL) when tested against parasites 60.

Hepatoprotective activity

- The hepatoprotective profile of *Solanum indicum* Linn fruit extract, in a 10 percent suspension stabilised with 1 percent acacia gum, was evaluated in male Wistar rats by exposing them to a single dosage of paracetamol suspended in a 40 percent sucrose solution and observing their responses. After the experiment was completed, the animals were slaughtered and blood and liver samples were obtained for biochemical and histological investigations. The research demonstrated that, despite the fact that there was no indication of a hepatoprotective effect, liver enzymes, which indicate the level of liver damage, were lowered by eighteen percent when compared to the paracetamol control group when *S. indicum* therapy was administered 61.

- The effects of *S. indicum* extract (200 mg/kg) were investigated in a rat CCl4-induced hepatotoxicity model. Rats were studied to determine the levels of liver markers such as Alanine amino transferase (ALT), Aspartate amino transferase (AST), alkaline phosphatase (ALP), acid phosphatase (ACP), and lactate dehydrogenase (LDH), as well as certain biochemical parameters such as total protein, total bilirubin, total cholesterol, triglycerides, and urea. The plant extract has been shown to considerably reduce the harm caused by CCl4 56.

Anticancer activity

- Numerous Indiosides (A to E) isolated from *S. indicum* have been shown to have a dose-dependent inhibitory impact on the proliferation of Bel-7402 cells, as well as the ability to trigger cell death through the mitochondrial route. The compound solavetivone-1, which is found in *S. indicum*, was shown to be cytotoxic to OVCAR-3 cells 62.

- *S. indicum* (whole plant) chloroform soluble and insoluble fractions of the ethanolic extract were tested for anticancer activity using in-vitro techniques on seven cancer cell lines: Colo-205 (colon), KB (nasopharynx), HeLa (uterine cervix), HeP-2 (laryngeal epidermoid), GBM9401/TSGH (glioma) and H1477 (colon) (melanoma). By using the DEA and MTT assays, the purified components dioscin and methyl protodioscin were shown to have more powerful effects. In addition, dioxcin, methyl protoprosapogenin A of dioscin, methyl protodioscin, and protodioscin were all found to have cytotoxic effects on cultured C6 glioma cells when tested in the PRE assay, and methyl protoprosapogenin A of dioscin, methyl protodioscin, and protodioscin were found to have a tumour Furthermore, dioxcin, at a concentration of 10 micrograms/mL, had an inhibitory impact on the DNA synthesis of C6 glioma cells 63.

- Furthermore, the anti-cancer activity of methanolic fruit extract was investigated using the MTT (3-(4,5-
  dimethylthiazolyl)-2, 5-diphenyltetrazolium bromide) cytotoxicity assay in various cancer cell lines, including human non-small cell lung carcinoma (H1975), prostatecarcinoma (PC-3 and DU145), colorectal carcinoma (HCT116), and malignant melanoma (A375). It was shown that the fruit extract had the greatest cytotoxicity in prostatecarcinoma cell lines, with an IC50 of 8.48 μg/mL in DU145 cells and 11.18 μg/mL in PC-3 cells, respectively, in prostatecarcinoma cell lines. In contrast, extract was shown to be cytotoxic in H1975 cells, with an IC50 of 9.03 μg/mL in vitro. Extraction demonstrated cytotoxicity with an inhibitory concentration of 17.58 μg/mL in HCT116 cells and cytotoxicity with an inhibitory concentration of 27.94 μg/mL in A375 cells in a similar manner. In addition, fresh fruit of *S. indicum* has been demonstrated to cause considerable brine shrimp fatality, with lethal concentrations of 4.42 ± 0.67 (μg/mL) (LC50) determined for the fruit 64, 65.

- The fractionated test extracts of *Solanum indicum* Linn. from the in vitro work; identified as containing protodioscin, methylprotodioscin and methyl protoprosapogenin A of dioscin, with solvent DMSO alone as a negative control and methotrexate as the positive control were studied. On determining the tumour weight post experiment, it was found that fractionated extract reduced tumour weight in a dose dependent manner up to forty-seven percent against methotrexate, which reduced tumour weight by sixty percent 63.

Haemolysis assay

The hemolysis activity of *S. indicum*, extracts was studied at various concentrations (0-128 μg/mL) using human erythrocytes, and the results were promising. In the extract, there is no evidence of visible hemolysis activity 64.

Laxative action

The laxative properties of a crude methanolic extract of *S. indicum* fruits have been investigated in male wistar albino rats. The laxative action of the medicine was assessed by weighing the faeces matter after 8 and 16 hours of treatment with the drug. The laxative action of the extract was substantial, and it was shown to be dosage dependent. After 8 hours of treatment, it was discovered that the MeOH extract treated groups (250 and 500 mg/kg p.o.) had significantly larger faecal production (133.32 ± 1.136 mg and 149.01 ± 1.835 mg, respectively). After 8-16 hours, the test drug showed an increase in faecal output at both the conc. (258.8 ± 32.045mg) and the supplemental doses (293.66 ± 2.219mg) 66.

Cardiotonic activity

The cardiotonic action of methanolic extract of the fruits of *S. indicum* (5 and 10 mg/mL) was investigated using the heart of a frog (Bufo melanoosticus). According to the findings, the extract produces significant cardiotonic action in a dosage dependent manner. The presence of MeOH extract at a concentration of 5 mg/mL results in a modest increase in the
force of contraction but no significant change in the heart rate. Extract at a concentration of 10 mg/mL causes a considerable rise in the force of contraction and a small increase in the heart rate when tested. Despite the fact that the plant extract has a broad therapeutic index, it has not been shown to cause cardiac toxicity at higher levels evaluated up to 5 gm/mL.

CNS action

- Researchers employed an extract of the plant Solanum indicum dissolved in petroleum ether. The extract, according to the scientists, included alkaloids with psychotropic properties. It was studied if any changes in general behaviour of the test group occurred when albino mice were given an IP dosage of 40mg/kg body weight. In the study, the animals demonstrated drooping of their heads and were silent for one hour after being given an extract of Solanum indicum, which caused them to become sleepy. Aside from that, the animals exhibited no signs of becoming alarmed when exposed to external stimuli.

- Another study was carried out in order to investigate the effects of Abana, an Ayurvedic herbomineral preparation, on mice’s memory and brain cholinesterase activity. Solanum indicum was used as the active ingredient in the formulation, which was designed to investigate the effects of Abana on memory and brain cholinesterase activity. The elevated plus maze and passive avoidance apparatus were used as the exteroceptive behavioural models for evaluating memory throughout the experiment. Diazepam and scopolamine were used as interoceptive behavioural models in this experiment. Abana (50, 100, and 200mg/kg, orally) improved the memory scores of both young and old mice in a dose-dependent manner, according to the results. Furthermore, it was shown to counteract the amnesia generated by scopolamine (0.4mg/kg, intraperitoneally) and diazepam (0.4mg/kg, intraperitoneally). Abana, when taken orally for 15 days, was shown to have a lowering effect on brain cholinesterase activity, which was unexpected. According to the authors, it may prove to be a beneficial treatment for Alzheimer’s disease in the future.

Gastrointestinal action

- The anti-ulcerogenic properties of the methanolic extract of the fruit of S. indicum var. distichum have been examined in rats that have been subjected to aspirin and ethanol-induced ulceration. The extract (750 mg/kg) not only protects the stomach mucosa against the harmful effects of aspirin and ethanol, but it also has the additional benefit of promoting ulcer repair. Its antioxidant capacity, as shown by the restoration of antioxidant indicators such as glutathione, SOD, GR, CAT, and LPO, was most likely responsible for the result.

- A study was conducted on rats to determine the choleric activity of a suspension of the fruit of Solanum indicum. Rats were initially anaesthetized with IP sodium pentobarbitone before being exposed to bile dust and cannulated with a catheter. It was necessary to collect the bile for one hour before administering the plant solution intraduodenally at a dosage of 500mg/kg. The therapy with Solanum indicum resulted in a 31 percent increase in bile flow. Conclusion: The difference in stimulation of bile flow in normal rats and the absence of hepatoprotective effects in normal rats showed that the two effects were mediated by separate active principles in herbal material, according to the authors’ findings.

CNS depressant activity

It was determined whether or whether adult wistar albino rats had increased spontaneous locomotor activity after being administered a methanolic extract of fruit. After 1 hour, the extract (500 mg/kg) displayed the greatest amount of locomotor inhibitory action. Medication’s CNS depressant action was shown to be substantially superior to that of the conventional drug diazepam (0.5 mg/kg), according to the findings.

Antihypertensive activity

The effects of a standardised ethanolic extract of the S. indicum ssp. distichum fruit (containing > 0.15 percent chlorogenic acids) on blood pressure were studied in both normotensive and hypertension (N(W)-nitro-L-arginine methylester (L-NAME) treated rats. In normotensive rats, a four-week treatment with extract (30 mg/kg) had no impact on blood pressure. However, following L-NAME delivery, it stops the animal from developing hypertension.

CONCLUSION

In every part of the globe, plants are utilised for healing, survival, medicine, and sustenance by all members of the human race. Both in developing and developed countries, medicinal plants are still important in this regard. They have the potential to aid in the discovery of novel phytomedicines such as steroidal saponins, sesquiterpenoids, hydroxycoumarins, phenolic compounds, coumarins, coumarinolignoids alelaoids, saponin, fatty acids, glycerides of the oil, and triterpenes. It is becoming increasingly common to conduct translational research to investigate the therapeutic potential of plants associated with indigenous knowledge to benefit human health, as herbal therapy has fewer side effects and can play an important role in the advancement of sustainable health development. Translational research is being conducted to investigate the therapeutic potential of plants associated with indigenous knowledge to benefit human health. Many of the medicinal and biological properties of plants belonging to the genus Solanum are beneficial in a variety of applications, including antibacterial, antioxidant, anthelmintic, antiprasmodial, hepatoprotective, anticancer, laxative, cardioactive activity, CNS depressant, and antihypertensive activity. It is believed that phytomolecules contained in these plants are responsible for a wide range of biological activities. There has been a slew of studies undertaken to investigate the traditional applications of Solanum species, and every one of them has found evidence to support the traditional claims. However, there are still a plethora of conventional applications that have not yet been assessed, which is a concern. To review the ethnobotanical applications, phytochemical profiles, and biological activities of the S. indicum, the authors utilised relevant types of literature to compile a comprehensive overview of the species. The bioactivities of S. indicum and their active phytoconstituents, which have been extracted from diverse plant sections of Solanum species, have also been demonstrated to have therapeutic potential, providing evidence for future medical uses of these species of the genus Solanum.

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Conflict of interest statement

The author declares that there is no conflict of interest.

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