

Solanum Xanthocarpum: A Review

Fathima T, Suresh Joghee* and Akaash M

Department of Pharmacognosy JSS college of pharmacy, JSS Academy of Higher education and research, India

***Corresponding author:** Suresh Joghee, Professor and Head, Department of Pharmacognosy JSS college of pharmacy, JSS Academy of Higher education and research, SS Nagar, Mysore-570015, India, Tel: +91 9480197611; Email: jsuresh@jssuni.edu.in

Review Article

Volume 3 Issue 3

Received Date: August 17, 2019

Published Date: September 04, 2019

DOI: 10.23880/ipcm-16000177

Abstract

Solanum xanthocarpum is also called as Yellow Berried Nightshade (kantkari) belonging to the family *Solanaceae*. The plant is well represented in the tropical and warmer temperate regions. In ancient times Ayurveda, the plant is characterized as bitter, digestive, pungent, alternative astringent. Stems, flowers, fruits are bitter, carminative. Leaf of the *Solanum xanthocarpum* shows the following pharmacological activities like Antifungal activity, Wound healing, Larvicidal activity, Bacterial activity, Antihyperglycemic, Antioxidant, Hepato protective activities. A brief literature survey was made through internet like pubmed, google scholar forming the search platform to illustrate the ethano-pharmacology of the plant. Information's of traditional usage, chemical constituents and selected pharmacological activities of the plant were gathered from available research papers to frame the review. The aim of the current review is to define the phytochemical and pharmacological aspects of *Solanum xanthocarpum* which will help in the researchers for further qualitative research.

Keywords: Solanum Xanthocarpum; Solasodine; Hepatoprotective Activity; Hypoglycemic Activity; Anti-Inflammatory; Anti-Oxidant Activity

Introduction

Solanum xanthocarpum is also called as Yellow Berried Nightshade (kantkari) with a height of 2-3 m especially found in dry places in India. It belongs to the family *Solanaceae* [1].

In ancient times Ayurveda, the plant is characterized as bitter, digestive, pungent, alternative astringent. Stems, flowers, fruits are bitter, carminative. Leaf of the *Solanum xanthocarpum* shows the following pharmacological actions Antifungal activity, Wound healing, Larvicidal

activity, Bacterial activity, Antihyperglycemic, Antioxidant, Hepatoprotective activities. It was found that fruits are having several steroidal alkaloids like solanacarpine, solanacarpidine, solanacarpine, solasonine, solamargine and other constituents like caffeic acid, coumarins like aesculetin and aesculin, steroids carpesterol, diosgenin, campesterol, daucosterol and triterpenes like cycloartenol and cycloartenol [2]. The fruit has several medicinal properties like antipyretic, anthelmintic, anti-inflammatory, urinary bladder, enlargement of the liver, laxative, anti-asthmatic activities [3].

The decoction of the root is used as an effective diuretic, febrifuge, and expectorant, cough, asthma, and chest pain [4,5]. The whole plant is used for healing different ailments. Plant decoction is used for treating gonorrhoea; paste of leaves is applied to relieve pains, piles; fruit is laxative, paste is used in the treatment of swellings and pimples; seeds used as expectorant in cough and asthma; roots are used in the treatment of diuretic, catarrhal fever, coughs, asthma and chest pain [6]. This plant has properties like pest repellent and used as a molluscicide and poison. Clinically safe to consume human beings [7]. It is used as an ingredient in many formulations like Chavanaprasha, Dasamoolarishta, Vyaghriharitaki avaleha, Vyaghri tailam, Vyaghriyadi kwatha, Vyaghri ghrtam, etc. [8-12]

Sanskrit Synonyms

Kantakari, Vyaghri, Dhavani, Kshudra, Kantakarika, Kantalika [13].

Regional Names

- English : Febrifuge Plant
- Hindi : Katali, Bhatakataiya, Chhotikateri, Ringani,
- Telugu : Nelamulaka, Chinnamulaka, Mulaka, Pinnamulaka,
- Kannada : Kiragulla, Nelagulla,
- Tamil : Kandangatri, Kandan Katri, Kandangathiri
- Gujarati : Bhorngani [13]

Description and Distribution

Solanum xanthocarpum is an herbaceous plant [14]. Other names for *solanum xanthocarpum* are Kateli, Bhachkatiya. In India mostly seen in Uttar Pradesh, West Bengal, Assam, Mysore, Bihar, Punjab, etc. It is also found in Ceylon and Malacca through South-East Asia, Malaya, tropical Australia, and Polynesia [15]. It is generally grown in March to April, fruits from May to June. It grows mainly in hot and dry places, height about 2-3 m, Fruits are white or yellow colored, measured about 1-3 cm, the stem is like zigzag branches are plentiful, bases are somewhat woody.

Ethnobotany

Taxonomic classification

Botanical Name: *Solanum xanthocarpum*

Kingdom: Plantae

Subkingdom: Tracheobionta

Division: Magnoliophyta

Class: Magnoliopsida

Subclass: Asteridae

Order: Solanales

Family: Solanaceae

Genus: *Solanum*



Figure 1: Taxonomic classification of plant.

Climate and Soil

- It mainly grows in rich loamy soils and well-drained sandy soils with a PH ranging from 7.0-8.0.
- This plant can grow in saline soil.
- Temperature ranging from 21 to 27°C is supportive for growth and reproduction.

- The crop will be adversely affected by frost and recovered during springs.

Propagation Material

- The seed is raised from the crop.
- The seeds measure about 2.5 mm diameter and are in yellowish-brown color.

- These seeds have no latency period.
- Germination range is about 60-70 %.
- The Germination period is around 10-16 days [16].

Ethnopharmacology

Medicinal Properties of *Solanum Xanthocarpum*

Solanum xanthocarpum is a crucial traditional medicinal plant having numerous medicinal properties which are reviewed in this article.

Anti-Fertility Activity

Solasodine is an alkaloid which is extracted from *Solanum xanthocarpum* and acquires anti-spermatogenic activity [17]. It inhibits testosterone but it has no effects on estrogen [18]. Testicular lesions are caused due to continuous administration of solasodine (20 mg/kg for 30 days alternatively) which leads to severe spermatogenic elements impairment. Epididymides lack spermatozoa. The levels of total protein, glycogen and sialic acid in testis and epididymis were diminished where an increase in testicular cholesterol levels is observed. After treating with solasodine the activity of acid phosphatase enzyme is reduced. When compared to controls the levels of serum enzymes, serum proteins, triglycerides, non-essential fatty acid levels are normal. Exalted levels of cholesterol and phospholipid are observed in intact dogs that are treated with solasodine. Low levels of silica acid and reduced Leyden cell nuclei in testes and epididymides are reflected by reduced androgen production. Castration itself causes a reduction in epididymis size. Epididymal degeneration is caused by treating an individual with castration followed by solasodine.

Anti-Inflammation Activity

Chronic inflammation is an unusual reaction that is caused because of chronic diseases such as autoimmune disorders, cancer, vascular disorders, and arthritis. Natural compounds or extracted are demonstrated as human health rejuvenators with safe and non-toxic properties by various studies. Only a few studies have been investigated for anti-inflammatory effects among the numerous phytochemicals isolated from the herbs. Solanidine, α -solanine, and α -chaconine are having anti-inflammatory effects [19].

The compounds such as carpesterol, diosgenin, and stigmasterol are also found to possess anti-inflammation action [20,21]. Lupeol which is constituent of *Solanum xanthocarpum* is also having some immense anti-inflammatory potential which can act as a multi-targeting

agent. Key molecular pathways can be targeted involving the phosphatidylinositol-3-kinase (P13)/Akt, Fas, Wnt/ β catenin, kappa B (NFkB), cFLIP, and Kras nuclear factors in a variety of cells. Lupeol exhibits no toxicity when administered at its effective therapeutic doses to normal cells and tissues. Hence, it may be employed in the treatment of inflammation as a therapeutic and chemopreventive agent [22].

Hepatoprotective Activity

In Chandana VR, *et al.* investigation, the Hepatoprotective activity of *Solanum xanthocarpum* extracts is evaluated in rats by inducing hepatotoxicity using CCl₄. The CCl₄ gets converted into CCl₃, which is the main reason for the hepatotoxicity. Elevated levels of the enzyme in rats are seen which are treated using *Solanum xanthocarpum* after inducing hepatotoxicity with CCl₄ indicating the antioxidant activity of *Solanum xanthocarpum*. Polypharmaceutical herbal formulation called jigrine, used for liver ailments which contain 14 medicinal aqueous extracts including *Solanum xanthocarpum* [23]. Najmi AK, *et al.* [24] investigated the DPPH-free radical scavenging activity, the hepatoprotective and antioxidant activity of Jigrine against galactosamine induced hepatotoxicity in rats [24].

Cardiovascular Effects

Pasnani JS (1988) addressed three activities of Abana, a polyhedral formulation containing solasodine causes: (i) A direct sensitization of the atrium through an increase in permeability to Ca²⁺ and (ii) An effect similar to disengagement of chronic ISO administration, i.e. down regulation of beta-adrenoceptors [25].

Apoptosis-Inducing Activity

Solamargine, lapel, and apigenin from *Solanum xanthocarpum* show anticancer property. Appearance in solamargine-treated cells of the sub-G1 peak, DNA fragmentation, and chromatin condensation in a DNA histogram suggested that apoptosis was induced by solamargine [26-28]. Bhutani KK, *et al.* [2] explains that *Solanum xanthocarpum* and *Asparagus racemosus* contains steroidal constituents which cause tumor cell death and these natural products represent interesting lead compounds for the development of potential cancer therapeutics. This is the first report on the apoptosis-inducing activity of immunoside, which was found to be the most active inducer of apoptosis amongst all the compounds tested in the study in HCT 116 human colon carcinoma cell line. Necrotic cell death is induced by the sugar moieties present in the *Solanum* compounds [29].

Anti-Asthmatic Activity

To prove the potent use of *Solanum xanthocarpum* and *Solanum trilobatum* in the treatment of asthma a pilot study is undertaken [30]. The usage of the whole plants is suggested by major literature data. The therapeutic effect of the whole plant is evaluated by Gautam et al 2008 i.e. asthma relieving or antihistaminic, antiallergic property.

It has a few exercises, for example, smooth muscle unwinding, opposing impacts of asthma go-betweens like histamine, eosinophils. It likewise secures against pole cell degeneration which is significant in asthma pathophysiology [31]. Further, they demonstrated that ethanolic extract has noteworthy antihistaminic movement in histamine incited constriction in the goat tracheal chain arrangement. Along these lines, the critical restraint of histamine initiated compressions delivered by ethanol concentrate of *Solanum xanthocarpum* bloom on disconnected goat tracheal chain arrangement demonstrates that the plant blossom has antihistaminic (H1-receptor enemy) activity. While screening the concentration of 50 and 100 mg/kg diminished milk induced eosinophilia of measurable centrality.

Hypoglycemic Activity

The aqueous concentrate demonstrated a huge hypoglycemic impact in both ordinary and streptozotocin instigated diabetic rodents at a portion of 100 and 200 mg/kg. The action that appeared by fluid concentrate was similar to that of standard oral hypoglycemic operator glibenclamide. The exploratory outcomes showed that it displayed strong blood glucose bringing down property both in ordinary and streptozotocin actuated diabetic rodents. The LD50 of the concentrate was observed to be high showing the high edge of wellbeing [32].

Mosquito Larvicidal Activity

The natural product concentrates on *Solanum xanthocarpum* uncovered larvicidal action against *An. stephensi* and *Cx. quinquefasciatus* and one culicine animal categories *Ae. Aegypti*. Unpredictable oil acquired from *Solanum xanthocarpum* displayed repellency against mosquito *Cx. quinquefasciatus* at a very lower fixation than those of the plants considered before. The deadly groupings of organic products separate at LC50 and LC90 levels against *An. culicifacies*, *An. stephensi* and *Ae. aegypti* were resolved as 0.112 and 0.258, 0.058 and 0.289 and 0.052 and 0.218% individually. The root concentrate is likewise powerful against anopheline and culicine mosquito species, however at higher focuses in contrast with organic product extricate [33-36].

Anti-Oxidant

Uncontrolled synthesis of free radicals or ROSs results in many neurodegenerative disorders that can trigger aging and can be regulated by exogenous antioxidants. Potential antioxidant activity is exhibited by the extracts of *Solanum* species in scavenging of 1,1-diphenyl-2-picryl hydroxyl (DPPH) radical scavenging, ABTS, FRAP, O₂⁻, H₂O₂, etc. Extracts of *Solanum* species have shown potential antioxidant power in 1,1-diphenyl-2-picryl hydroxyl (DPPH) radical scavenging, ABTS, FRAP, O₂⁻, H₂O₂, etc. About signifying the radical scavenging potentiality of the compounds, a positive correlation is identified between the content of alkaloids and the antioxidant activity. Stimulation of cytokines (interleukin [IL] -2, IL-4, IL-12, IFN- γ and tumor necrosis factor-alpha [TNF- γ]) by scavenging action should be elucidated [37].

Locomotor Activity

Behavioral suppression along with locomotor activity is observed when the mice strains C57BL/6 and ADBA/2 are administered by scopolamine followed by shock treatment [38]. Another study in rats demonstrated the effects of scopolamine on pre and post-synaptic events related to dopaminergic function. Behavioral actions associated with spiperone on apomorphine can be inhibited by treating with scopolamine. α -methyl tyrosine inhibits the increased scopolamine locomotor activity in the animals which are exposed to 6-hydroxydopamine (6-OHDA). The hypothesis of presynaptic dopaminergic fibers associating with scopolamine is supported by the unaffected dopamine- β -hydroxylase enzyme. The inhibitory activity of spiperone is suppressed when the rats are administered with 6-OHDA along with α -methyltyrosine. Postsynaptic association of scopolamine is confirmed by unchanged levels of dopamine associated activity of adenylate cyclase and 3H-spiperone in the brain [39]. Studies on the compounds such desacetylsolaphyllidine from *S. oblongifolium* and solaphyllidine, are performed for understanding their effects on locomotor activity (mice) i.e., reducing the duration of sleep is common for both the alkaloids while solaphyllidine also enhances the locomotor activity [40].

Snail-Killing Activity

Solamargine is a chemical compound which is obtained from the methanolic extract of *Solanum xanthocarpum* fruits shows the activity of killing oncomelania snails when an alpha-solamargine solution of 0.2mg/l is used [41].

Anti-Allergic Activity

Apigenin obtained from the extract of *Solanum xanthocarpum* is having anti-allergic effects [42]. This

group exhibits symptoms such as allergic reactions in the bronchioles and elevated levels of eosinophils. Infiltration of the inflammatory cells into the airways and blood vessels around the lungs, development of airway hyper-responsiveness (AHR), and airway luminal narrowing. Administration of apigenin before the last airway OVA challenge resulted in significant inhibition of all asthmatic reactions.

Condensation Effect

Studies conducted by Su Y, *et al.* [40] explain that after the incorporation of stigmaterol, cholesterol, sitosterol into dipalmitoyl phosphatidylcholine (DPPC) monolayers, observed the incorporation abilities of all the compounds. It shows that stigmaterol and sitosterol have interacted very less when compared to the phospholipid and cholesterol. All the sterol moieties can source the condensation effect on monolayers of DPPC. Hydrophobic effect or attractive interactions between DPPC and sterol molecules are playing a major role. This can be asserted by negative excess molecular areas at the particularly negative partial molecular area and low surface pressures of three sterols at low surface pressures. Least extraordinary focuses for the overabundance region were altogether situated at around 0.3 mol divisions for three sterols at 30 mN/m, proposing DPPC/sterol (2:1) in requested structures.

Suppressing Effect

HER2-overexpressing cancer breast cells contain FAS expression which is suppressed by the diosgenin extracted from *S. xanthocarpum* [43]. This is because the diosgenin from the extract is responsible for both inhibitions of proliferation and inducing apoptosis in HER2-overexpressing cancer cells. The phosphorylation is also got affected because of it, mTOR and Akt phosphorylation is inhibited whereas the JNK phosphorylation is enhanced. The study conducted using the pharmacological inhibitors explains that JNK, mTOR, and Akt modulated phosphorylation is important for FAS suppression induced by diosgenin. The cytotoxicity in HER2 overexpressing which is induced by paclitaxel can be enhanced by diosgenin. Hence diosgenin can act as potential chemoprotective agent in the treatment of cancers which overexpress HER2.

Miscellaneous Activities

In the year of 1982, Dixit VP has reported *Solanum xanthocarpum* has an anti-androgenic activity of solasodine, which is a plant alkaloid [34]. An anti-fertility effect of solasodine is reported in the male rats and dogs during further studies [35]. The methanolic extract of

Solanum xanthocarpum fruits contains carpesterol and four steroidal glycosides which when isolated, shows radial growth inhibition on *Aspergillus niger* and *Trichoderma viride* [36]. Antifungal activity is exhibited against *A. brassicae* by the SX dried fruit tissues methanolic extract. The abdominal constrictions in mice induced by acetic acid can be suppressed dose-dependently by giving the methanolic extracts of *Solanum xanthocarpum* aerial parts.

Conclusion

Nowadays herbal medicines have demand in the market because of their cost-effectiveness friendly peculiarity. Hence a lot of attention has been giving to herbal formulations. Number of pharmacological activities has been reported from the studies on *Solanum xanthocarpum* because of the presence of medicinally crucial components like campeferol, diosgenin, campesterol, solasonine, and numerous useful alkaloids.

Present review on *Solanum xanthocarpum* supports the safety of usage in human for Anti-Fertility activity, Anti-inflammation activity, Hepatoprotective activity, **Cardiovascular effect**, Apoptosis-Inducing activity, Anti-asthmatic activity, Hypoglycemic activity, Mosquito larvicidal activity, **Miscellaneous activities**, **Anti-oxidant**, Locomotor activity, *Snail-killing Activity*, **Anti-allergic activity**, **Condensation Effect**, and **Suppressing Effect** due to this the plant gained much more **importance** in both modern drug and Ayurveda. Still some of the phytochemicals have been untouched. Hence there is a need to continue the studies on *Solanum xanthocarpum*.

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