

# “Pharmacognostic and Therapeutic Overview of Solanum xanthocarpum: A Multifaceted Medicinal Herb of the Solanaceae Family”

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## ABSTRACT

*Solanum xanthocarpum* (Family: Solanaceae) is a significant medicinal herb widely recognized in Ayurvedic medicine. As limited literature is available on this species, the present review aims to consolidate and present updated information regarding its phytochemical constituents and pharmacological activities. Previous research has demonstrated that *S. xanthocarpum* exhibits diverse biological properties, including antiasthmatic, hypoglycemic, hepatoprotective, antibacterial, and insect-repellent effects. Although these findings are promising and suggest that bioactive compounds such as solasodine and diosgenin contribute to its therapeutic potential, further comprehensive studies are needed to substantiate these observations and uncover additional pharmacological benefits. Several traditional uses—such as immunomodulatory, anti-inflammatory, antiallergic, antianaphylactic, and antitumor activities—still require systematic scientific validation. Therefore, well-designed clinical trials are essential to confirm the preclinical outcomes and establish the herb's efficacy and safety in human subjects.[1]

**Key Words:** *Solanum xanthocarpum*; Pharmacognostic evaluation; Phytochemical profiling; Solasodine; Antiasthmatic activity; Ayurvedic medicinal plant; Steroidal alkaloids

## I. INTRODUCTION

Nearly 80% of the global population relies on herbal medicines for primary healthcare needs, particularly in developing countries[4]. In the coming years, the limitations of existing healthcare systems in adequately addressing the drawbacks of synthetic drugs are expected to become increasingly evident. Reports indicate that the incidence of adverse reactions and complications associated with synthetic medications has increased, encouraging a growing preference for traditional herbal remedies.[2,3]

India has documented and characterized more than 1,08,276 species of plants, animals, fungi, and bacteria. Among its ancient healing systems, Ayurveda has been practiced for thousands of years as a holistic medical tradition. Extensive investigations on Ayurvedic medicinal plants have been conducted in pharmacognosy, phytochemistry, pharmacology, and clinical research. Although modern allopathic medicine has advanced through structured scientific methodologies, traditional knowledge has significantly contributed to its conceptual and therapeutic foundations.[5]

The discovery of novel therapeutic agents from plants is most effectively guided by selecting species with well-established traditional uses and validating them through systematic scientific evaluation. This review focuses on *Solanum xanthocarpum* Schrad. & Wendl. (Family: Solanaceae), commonly known as Indian nightshade or yellow-berried nightshade in English and Kantakari in Sanskrit.<sup>1</sup> It is one of the ten roots (Daśamūla) described in Ayurveda and is also included in the Panchamula group of medicinal plants.[6] The plant contains important bioactive constituents such as solasodine and diosgenin. Because of its thorny morphology, it is also referred to as *Duhsparśa*, meaning “difficult to touch.” Ayurveda describes three varieties of this herb—violet-flowered, yellow-flowered, and white-flowered types.[6]

This review compiles comprehensive information on *Solanum xanthocarpum*, including its taxonomical classification, cultivation practices, phytochemical composition, therapeutic significance, mechanism of action, adverse effects, extraction methods, formulation strategies, preclinical and clinical studies, and pharmacological activities.<sup>1</sup> The plant grows up to 2–3 meters in height and is commonly found in dry regions of India.[1,6] Classical Ayurvedic texts describe it as bitter, pungent, digestive, and astringent, with notable carminative properties.[6]

Various plant parts—particularly the leaves—exhibit multiple pharmacological effects such as antifungal, wound-healing, antibacterial, antihyperglycemic, antioxidant, hepatoprotective, and larvicidal activities.[5]

The fruits are rich in steroidal alkaloids and demonstrate diverse medicinal properties, including antipyretic, anthelmintic, anti-inflammatory, laxative, anti-asthmatic, and hepatoprotective effects, and are traditionally used in managing urinary bladder disorders and hepatomegaly.[5] The roots also possess significant therapeutic value, acting as diuretics and being used in the management of fever, cough, asthma, and chest pain.[6] Solanum xanthocarpum is an important ingredient in several classical Ayurvedic formulations such as Chyavanprasha, Dasamoolarishta, VyaghriharitakiAvaleha, Vyaghri Tailam, VyaghriyadiKwatha, and Vyaghri Ghritam.[6]

#### SCIENTIFIC CLASSIFICATION [1,4,10]

<b>Kingdom – Plantae</b>
<b>Subkingdom – Tracheobionta</b>
<b>Phylum- Pinophyta</b>
<b>Division – Magnoliophyta</b>
<b>Class - Magnoliopsida</b>
<b>Subclass – Asteridae</b>
<b>Order – Solanales</b>
<b>Family - Solanaceae</b>
<b>Genus – Solanum</b>
<b>Species - Xanthocarpum</b>

#### Botanical description[1,2,23,7]

<b>Synonyms</b>
<b>English: Febrifuge plant</b>
<b>Latin: Solanum surattense, Syn. S. Xanthocarpum</b>
<b>Sanskrit: Kantkari, Vyāghri, Nidigdika, Ksudra, Kantakārika, Dhavani, Nidigdha, Dusparsa</b>
<b>Hindi: Katali, Bhatakataiya, Chhotikateri, Ringani</b>
<b>Gujarati: Bhoringan (Pharmacopoeias1999), Bharingani</b>
<b>Tamil: Kandangatri, KandanKatri, Kandanghathiri</b>
<b>Telugu: Nelamulaka, Chinnamulaka, Mulaka, Pinnamulaka</b>
<b>Kannada: Kiragulla, Nelagulla</b>
<b>Assam :Kataedana, Kantakar</b>
<b>Bengali :Kantakari</b>
<b>Malayalam: Kantakarichunda</b>
<b>Orissa: Bhejibaugana, Ankarati, ChakadaBhoji</b>
<b>Punjabi: Kandiari</b>
<b>Marathi :Bhauringani, Kataringani</b>

#### PROPERTIES AND ACTION-

Dipana, Pacana, Amadosanāsaka, Kanthya, Sothahara

RasaKatu, Tikta

Guna Laghu, Ruksa

Virya Usna

**VipakaKatu**  
**KarmaDipana, Pacana, Amadosanāsaka,**  
**Kanthya, Sothahara[7]**

### GEOGRAPHICAL SOURCE

It grows broadly across India, thriving in dry areas as a common weed along roadsides and in wastelands. The plant naturally reproduces through seeds discover in barren lands. It's also distributed in Sri Lanka, different parts of Asia, Malaysia, tropical regions, Australia, and Polynesia. This plant is globally found in India, in Uttar Pradesh, West Bengal, Assam, Bihar, Punjab, etc. And also discover in Ceylon and Malacca through South-East Asia, tropical Australia, and Polynesia. Its growing season extends from March to April, while the fruit-bearing phase occurs between May and June. It's mainly found in hot and dry places.[1,2,5]

### CULTIVATION

For the growing of this herb, rich loamy soil is needed which is well- drained and having a pH range between 7 to 8. This herb grows in saline soil as well. The temperature needed for this civilization is 21 to 27 °C. This crop was negatively affected by the frost and it recovered during spring. These seeds are obtained from the crop, and their approximate diameter is 2.5 mm. These seeds have no latency period. Its germination range is between 60 to70 and the germination period is around 10 to 16days.[5]

### MORPHOLOGY[7]

#### (a) Macroscopic Characters

##### 1) Root

The root measures approximately 10–45 cm in length and ranges from a few millimetres to about 2 cm in diameter. It is nearly cylindrical and gradually tapering, bearing numerous fine longitudinal striations and a few transverse wrinkles, along with occasional scars, lenticels, and small lateral rootlets. On transverse view, the surface appears smooth, showing a thin bark enclosing a broad, compact woody cylinder. The fracture is short, and the taste is distinctly bitter.

##### 2) Stem

The stem is herbaceous and prickly, with clearly visible nodes and internodes. When fresh, it is green in colour. Young branches are densely hairy, whereas mature stems become nearly hairless. Furrows are more pronounced in younger

stems and tend to appear almost circular near the basal region. Stem fragments measure about 8–10 mm in thickness and vary in length. The external surface is light green when fresh, turning yellowish-green and smooth on drying. A transverse section reveals a very thin bark, a prominent woody region, and a large central pith; in older dry stems, the pith is often hollow. The fracture is short to slightly fibrous.

##### 3) Leaves

Leaves are petiolate and exstipulate, with blades that are ovate, oblong, or elliptic in shape. Margins are sinuate to shallowly pinnatifid, the apex sub-acute, and the surface hairy. Leaf size ranges from 4–12.5 cm in length and 2–7.5 cm in width. The lamina is green, with the midrib and veins armed with sharp prickles. Odour and taste are not well defined.

##### 4) Flower

Flowers are ebracteate, pedicellate, bisexual, pentamerous, regular, and complete, exhibiting a bright blue to bluish-purple colour. The calyx is persistent, gamosepalous, with a short globose tube and linear-lanceolate, acute, hairy lobes, measuring 0.5–1.3 cm in length and densely covered with prickles. The corolla is gamopetalous, with deltoid, acute, hairy lobes, about 1–2 cm long, and purple in colour.

There are five stamens, epipetalous and basifixed, with short filaments (1–15 mm). Anthers are oblong-lanceolate, measuring 0.7–0.8 cm in length. The ovary is superior, ovoid, glabrous, bilocular, with axile placentation and numerous ovules.

##### 5) Seeds

Seeds are numerous, circular, and flattened, embedded within a fleshy mesocarp, and measure approximately 0.2 cm in diameter. They possess a bitter and acrid taste.

##### 6) Fruit

The fruit is a globose berry, measuring about 0.8–1.0 cm in diameter, and is enclosed at the base by a persistent calyx. Unripe fruits display green and white variegated stripes, while ripe fruits exhibit various shades of yellow and white.

#### (b) Microscopic Characters

##### 1) Root

The transverse section of a mature root reveals a cork region consisting of 3–6 layers of thin-walled, rectangular, tangentially elongated cells. Beneath the cork lies a single-layered cork cambium, followed by 6–15 layers of thin-walled parenchymatous cells that are tangentially elongated to oval or circular in shape. Stone cells occur either singly or in clusters ranging from 2 to 20 or more within this region.

The secondary phloem is composed of sieve elements and phloem parenchyma, intersected by medullary rays. Stone cells are distributed singly or in groups of 2–20 or more in the outer and middle phloem zones. Phloem rays are 1–4 cells wide and 2–22 cells high. The cambium consists of 3–5 layers of thin-walled rectangular cells.

The xylem comprises vessels, tracheids, fibre-tracheids, and parenchyma, all traversed by medullary rays, with all xylem elements being lignified. Vessels and tracheids exhibit bordered pits, while fibres contain a few simple pits. Xylem parenchyma cells are rectangular or slightly elongated, showing simple pits and, rarely, reticulate thickening. Xylem rays are 1–3 cells wide and 1–20 cells high. Microsphenoidal calcium oxalate crystals in sandy form and simple starch grains are observed in the secondary cortex, phloem, and medullary rays.

## 2] Leaves

### I) Petiole

A transverse section of the petiole shows a circular to slightly undulating outline. The epidermis is single-layered and externally covered by a thick cuticle. Beneath it, the hypodermis consists of 3–4 layers of collenchymatous cells. The vascular system includes one large crescent-shaped bicollateral central bundle along with two smaller lateral bundles. The remaining tissue is composed of thin-walled, angular to polygonal parenchymatous cells. The epidermis bears numerous stellate hairs, with occasional uni- to tricellular hairs.

### II) Midrib

The transverse section of the midrib exhibits a biconvex configuration. Epidermal layers are present on both surfaces and are protected externally by a thick cuticle. Below the epidermis, 3–4 layers of collenchyma are observed. The stele consists of a crescent-shaped bicollateral central vascular bundle accompanied by two smaller lateral bundles. The remaining tissue is parenchymatous, and stellate hairs are sparsely distributed on the epidermis.

### III) Lamina

The lamina shows a dorsiventral anatomy in transverse section. The epidermis on both sides is wavy in outline and covered by a thick cuticle. The mesophyll on the upper surface comprises a single palisade layer, followed by 4–6 layers of loosely arranged spongy parenchyma. Stellate hairs with 4–8 arms occur on both epidermal surfaces. Anisocytic stomata are present on both sides of the leaf.

The vein-islet number ranges from 46–80 on the lower epidermis (mean 63) and 61–80 on the upper epidermis (mean 70). The stomatal index is 20–25 (mean 22.5) on the lower surface and 14–24 (mean 19) on the upper surface. The palisade ratio averages 2.85.

## 3] Stem

The transverse section of a mature stem measuring 1.5–2.0 cm in thickness shows 6–12 layers of cork composed of thin-walled, somewhat rectangular cells. The epidermis persists for an extended period. The secondary cortex consists of 7–11 layers of parenchymatous cells, some of which become thickened and lignified to form stone cells. The primary cortex remains intact even at advanced stages but eventually becomes crushed.

Pericyclic fibres occur singly or in small groups of 2–3. The secondary phloem comprises sieve elements, parenchyma, a few fibres, stone cells, and phloem rays. Fibres are scattered singly or in small groups in the outer and middle phloem regions, while the inner phloem lacks fibres. Stone cells occur singly or in clusters of 2–4. Phloem rays are 1–2 cells wide, occasionally 3 cells wide.

The cambium is composed of 2–3 layers. The xylem contains vessels, tracheids, fibres, and parenchyma, traversed by xylem rays. Vessels vary widely in size and shape and possess bordered pits. Tracheids are elongated with irregular walls and bordered pits. Fibres are long, thick-walled, lignified, and tapering at the ends, with some showing truncated or bifurcated ends and a few simple pits. Fibre-tracheids are smaller, taper at both ends, and show reticulate thickening. Xylem parenchyma cells are cubical to rectangular with simple or bordered pits or reticulate thickening. Xylem rays are prominent, 1–2 (rarely 3) cells wide and 2–25 cells high.

An internal phloem band, composed of sieve elements and parenchyma, is embedded within the perimedullary zone and contains a few fibres similar to those in the outer phloem. The central region is occupied by a large pith.

Microsphenoidal calcium oxalate crystals and simple starch grains are distributed throughout the cortex, secondary cortex, phloem, medullary rays, and pith.

#### 4] Fruit

The transverse section of a mature fruit shows a single-layered epidermis covered by a thin cuticle. Beneath the epidermis, 1–2 layers of collenchyma are present. The mesocarp consists of thin-walled, oval to polygonal cells, with scattered fibrovascular bundles. The seed comprises a thick-walled, radially elongated testa, a narrow endosperm, and an embryo. Certain endosperm cells contain oil globules.

#### 5] Powder Characteristics

The powdered drug is greenish in colour. Microscopic examination reveals stone cells occurring singly or in groups, aseptate fibres with tapering ends, pitted vessels, clusters of spongy parenchyma, fragments of palisade tissue, anisocytic stomata, stellate hairs, and simple starch grains that are round to oval in shape, measuring 2.75–11 µm in diameter.

#### IDENTITY, PURITY AND STRENGTH

- 1) Foreign matter -Not more than 2 per cent
- 2) Total ash -Not more than 9 per cent
- 3) Acid-insoluble ash -Not more than 3 per cent
- 4) Alcohol -soluble extractive -Not less than 6 per cent
- 5) Water soluble extractive -Not less than 16 per cent [7]

#### ETHNOMEDICINAL USES

In ancient Ayurvedic literature, the plant is characterized as pungent, bitter, digestive, alterative, and astringent. The stems, flowers, and fruits possess a bitter and carminative nature. A decoction of the root is employed as a febrifuge and is known for its diuretic and expectorant effects. Charaka and Sushruta recommended the extract of the entire plant and its fruits for internal use in conditions such as bronchial asthma, tympanitis, irregular peristalsis, piles, and dysuria, as well as for rejuvenation purposes. Charaka's KantkariGhrita is particularly indicated for cough and asthma. According to Bangasena, linctuses made from the stamens of the flowers are prescribed for chronic coughs in children.

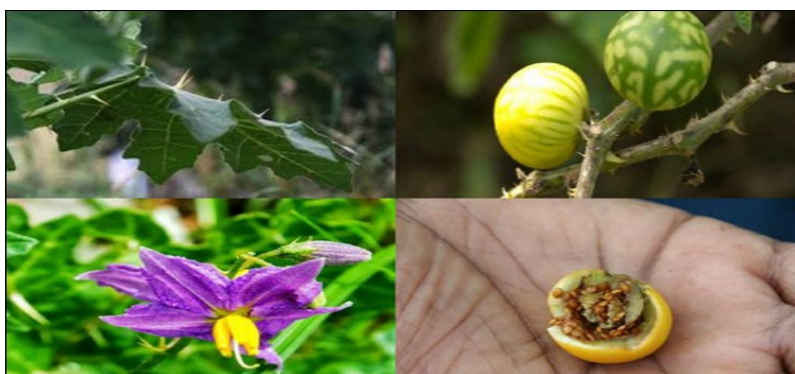
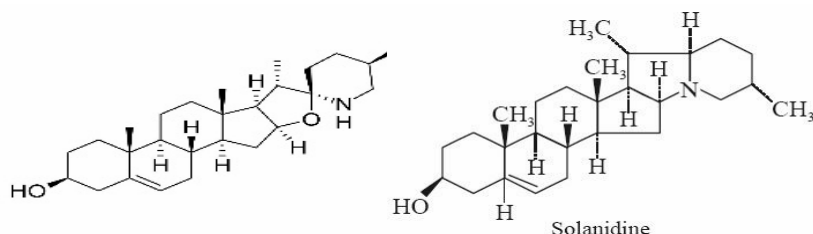
Traditionally, the whole plant has been utilized to treat a variety of ailments. Its decoction is taken for gonorrhoea, while a paste of the leaves is applied externally to relieve pain. The seeds serve

as expectorants in cases of cough and asthma, and the roots—being expectorant and diuretic—are effective in managing catarrhal fever, cough, asthma, and chest pain. The plant also exhibits pest-repellent properties and is used as a natural contact poison and molluscicide. The roots form one of the components of the renowned Ayurvedic formulation DasmulAsava, which is prescribed for cough, asthma, and chest ailments.

The fruits are edible and commonly used in folk medicine for treating throat infections and inflammatory conditions. The stems, flowers, and fruits are also administered to alleviate burning sensations in the feet accompanied by vesicular eruptions. Reported pharmacological activities include antispasmodic, antitumor, cardiotoxic, hypotensive, antianaphylactic, and cytotoxic effects. Fruit juice is beneficial for sore throat and rheumatism, while a decoction of the fruits is traditionally used by tribal and rural communities in Orissa, India, for managing diabetes. Additionally, the fruits are consumed as an anthelmintic and to aid digestion.[1,10]

#### PHYTOCHEMISTRY

*Solanum xanthocarpum* Schrad. & Wendl. is rich in alkaloids, sterols, saponins, flavonoids and their glycosides, as well as carbohydrates, fatty acids, and amino acids. The structures of certain biologically active constituents derived from *Solanum xanthocarpum* Schrad. & Wendl. are presented.[1,5,9]



Part of plant	constituent	percent
fruit	Benzoyl benzoate	21.7%
	(E,E)-Geranyl linalool	12.6%
leaf	heptacosane	20.0%
Stem	Palmitic acid	28.9%
	heptacosane	12.8%
	Linoleic acid	10.1%
root	Solavetivone	22.9%
	Palmitic acid	21.0%
	Linoleic acid	8.2%
Berries fruits	solasodine	1.1 -4.6%
Unripe berries	solasodine	1.7%

## II.

### III. MATERIALS AND METHODS

#### Collection of Plant Material

Leaves of *Solanum xanthocarpum* were gathered from Kaloha village, Kangra District, Himachal Pradesh, India. The harvested plant material was transported to the laboratory for subsequent experimental investigations.

#### Processing of Plant Material

Fresh leaves of *Solanum xanthocarpum* were harvested and initially rinsed thoroughly under running tap water, followed by surface sterilization using 2% mercuric chloride solution. The cleaned leaves were cut into smaller segments to facilitate faster drying. The plant material was then shade-dried for 15–20 days under ambient conditions.[12]

Once completely dried, the leaves were ground into a fine powder using a pestle and mortar. The resulting powdered material was stored in airtight containers at room temperature until further use. Development of Methanolic and Acetone Extracts from *Solanum xanthocarpum* Leaves.[12]

#### Preparation of Methanolic and Acetone Leaf Extracts of *Solanum xanthocarpum*

Shade-dried leaves (50 g) were ground using a mechanical blender to obtain a coarse powdered material. The powdered sample was divided and macerated separately in 300 mL of methanol and acetone in Erlenmeyer flasks. The flasks were sealed with aluminium foil and kept undisturbed for 3–5 days to facilitate extraction.

After the extraction period, the mixtures were filtered through Whatman No. 1 filter paper, and the resulting filtrates were concentrated using a rotary evaporator at 40 °C. The dried extracts were collected, and stock solutions with a concentration of 50 mg/mL were prepared for further analysis[12]

#### **Extractive techniques**

##### **1. Soxhlet extraction**

Sequential extraction starting with hexane, chloroform, ethyl acetate and finally with methanol was done each for 24 h in a Soxhlet apparatus, by placing the plant material (30 g) in a thimble-holder. The methanolic extract was evaporated to dryness in vacuum evaporator under reduced pressure, weighed and the extractive value (the amount of active constituent(s) extracted with solvent from a given amount of medicinal plant material) was calculated. Extraction was done in sextet.[11]

##### **2. Ultrasonication**

Sequential ultrasound-assisted solvent extraction (USAE), as described in Section 2.3.1, was carried out using an ultrasonic bath (Barson, USA) at room temperature (25 °C). The extraction process was repeated three cycles of 30 min each by immersing 30 g of plant material in glass conical flasks.

Following extraction, the methanol-based extract was filtered and concentrated to complete dryness using a vacuum evaporator under reduced pressure. The dried extract was weighed, and the extractive yield was subsequently determined. All extraction procedures were conducted in sextuplicate.[11]

##### **3. Pressurized liquid extraction**

Pressurized liquid extraction (PLE) was carried out using a Dionex ASE system fitted with an additional solvent controller for ASE 300 (Dionex, Sunnyvale, CA, USA). A measured quantity of plant sample (30 g) was loaded into stainless steel extraction cells with a capacity of 100 mL. All extractions were performed at the same pressure (100 bars) and in a sequential manner as mentioned in Section 2.3.1. The ASE cells were heated for 5 min and kept static for 10 min under 100 bar nitrogen pressure at 60 °C. After completing the extraction the cells were flushed by 60% of the total volume of solvent in cells. Then cells were purged for 100 s to collect the extracts. This cycle for extraction was repeated for two times. The methanolic extract was evaporated to dryness in vacuum evaporator under reduced pressure, weighed and the extractive value was calculated. Extraction was done in sextet.[11]

## **PHARMACOLOGICAL ACTION**

### **Anti-fertility activity**

In experimental animals, prolonged administration of solasodine extracted from *S. xanthocarpum* berries led to a decrease in sperm count, total protein, sialic acid, and glycogen content in the epididymis, causing long-term infertility. The treatment also resulted in elevated levels of cholesterol and phospholipids. Similar antifertility effects of solasodine were noted in Rhesus monkeys. In female rats, oral administration of an aqueous suspension of *S. xanthocarpum* seed powder at doses of 100 and 150 mg/kg for 30 days caused a reduction in the weight of reproductive organs and fertility, along with histopathological alterations in the ovary and uterus.

### **Antipyretic effects**

A single dose of solasodine lowered body temperature in animal models of pyrexia induced by pyrago and DNP, as well as in normal rats, likely through a central mechanism of action.

### **Anticancer activity**

Oral administration of an aqueous leaf extract of *S. xanthocarpum* (SXC) at a dose of 150 mg/kg body weight in male Wistar albino rats with Diethylnitrosamine (DEN)-induced hepatocarcinogenesis prevented tumor formation and normalized the elevated liver marker enzyme activities and antioxidant levels, while reducing lipid peroxidation. In Hep3B cells, treatment with solamargine induced apoptosis at the G2/M phase of the cell cycle and upregulated TNFR-I and TNFR-II (TNF-I and II) expression.

### **Snail killing activity**

In A study, a 0.2 mg/l solution of  $\alpha$ -solamargine isolated from the fruits of *S. xanthocarpum* was observed to cause complete (100%) mortality of *Oncomelania* snails at 28°C.[13]

### **Anti-inflammatory activity**

Lupeol, one of the bioactive components of *S. xanthocarpum*, demonstrated anti-inflammatory properties in experimental models by acting on multiple targets such as nuclear factor kappa B (NF $\kappa$ B), Cflip, Fas, Kras, and phosphatidylinositol-3-kinase<sup>12</sup>. Stigmasterol, carpesterol, and diosgenin also exhibited comparable effects, contributing to the plant's

overall anti-inflammatory potential. Acute administration did not produce significant anti-inflammatory action against carrageenan- and histamine-induced paw edema. However, the ethanolic extract of *S. xanthocarpum* showed acute, sub-acute, and chronic anti-inflammatory activity by inhibiting carrageenan- and dextran-induced edema as well as cotton pellet granuloma formation. Suppression of granuloma development was also observed in the rat model.[15]

#### Hepatoprotective activity

In a study, extracts of *S. xanthocarpum* were assessed for hepatoprotective potential against  $\text{CCl}_4$ -induced liver toxicity in rats, showing a marked elevation in enzyme levels, which reflects the plant's antioxidant activity.[16,17]

#### Anti-hyperglycemic activity

The alkaloids and flavonoids found in *Solanum xanthocarpum* demonstrate hypoglycemic effects by enhancing pancreatic insulin secretion from existing  $\beta$ -cells, indicating their potential role in pancreatic beta-cell regeneration. Methanolic extracts of *S. xanthocarpum* leaves (both field-grown and in vitro cultured) at a dose of 200 mg/kg body weight showed significant anti-hyperglycemic effects in alloxan-induced diabetic rats along with strong antioxidant activity. In another study, the ethanolic extract of *S. xanthocarpum* Schrad. & Wendl. was found to upregulate Glu-4 and PPAR- $\gamma$  gene expression in L6 cell lines. The leaf extract of *S. xanthocarpum* also exhibited a strong ability to counteract alloxan-induced hyperglycemia by restoring normal levels of antioxidant enzymes such as SOD, catalase, superoxide dismutase, glutathione peroxidase, and lipid peroxidase.[9,14,18,19,21]

#### TOXICOLOGY

##### Compounds Associated with Potential Toxicity

The primary constituents contributing to possible toxic effects include steroidal glycoalkaloids (such as solasodine, solasonine, and solamargine), along with saponins and other alkaloidal compounds. Glycoalkaloids are known to possess cell membrane-disrupting activity and, at elevated concentrations, may inhibit cholinesterase enzymes.

When consumed or applied in excessive amounts, these compounds may produce adverse reactions such as gastrointestinal discomfort, nausea, emesis, and, in rare instances, central nervous system depression, particularly at very

high alkaloid levels. Overall, the toxicological risk is predominantly linked to increased glycoalkaloid content.[8,22,23,24]

#### MARKETED FORMULATION

##### 1] Preparation of a Topical Therapeutic Hydrogel Incorporating Plant Extract

Hydrogels were prepared using varying ratios of Carbopol 934 and Sodium CMC in the proportions 3:0, 3:1, 2:1, 1:1, 0:3, 1:3, and 1:2. The selected polymers were gradually dispersed in 50 mL of distilled water under continuous mechanical stirring to obtain a uniform dispersion.

Separately, methyl paraben and propyl paraben were dissolved in 5 mL of distilled water with gentle heating on a water bath and allowed to cool to room temperature. To this preservative solution, propylene glycol (5% w/v) was added and thoroughly mixed, after which it was incorporated into the polymer dispersion.

A measured quantity (1 g) of the plant extract was solubilized in a minimal volume of a suitable organic solvent and subsequently blended into the polymeric mixture. Distilled water was added to make the total volume 100 mL. All components were mixed uniformly with the Carbopol gel under continuous stirring to ensure homogeneity.

The pH of the formulation was adjusted to the skin-compatible range (6.8–7.0) by the gradual addition of triethanolamine, which also facilitated the development of the desired gel consistency. A control formulation was prepared using the same procedure, excluding the plant extract.

During formulation, turbidity and formation of lumps were observed in batches F1, F2, F6, and F7; therefore, these formulations were excluded from further evaluation. The remaining batches (F3, F4, and F5) exhibited acceptable physical characteristics and were selected for subsequent studies.[22]

##### 2] Reformulated Ayurvedic Preparations

Kantakari-based Avaleha formulation

Medicated ghee prepared with five bitter herbs (PanchatiktaGhrita)

Vyaghri-Haritaki herbal preparation [23]

#### IV. CONCLUSION

The present review provides a comprehensive pharmacognostic and therapeutic appraisal of *Solanum xanthocarpum*, a well-recognized yet under-explored medicinal plant of the Solanaceae family. The plant demonstrates a

wide spectrum of pharmacological activities, including anti-inflammatory, antiasthmatic, hepatoprotective, antihyperglycemic, anticancer, and antimicrobial effects, which are largely attributed to its rich phytochemical composition, particularly steroidal alkaloids such as solasodine and solamargine, along with flavonoids, sterols, and saponins.

Traditional Ayurvedic applications of various plant parts strongly support its ethnopharmacological significance, while modern experimental studies validate several of these claims at the preclinical level. However, despite promising biological evidence, systematic clinical investigations remain limited. Standardization of extracts, elucidation of precise mechanisms of action, safety profiling, and well-designed clinical trials are essential to translate traditional knowledge into scientifically validated therapeutic applications. Overall, *Solanum xanthocarpum* holds substantial potential as a natural source for drug discovery and development, warranting further interdisciplinary research.

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#### REFERENCES

- [1]. *Solanum xanthocarpum* (Yellow Berried Night Shade): A Review.
- [2]. Sheth AK. The Herbs of Ayurveda. Vol. IV. A.K. Sheth Publisher; 2005. p.1044.
- [3]. Goldberg B. Alternative Medicine: The Definitive Guide. Future Medicine Publishers; 1994. p.257.
- [4]. *Solanum Xanthocarpum*: A Review. DOI: 10.23880/ipcm-16000177.
- [5]. A systematic review on *Solanum xanthocarpum* L. (Sola4naceae) plant and its potential pharmacological activities. DOI: 10.14303/irjps.2022.008.<sup>12-21</sup>
- [6]. Kantakari (*Solanum xanthocarpum*): An Ayurvedic review with contemporary correlation. DOI: 10.22271/phyto.2025.v14.i5e.15590.
- [7]. The Ayurvedic Pharmacopoeia of India (API). Part I, Vol I. Ministry of AYUSH, Government of India.
- [8]. Indian Pharmacopoeia. Indian Pharmacopoeia Commission.
- [9]. Phytochemical and pharmacological profile of *Solanum xanthocarpum* Schrad and Wendl: A review. Vol 7, Issue 11, p.482-491.<sup>12-21</sup>
- [10]. Phyto-Pharmacological Review of *Solanum xanthocarpum* Schrad and Wendl. DOI: 10.25258/phyto.11.4.2.<sup>12-21</sup>
- [11]. Liquid chromatography–mass spectrometry-based quantification of steroidal glycoalkaloids from *Solanum xanthocarpum* and effect of different extraction methods on their content. DOI: 10.1016/j.chroma.2008.08.089.
- [12]. Antibacterial Activity of *Solanum xanthocarpum* Leaf Extract. DOI: 10.20546/ijemas.2016.504.038.
- [13]. *Solanum Xanthocarpum*: Antibacterial Properties, Phytochemical Profiling, and Prospects for Therapeutics. DOI: 10.64252/2p7jsm51.
- [14]. Medicinal attributes of *Solanum xanthocarpum* fruit consumed by several tribal communities as food: An in vitro antioxidant, anticancer and anti-HIV perspective. DOI: 10.1186/1472-6882-14-112.
- [15]. Evaluation of anti-inflammatory activity of *Solanum xanthocarpum* Schrad and Wendl (Kaṅṭakāri) extract in laboratory animals. DOI: 10.4103/0257-7941.131976.
- [16]. Hepatoprotective effect of *Solanum xanthocarpum* fruit extract against CCl4-induced acute liver toxicity in experimental animals. DOI: 10.1016/S1995-7645(11)60227-7.
- [17]. Evaluation of antihepatotoxic potential of *Solanum xanthocarpum* fruit extract against antitubercular drugs-induced hepatopathy in experimental rodents. DOI: 10.1016/S2221-1691(12)60075-6.
- [18]. Antihyperglycemic and antioxidant effects of *Solanum xanthocarpum* leaves (field grown & in vitro raised) extracts on alloxan-induced diabetic rats. DOI: 10.1016/S1995-7645(11)60193-4.



- [19]. Wound healing potential of Solanum xanthocarpum in streptozotocin-induced diabetic rats. DOI: 10.1111/jphp.12975.
- [20]. Antiuro lithiatic effects of Solanum xanthocarpum fruit extract on ethylene-glycol-induced nephrolithiasis in rats. DOI: 10.4103/0975-1483.100022.
- [21]. Solanum xanthocarpum fruit extract promotes chondrocyte proliferation in vitro and protects cartilage damage in collagenase-induced osteoarthritic rats. DOI: 10.1016/j.jep.2021.114028.
- [22]. Formulation and evaluation of herbal antibacterial cream from Solanum xanthocarpum extract. DOI: 10.20959/wjpr202512-37258.
- [23]. Ayurvedic Pharmacopoeia of India. Ministry of AYUSH, Government of India.
- [24]. Indian Journal of Pharmaceutical Sciences and Journal of Ethnopharmacology reports on toxicity evaluation of Solanum xanthocarpum extracts.