ISSN 2456-3110
Vol 8 · Issue 4
April 2023

JAiMS
INTERNATIONAL

Journal of Ayurveda and Integrated Medical Sciences

www.jaims.in

JAIMS

An International Journal for Researches in Ayurveda and Allied Sciences

Maharshi Charaka
Ayurveda

Indexed

Journal of
Ayurveda and Integrated Medical Sciences
ISSN 2456-3110
REVIEW ARTICLE April 2023

Exploring the Medicinal Importance of *Kantakari*: A Review

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ABSTRACT

The use of therapeutic herbs for healing is as old as humanity itself. There is substantial proof that man and his hunt for natural remedies have a long history, including written records, surviving monuments, and even the first plant medicines. The knowledge of using medicinal plants came about as a result of man's long-standing battles with disease, which taught him to look for pharmaceuticals in the barks, seeds, fruit bodies, and other parts of plants. Modern pharmacology includes various plant-based medications that have been used for centuries and were known to ancient cultures. Modern science has recognized their active effect. *Kantakari*, also known as Yellow Berried Nightshade, is a medicinal plant that is mostly found in India's arid areas. This plant, which is a member of the Solanaceae family, has a range of pharmacological and phytochemical traits. Studies and research conducted over the years have revealed that the plant's medicinal benefit includes anti-inflammatory, bronchodilator, anti-microbial, wound-healing, anti-cancer, and insecticidal properties. The review that follows provides a critical analysis of the existing literature while integrating details on *Kantakari*, including a mention of its botanical description, chemical composition, and *Ayurvedic* medicine applications.

Key words: *Medicinal plants, Kantakari, Solanaceae, Pharmacological properties, Phytochemical traits, Medicinal benefits.*

INTRODUCTION

Medicinal Plants or Medicinal herbs are essences of Traditional medicine practice. Treatment using herbs developed in different parts of the world with different names. Herbalism is the systematic study of medicinal herbs and their botany. Mainly focusing on its medicinal uses. Ethnomedicine is the study of traditional medicine. Researchers identify and separate various active chemicals in medicinal plants.[1] The World Health Organization (WHO) defines herbal medicine as a practice that includes herbs, herbal materials, herbal preparations, and finished herbal products, that contain active ingredients parts of plants, or other plant materials, or combinations.[2] Over the years, the usage of traditional medicine has given us invaluable knowledge on the choice, preparation, and use of herbal medicines. Today, herbal medicine is still the primary healthcare system for roughly 80% of the world's population, especially in underdeveloped nations. To be a credible alternative to western medicine, the same rigorous clinical and scientific techniques must be used to confirm the efficacy and safety of therapeutic products. Indian herbal remedies or *Ayurvedic* treatments are fundamentally based on plants. They have remarkable results when utilized properly and in keeping with the basic principles. Their

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Submission Date: 11/02/2023 Accepted Date: 14/03/2023

Access this article online

Quick Response Code

Website: www.jaims.in

DOI: 10.21760/jaims.8.4.33

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function extends beyond the simple treatment of illness. Thus, *Ayurvedic* medicines are appropriately referred to as the elixirs of life.

The human race has also looked into many plants for basic therapeutic and preventive health care. One such plant of medicinal value in *Ayurveda* is *Kantakari* or *Solanum xanthocarpmum/surratense*, also known as Yellow Berried Night Shade is a member of the family Solanaceae. It is primarily found in arid areas of India. It is a prickly diffuse, bright green perennial herb, woody at the base, 2–3 m in height, found throughout India, mostly in dry places as a weed along roadsides and waste lands.[3] It has been used traditionally for curing various ailments such as fever, cough, asthma, and diabetes in south Indian traditional medicines. The information in the current study has been divided into several areas by the *Ayurvedic* concept, modern aspect, and a few of the plant's confirmed functions and activities.

Materials and Methods

The information was gathered from academic publications, *Ayurvedic* literature, and other sources.

Ayurvedic Review

Synonyms

Vyaghri, Nidigdhika, Ksudra, Kantakarika, Dhavani, Nidigda, Dusparsa.[4] *Sprushi, Anakranta.*[5] *Kantakini, Dupradharsini, Kapatesvari, Kasaghani, Candrapuspa, Priyankari, Gardabha, Candrabhasa, Katuvrntakini,*[6] *Ksudrakantika, Bahukanta, Kshudraphala, Chitraphala,*[7] *Sita, Lakshmana, Candrahasa.*[8]

Vernacular Names[9,10]

Arabian	Badajanbarri
Assamese	Katvaedana, Kantakar
Bengali	Kantakari
English	Febrifuge plant, Yellow-berried Nightshade
Farsi	Badagan barri
Gujrati	Bharingani
Hindi	Katai, Katali, Ringani, Bhatakataiya,ChhotiKateri, Kattay
Kannada	Nelagulla, Kiragulla
Kashmiri	Kath
Malayalam	Kantakari chunda, Kantkariccunta, Kantakarivalutana, Kantankattiti
Marathi	Bhauringani, Kataringani
Oriya	Bhejibaugana, Ankarati, Chakada Bhoji
Punjabi	Kandiari
Tamil	Kandangatri, Kandankatri, Kandanghathiri
Telugu	Nelamulaka, Pinnamulaka, Mulaka, Chinnamulaka, Vakudu

History

Vedic Kala: No specific mention.

Samhita Kala:

SN	*Samhita*	*Varga*	*Karma*
1.	*Charaka Samhita*	*Kanthyamahakashaya, Hikkanigrahana Mahakashaya, Kasahara Mahakashaya, Shothahara Mahakashaya, Angamardaprashamana Mahakashaya, Sheetaprashamana Mahakashaya*[11], *Madhura Skandha* [12]	*Basti.*
2.	*Susruta Samhita*	*Brihatyadi, Varunadi, Laghupanchamoola*	*Vataghna, Pittashamana, Brimhana*
3.	*Ashtanga Sangraha*	*Hrisvapanchamula*	*Sarvadoshahara*
4.	*Ashtanga Hridaya*	*Hrisvapanchamula*	*Sarvadoshahara*

Nighantu Kala

SN	*Nighantus*	*Varga*
1.	*Dhanvantari Nighantu*	*Mishrakadi Varga*
2.	*Madanpaal Nighantu*	*Abhayadi Varga*
4.	*Shodhal Nighantu*	*Guduchyadi Varga*

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5.	*Priya Nighantu*	*Haritakiyaadi Varga* [13]
5.	*Kaidav Nighantu*	*Aushadhi Varga* [14]
5.	*Bhavprakash Nighantu*	*Guduchyadi Varga*
6.	*Raaj Nighantu*	*Shatavahadi Varga*

Adhunik Kala

Kantakari is described in various texts:

- *Dravyaguna Vigyan*, The *Ayurvedic* Pharmacopoeia of India.
- Hindu Materia Medica, principally as an expectorant and antipyretic as various medicinal properties are recognized, particularly in the treatment of asthma, chronic cough, and catarrhal fever.[15]

Properties

Showing the various classics like *Bhavaprakasha Nighantu*, etc. *Rasa* (taste) of *Kantakari* is *Katu* (pungent) and *Tikta* (bitter). Other properties are mentioned in below table.

Nighantus / other texts	***Rasa***		***Guna***		***Virya (Ushna)***	***Vipak (Katu)***
	Katu	***Tikta***	***Laghu***	***Ruksha***		
Bhavaprakasha Nighantu	✓	✓	✓	✓	✓	✓
Dhantwantari Nighantu	✓	✓	x	x	✓	✓
Kaidev Nighantu	✓	✓	✓	✓	✓	✓
Raaj Nighantu	✓	✓	x	x	✓	x
Nighantu Adarsh	✓	✓	x	x	✓	✓
Dravyaguna Vigyan	✓	✓	✓	✓	✓	✓

Karma:

Vedanasthapana (pain reliever), *Shothahara* (reduces swelling), *Swedajanana* (increases sweating), *Jwaraghna* (Anti-pyretic), *Deepana* (appetizer), *Pachana* (digestive), *Rechana* (purgative), *Bhedana, Krimighna* (anthelmintic), *Amadoshanashaka, Raktashodhaka* (blood purifier), *Kasahara* (relieves cough), *Shwasahara* (Bronchodilator), *Kanthya, Hikkanigrahana, Mootrala* (Diuretic), *Garbhashayasankochaka, Vajikarana* (aphrodisiac), etc. are the therapeutic actions of *Kantakari.*

Some important formulations

Some of the important formulations which have *Kantakari* as one of its ingredient or main content are as follows:

Tulasi Kantakari Cough Syrup, Asthma Cough Syrup, Vaidya Kantakari Capsule, Khadiradi Gutika, Sudharshana Choorna, Jwarabhairava Choorna, Jwaranagamayura Choorna, Vyaghri Haritaki, Kantakarya Avaleha, Kantakari Ghrita, Vyaghrighrta Ghrita, Vyaghri Taila, Bhringarajadya Ghrita, Dasamoola Pralepa, Nagaradi Kwatha, Kshudradi Kwatha, Bilwadipanchamoola Kwatha, Kiratadi Kwatha, Vishwadi Kwatha, Bhunimbadi Kwatha, Marichadi Kwatha,Triphaladi Kwatha, Vyaghriyadi Kwatha, Navanga Kwatha, Nidhigdhakadi Kwatha, Kantakaryadi Kwatha, Panchatikta Kwatha, Mustakadi Kwatha, Dasamoola Kwatha, Dwadasanga Kwatha, Chaturdasana Kwatha, Ashtadasanga Kwatha, Bhunimbadyaashtadasanga Kwatha, Shatyadi Varga Kashaya, Brihatkatphaladi Kwatha, Brihatyadi Kwatha, Laghupanchamoola Kwatha, Yogaraja Kwatha, Baswanmooladi Kwatha, Tagaradi Kwatha, Karavyadi Kwatha, Matulungadi Kwatha, Bharngyadi Kwatha, Kirathakadi Kwatha, Musthadi Kwatha, Swalpabharangyadi Kwatha, Madhya Bharangyadi Kwatha, Brihat Bharangyadi Kwatha, Darvi Kwatha, Guduchyadi Kwatha, Drakshyadiashtadasanga Kwatha, Nidhigdhikadi Kwatha, Brahma Rasayana, Chavanaprasha, Indroktha Rasayana, Baladhi Ghrita, Neelinyadhi Ghrita, Dasmooladi Ghrita, Panchama Haritaki Yoga, Bhramhani Gutika, Vyaghradi Kwatha, Nagaradi Kashaya, Vyaghri Leha, Dasamooladighrita, Dasamooladi Hima, Vyaghri Swarasa

Part(S) Used: Whole Plant[16]

Therapeutic Uses

- The plant is effective for treating asthma, coughing, and fever.
- The stem, flowers, and fruits are recommended to treat burning feet accompanied by vesicular eruptions.

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- For the treatment of fever, cough, and heart conditions, dried fruit aqueous extract is heated.
- Given in piles-post drinks, *Kantakari-Sunthi Dhanyak* acts as a laxative and carminative. If one wishes to get rid of piles, drink buttermilk that has been stored overnight in a container that has been pasted inside a *Kantakhariphala.*
- Numerous medical benefits of the fruit include anthelmintic, antipyretic, anti-inflammatory, anti-tumor, cytotoxic, anti-asthmatic, antispasmodic, and hypotensive properties.
- *Solanum surratense* fruit juice is useful for rheumatism and sore throats.
- The fruit paste is topically applied to the afflicted region to cure zits and swellings.
- Additionally, it is utilized to make contraceptive medications.
- The root is a stimulant. It comes in the form of an electuary and is recommended for cough, asthma, and chest discomfort.
- Plant powder is anti-tussive and its effect on patients with bronchial asthma and nonspecific cough has been explained as due to the depletion of histamine from the lung and its expectorant action as due to inorganic nitrogen content.[17]
- It possesses anti-inflammatory, blood-purifying, and cardio-stimulating qualities. It helps with pneumonia, chronic bronchitis, coughing, and asthma. Children are given plant powder to treat chronic bronchitis.
- The primary benefits of *Kantakari* in various dose forms are its *Shwasahara, Kasahara*, and *Jwarahara* properties.

Figure 1: *Kantakari* (Leaves, Flower, Fruit, Seed)

Modern Review:

Latin name - *Solanum surattense* Burm. *F.*

Botanical name - *Solanum surattense*

Family - Solanceae

Authority - Burm.F.

Solanum virginianum, also called *Surattense* nightshade, yellow-fruit nightshade, yellow-berried nightshade, Thai green eggplant, Thai striped eggplant (from the unripe fruit), is also known as Indian nightshade, or yellow berried nightshade plant, the common name is *Kantakari*, *Solanum surattense Brum. f*. and *Solanum xanthocarpum Schrad. and Wendl*. are synonyms of *Solanum virginianum L.*[18] It is a very prickly, perennial, diffuse, patch-forming herb, flowering and fruiting throughout the year. It is commonly found in Southeast Asia, Malaysia, Australia, and all districts of Tamil Nadu, India.[19]

Botanical classification

Kingdom	Plantae
Division	Spermatophytae
Sub-Division	Angiospermae
Class	Dicotyledonae
Order	Cucurbitales
Family	Solanaceae
Genus	*Solanum*
Species	*surattense*

Distribution:

It occurs throughout India, in dry situations as a weed along the roadsides and wastelands. It is naturally

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propagated by seeds in wastelands. It is also distributed in Ceylon, Asia, Malaya, and Polynesia.[20] The plant is found in all dry districts in the plain as well as low hills throughout India from Punjab and Assam to Cape Comorian. In South India, it is found abundantly along the Coromandel Coast and in the districts of Tinnevelly and Kanyakumari. Every type of soil and situation which is not too moist seems to suit it, and it is commonly found growing as a weed on roadside and wastelands, on rubbish heaps, and in similar situations near villages. The plant is in flower and fruit throughout the year.[21]

Botanical description

It is a very prickly, low diffuse suffrutescent, perennial herb or under-shrub, with little stem, but having numerous irregularly ramous or trailing woody divaricated slightly triangular, flexuous branches that spread close to the ground, often rooting at the nodes and covering the circular area 2-4 feet in diameter. The whole plant is thickly armed with strong broad-based sharp compressed straight whitish or yellowish-white prickles nearly half an inch long. They shoot when young and are covered with stellate down but become barely glabrous when mature. They bear ovate or ovate-oblong sinuately lobed or pinnatifid sparsely pubescent to glabrescent prickly membranous leaves which are dark green above and considerably lighter or paler below.[22]

Plant Description

Macroscopic:

Root - It is 10 to 45 cm long, a few millimeters to two centimeters in diameter, nearly cylindrical and tapering, bearing several fine longitudinal and transverse wrinkles with sporadic scars or lenticels and small rootlets; transversely smoothened surface reveals a thin bark and wide compact cylinder of wood, fracture, short, taste, bitter.

Stems are herbaceous with prominent nodes and internodes, green when young, young branches covered in many hairs, mature branches glabrous, furrows more prominent in young stems appearing almost circular toward the basal region, stem pieces 8 -10 mm thick of variable length, external surface light green, when dry, the surface yellowish green and smooth, transversely smoothened surface shows a very thin bark and prominent wood, centre shows a large and distinct, pith and droop down.

Leaves are petiolate, exstipulate, ovate oblong or elliptic, sinuate or sub-pinnatifid, sub-acutely hairy, green, and covered in sharp prickles along the veins and midrib. The flavor and odor are not distinguishable.

Flowers are ebracteate, pedicellate, bisexual, pentamerous, regular, vivid blue, or bluish purple. Calyx persistent, gamosepalous, tube short, globose, linear-lanceolate, acute, hairy, densely prickly; corolla gamopetalous, lobes deltoid, acute, hairy, purple; stamens five, epipetalous, basifixed; filament short, 1-1.5 mm long; anther, oblong-lanceolate; ovary superior, ovoid, glabrous, bilocular with axile placentation containing numerous ovules.

Fruit is berry-shaped globular, measuring encircled by persistent calyx at the base. The unripe fruit has green and white stripes, and the ripe fruit has various tones of yellow and white.

Seeds are circular, flat, and numerous with a glabrous mesocarp and a bitter, acrid flavor.

a) Microscopic:

Root - A transverse section of the mature root shows a cork composed of 3-6 layers of thin-walled, rectangular, and tangentially elongated cells, cork cambium single layered followed by 6-15 layers of thin-walled, tangentially elongated to oval or circular parenchymatous cells, stone cells either single or in groups of 2-20 or even more present in this region, secondary phloem composed of sieve elements and phloem stone cells present in singles or in groups of 2-20 and middle phloem regions, phloem cambium 3-5 layered of thin-walled rectangular cells, xylem composed of vessels, vessels, and tracheid with bordered pits, fibers with a few simple pits, xylem parenchyma rectangular or lightly elongated with simple pits and rarely with reticulate thickening, micro-

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sphenoidal crystals of calcium oxalate as sandy masses and simple starch grains are present.

Stem - A transverse section of mature stem, 1.5-2 cm thick consists of 6-12 layers of cork of thin- walled somewhat rectangular cells, epidermis remains intact for a long time, secondary cortex some cells thickened and lignified forming stone cells pericyclic fibre, occur singly or in small groups of 2-3, a few fibres, stone cells and traversed by phloem rays, fibres found scattered in singles or in small groups in outer and middle phloem region, inner phloem devoid of fibres, stone cells present in singles or in small groups of 2-4, phloem rays, cambium composed of 2-3 layers, xylem consists of vessels, tracheid, parenchyma, fibres and traversed by xylem rays, vessels vary greatly in shape and size and show bordered pits, tracheid elongated with irregular walls and bordered pits, fibres much elongated, thick-walled and lignified with tapering and pointed ends, some having truncated ends or bifurcated atone or both ends with a few simple pits, xylem parenchyma cubical to rectangular with simple or bordered pits or reticulate thickening, xylem rays conspicuous by their pitted thickenings, longer size and radial elongation of cells, 1-2 or rarely 3 cells wide and 2-25 cells high, internal phloem composed of sieve elements and parenchyma, forming more or less continuous band and embedded in perimedullary zone, a few phloem fibres similar to those of outer phloem region also present, central region occupied by a large pith, simple starch grains present in cortex, secondary cortex, phloem, medullary rays and pith cells.

Leaves

Petiole - A transverse section of petiole shows circular to wavy outlines, the epidermis is single-layered, covered externally by a thick cuticle, hypodermis consists of 3-4 layers of collenchymatous, cells, one large-crescent-shaped, bicollateral, central vascular bundle and two small lateral bundles present, rest of tissue of petiole composed of polygonal, angular, thin-walled, parenchymatous cells, epidermis shows mostly stellate and rarely turn to tricellular hairs.

Midrib - A transverse section of the midrib reveals a biconvex structure with an epidermis on either side that is externally covered by a thick cuticle. Below the epidermis, there are three to four layers of collenchyma, and the remaining tissue is made up of thin-walled parenchyma. The epidermis also has some stellate hair.

Lamina - The dorsiventral structure of the lamina is visible in the transverse section, along with the wavy-outlined epidermis on either side, which is covered externally by a thick cuticle. The upper side of the mesophyll is composed of a single layer of palisade and 4-6 layers of loosely arranged spongy parenchyma, as well as some stellate hairs (4-8 armed).

Fruit - A mature fruit's transverse section reveals a single layer of epidermis that is externally covered by a thin cuticle, one to two layers of collenchyma beneath the epidermis, a mesocarp made up of thin-walled, oval to polygonal cells, some fiber and vascular bundles that are dispersed, and a seed that is made up of thick-walled, radially elongated testa, narrow endosperm with the embryo, some cells of endosperm contain oil globules.

Chemical Composition

Alkaloids, sterols, saponins, flavonoids, and their glycosides are all present in the plant, along with carbohydrates, fatty acids, amino acids, etc. The main alkaloid is the steroidal alkaloid solasodine. Solasonine, Solasodine, Betasolamargine, Solanocarpine, and Solanocarpidine are all found in fruit. Isochlorogenic, neochronogenic, chronogenic, and caffeic acids can be found in small amounts in dry fruits. Apigenin came from the petals. Sitosterol and quercetin diglucoside were produced by stamens. Fruits in a plant species contain more alkaloids than any other organ, and alkaloid output varies with different chemical solvents. The presence of flavonoids, saponin, and permissible levels of heavy metals including Cu, Fe, Pb, Cd, and Zn was also assessed in addition to the alkaloid content.

Pharmacological Activities

1. Anti-hyperlipidemic activities[23]

The important indicators to determine if a person is hyper or hypolipidemic are plasma levels of total cholesterol, triglycerides, phospholipids, and free fatty

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acids. Hyperlipidemia activity was examined in the biochemical research on streptozotocin-induced experimental animal models. The study's findings, which represent the changed lipoprotein profile, indicated that levels of very low-density lipoprotein cholesterol and low-density lipoprotein cholesterol increased while levels of high-density lipoprotein cholesterol declined. When compared to the control group, animal models given *S. surattense* plant extract normalized the plasma lipid profile (without treatment). *S. surattense* has the same capacity to prevent hyperlipidemia as the common medication Glibenclamide.

In addition to providing a scientific justification for the use of S. *surattense* in the creation of a successful medication to treat diabetes and its related effects on body metabolism, this study confirms the potential efficacy of *S. surattense* as an anti-hyperlipidemic drug.

2. Wound Healing Activity[24]

When applied topically, the methanolic extract of *S. xanthocarpum* fruit successfully improved wound contraction (30%), tensile strength (37.5%) after 12 days, and wound healing process considerably (P0.01) compared to the control (Aloe vera Cream and Ketamine HCl). The outcomes supported its usage in traditional medicine to heal wounds.

3. Anti-urolithiatic Activity[25]

Solanum xanthocarpum fruit extract on male Wistar rat urolithiasis effect was generated in ethylene-glycol. Ethylene glycol (0.75%) was added to drinking water for 28 days to cause nephrolithiasis in male Wistar rats. The calculi-induced group showed hyperoxaluria, impairment of renal function, and oxidative imbalance in the kidney, as well as an increase in the excretion of calcium, phosphate, and uric acid, and a reduction in citrate and magnesium in urine. Treatment with *S. xanthocarpum* improved renal function, reduces hyperoxaluria, calcium, and uric acid, and had antioxidant properties as well. Calcium oxalate (CaOX) crystals, which were huge in the lithogenic group but smaller in the drug-treated group (Cystone (750 mg/kg, p.o.)) group, were excreted as crystalluria.

4. Hepatoprotective activity[26]

In experimental mice, *S. xanthocarpum* fruit extract (SXE), 50% ethanolic, was given daily for 14 days at doses of 100, 200, or 400 mg/kg body weight. Chemical liver damage was caused by giving 1 mL/kg of CCl_4 intravenously. Several biochemical markers, including serum alkaline phosphatase (SALP), aspartate aminotransferase (AST), alanine aminotransferase (ALT), and total bilirubin, were used to evaluate the hepatoprotective efficacy. Along with histological examinations, in vivo antioxidant activities such as lipid peroxidation (LPO), reduced glutathione (GSH), superoxide dismutase (SOD), and catalase (CAT) were investigated. By lowering the oxidative stress caused by CCl4 and providing liver protection, *Solanum* fruit extracts were effective.

5. Antifertility activity[27]

S. surattense has been found to have strong antifertility action, according to research. Fruit extracts were given to experimental animal models for a period of 60 days at a level of 0.5 mg/kg, and this resulted in the spermatogenesis process being stopped. It was also clear that a decrease in the number of primary, secondary, and spermatid cells was associated with a stop in spermatogenesis. Leading cells in the testis were also dramatically reduced, which supports the antispermatogenic properties of the fruit of *S. Surattense.*

6. Mosquito larvicidal activity[28]

The larvicidal activity of cypermethrin was investigated both alone and in combination with the root extract of *Solanum xanthocarpum* against anopheles larvae to minimize the use of ecologically dangerous chemical pesticides. The most poisonous extract was found to be petroleum ether, followed by carbon tetrachloride and methanol, with LC50 values of 1.41 and 0.93 ppm and LC90 values of 16.94 and 8.48 ppm after 24 and 48 hours after application, respectively. Cypermethrin's readings were as follows: LC50 after 24 hours was 0.0369 ppm, LC50 after 48 hours was 0.0096 ppm, and LC90 after 24 and 48 hours was 0.0142 ppm and 0.0091 ppm, respectively. Cypermethrin and petroleum ether extracts were evaluated in ratios of 1:1, 1:2, and 1:4.

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The 1:1 ratio of cypermethrin and petroleum ether extract was shown to be the most effective of the several ratios tested. Synergism was seen based on the individual effectiveness of each component. This is the perfect environmentally friendly method for reducing *Anopheles stephensi*, the vector of malaria, proving the larvicidal activity of *S.xanthocarpum*.

7. Diuretic activity[29]

Fruit extracts from *S. surattense* considerably improved urine production in a dose-dependent manner, according to studies on the diuretic and serum electrolyte regulating capabilities of the extracts. Plant extract's diuretic capacity was marginally inferior to the efficacy of the widely used medication furosemide.

8. Antidiabetic activity[30]

The crude methanol extracts of field-grown plants of *S. xanthocarpum* and in-vitro-raised leaves were evaluated against alloxan-induced diabetic rats at various doses (100-200 mg/kg/w). The antioxidant effect was also established, and several biochemical indicators were used to confirm the antidiabetic efficiency. The chlorophyll, carotenoids, total sugar, protein, amino acid, and minerals contents of *S. xanthocarpum* leaves that were grown in the wild and those that were cultivated in a laboratory were estimated. The findings showed that *S. xanthocarpum* leaves from both field-grown and in-vitro cultures may be effectively used as anti-hyperglycemic drugs at a concentration of 200 mg/kg bw and possess strong antioxidant activity. However, in all studied doses, the extracts of *S. xanthocarpum* leaves raised in vitro are more effective than leaves grown in the wild. *S. xanthocarpum's* proximal composition and mineral analysis showed that in vitro-raised *S. xanthocarpum* had a greater concentration of components than field-grown *S. xanthocarpum* did. Thus, *S. xanthocarpum* leaf extracts have the potential to be used as a treatment for hyperglycemia and as a tool to lessen oxidative stress.

9. Antinociceptive activity[31]

Animal models' occurrence of acetic acid-induced abdominal constrictions was markedly reduced by methanol extracts of aerial parts of *S. surattense*. The frequency of wirthiness was decreased and a 73.08% inhibition was seen at a dosage of 500 mg/kg. S. *surattense* demonstrated dose-dependent antinociceptive efficacy.

10. Antiulcer activity[32]

Alcoholic extracts have more antiulcer properties than other solvent extracts, according to *S. surattense* leaf extracts. Plant extract reduces overall acidity and increases gastrointestinal contents' pH (3.10), lowering the ulcer index. The effectiveness of the antiulcer properties of S. *surattense* in reducing acidity was equivalent to that of the common antiulcer medication Omeprazole. Compared to plant extracts, omeprazole had a more noticeable effect in lowering the ulcer index. reduced effectiveness of plant extracts since fewer anti-ulcer chemicals are present in basic form.

11. Antibacterial activity[33]

Numerous research has been conducted to demonstrate how plant extracts can stop the development of bacterial species. *S. surattense* leaf extract has a significant impact on bacterial strains. Eight bacterial species, including *Staphylococcus aureus* (11.23 mm), *Streptococcus* (9.22 mm), *Bacillus subtilis* (16.25 mm), *Escherichia coli* (14.19 mm), *Pseudomonas aeruginosa* (4.16 mm), *Salmonella typhi* (1.16 mm), and *Vibrio cholera* (10.17 mm), were significantly inhibited by ethanol extract. While *Shigella* has no impact.

12. Analgesic activity[34]

Leaf extracts from the *Solanum surattense* plant may be used as an analgesic. Studies using plant extract on lab animals revealed an enhanced response that was dose-dependent. This study verifies the historical usage of *S. surattense* as an analgesic and offers the opportunity to create natural analgesics based on folklore claims.

13. Anti-piles activity[35]

According to the Ayurvedic literature, *S. surattense* has anti-pile properties. Since ancient times, Indian tribes have utilized the root of *S. surattense* as a traditional

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remedy to treat piles. Still, because of its extraordinary healing qualities, it is performed in many parts of India. There haven't been any recent scientific reports. The prospect of creating a more potent medicine that is more potent than those already on the market is made possible by systematic analysis and extraction of bioactive components from the crude extracts of *S. surattense* roots that are useful to treat piles.

14. Anti-asthmatic activity[36]

Asthma is a chronic inflammatory illness that affects the airways by obstructing them, causing eosinophilia, and increasing bronchial sensitivity. A pilot investigation on the therapeutic effectiveness of *Solanum xanthocarpum* showed considerable improvement in several respiratory disorders such as bronchial asthma. In-vitro and in-vivo animal models were used to examine the anti-asthmatic effects of petroleum ether, ethanol (95%), and water extracts of *Solanum xanthocarpum* flowers. Only the ethanolic (95%) extract (SXEX) showed some promising results as it relaxed the isolated goat tracheal chain that had been pre-contracted by histamine (P0.05). Goat tracheal chain contraction is observed to be dosage dependent. Treatment with SXEX (100 mg/kg, i.p.) treatment remarkably (p< 0.05) reduced milk-induced eosinophilia (18.16±0.912), and SXEX (50 mg/kg, i.p.) was able to control the milk-induced eosinophilia (25.5± 5.71) as compared control group which receives only vehicle and milk (43.2±0.663) in mice (n=5), while mast cells were protected at a dose of (50 &100 mg/kg, i.p) by 74.39% and 78.26 % respectively by SXEX as compared to Disodium cromoglycate(DSCG) shown protection by 83.81%. Also, SXEX decreased capillary permeability by 62% in mice was evident from its effect on the optical density of the dye. Further evidence that SXEX reduced capillary permeability by 62% in mice may be seen in its impact on the dye's optical density.

15. Anti-cancer activity / Apoptosis-inducing activity[37]

Numerous substances from *S. xanthocarpum* and *Asparagus racemosus* were discovered to cause colon cancer cells to die. But most of the time, apoptosis was not linked to cell death. Compared to the usual medication cisplatin, the apoptotic efficiency was low. Solamargine and solasonine's 2-rhamnose moiety were necessary for the triggering of apoptosis. Due to the absence of carbohydrate moieties, solasodine, and diosgenin were only marginally cytotoxic. The study's findings support the steroidal components of *Solanum's* role as an apoptosis inducer and cause of cell death. To fully comprehend the intricate mechanism of cell death and apoptosis and to create a viable therapeutic medication to treat cancer, extensive, systematic research is needed.

16. Cardio-protective activity[38]

The effectiveness of *S. surattense* extracts as cardioprotective agents against isopropanol-induced myocardial damage in animal models. In the plasma of myocardial wounded animal models, higher levels of the marker enzymes lactate dehydrogenase (LDH) and creatine kinase-muscle/brain (ck-MB) were found. The β-androgenic receptor is the mechanism through which isopropanol causes myocardial damage. Rapid production of ROS is caused by acute activation of the -androgenic receptor, which also reduces the capacity of all antioxidants. In comparison to the usual medication propanol, treatment with plant extracts demonstrated considerable cardiac protection in a dose-dependent manner.

17. Anti-HIV activity[39]

The fruit extract of *S. surattense* has anti-reverse transcriptase (RT) activity. To determine the anti-RT action, non-polar extracts (hexane, benzene, chloroform, ethyl acetate, and acetone) and aqueous extracts at dosages of 0.6 and 6.0 g/ml were evaluated. Results demonstrated that nonpolar extracts had inhibitory action that was dose-dependent. At 0.6 g/ml conc., benzene and acetone extracts showed the highest percentage of RT inhibition (20%), but at 6 g/ml conc., benzene showed the highest percentage of RT inhibition (25%) and was followed by hexane (20%) and chloroform (15%). However, compared to the common medication Nevirapine, the fruit extracts (non-polar) of *S. surattense* demonstrated lower percentages of RT inhibition.

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18. Anti-inflammatory activity[40]

Inflammation is a complicated series of cell-soluble factor interactions that develop in the tissues in response to infection, trauma, or damage. Traditional medicine uses the fruits of *S. surattense* as an anti-inflammatory medicine. Only a relatively small amount of paw edema caused by carrageenan in rats was inhibited, according to research into the anti-inflammatory effects of *S. surattense* leaf extracts. The administration of *Solanum surattense* Extract inhibits edema beginning one hour after administration and all phases of inflammation in a dose-dependent manner, which is likely due to the suppression of many physical and chemical mediators of inflammation.

19. Anti-helminthic activity[41]

The anthelminthic activity of *S. surattense* whole plant with crude aqueous, hydroethanolic, and ethanolic extracts at 25, 50, and 100 mg/ml conc. in distilled water was calculated. Piperazine citrate 10 µg/ml was employed as a reference standard. The study revealed ethanolic plant extracts (100 µg/ml conc.) showed a remarkable anthelminthic property than aqueous and hydroethanolic extracts.

20. Acute Toxicity Studies[42]

The poisonous glycoalkaloids α -solanine and α -chaconine are found in the potato plant *(Solanum tuberosum)* naturally. Glycoalkaloids (GAs), especially α -solanine and α -chaconine, which are naturally found in all potatoes, are thought to be responsible for these effects. As a result of inappropriate treatment and post-harvest storage, it has previously been demonstrated that the amount of GAs in potato tubers rises significantly. High amounts of glycoalkaloids taken by humans have caused acute intoxication, severe episodes of coma, and even death. When given by gavage to female Syrian hamsters, daily dosages of 100 mg of α-solanine [kg body weight (BW)]1 caused the deaths of two of the four hamsters within 4 days. One of four hamsters died after receiving doses of 75 or 100 mg (kg BW)1 of either α-chaconine alone or α-solanine and α-chaconine combined in a ratio of 1:2.5. The small intestines of animals given doses of α-solanine either alone or in combination with α-chaconine dilated and filled with fluid. Acetyl cholinesterase (AChE) and butyryl cholinesterase (BuChE) activity in plasma or the brain were unaffected by GA treatment. It was shown by metabolomics using liquid chromatography and mass spectrometry that there was a particular buildup of α -chaconine in the liver tissues. Thus, a synergism amongst these Solanaceae family species due to the presence of these steroid glycosides (α -solanine and α-chaconine) which can cause acute poisoning and even death in severe situations has been expected and established but no directly linked negative effect has been seen in *S. surattense* for the same.

21. Anti-oxidant activity[43]

Reactive oxygen species (ROS), which cause oxidative damage, are susceptible to harm from antioxidants. Toxic consequences are produced when free radicals interact with biomolecules including DNA, proteins, and lipids. Many plants have been identified as having the potential to be anti-oxidants due to their abundance of phytochemical components such as phenols and flavonoids. When 2,2-diphenylpicrylhydrazyl was used to examine the ROS scavenging effectiveness of S. *surattense* leaf extracts, it was shown that the plant extract displayed exceptional antioxidant activity at all test levels in a dose-dependent manner.

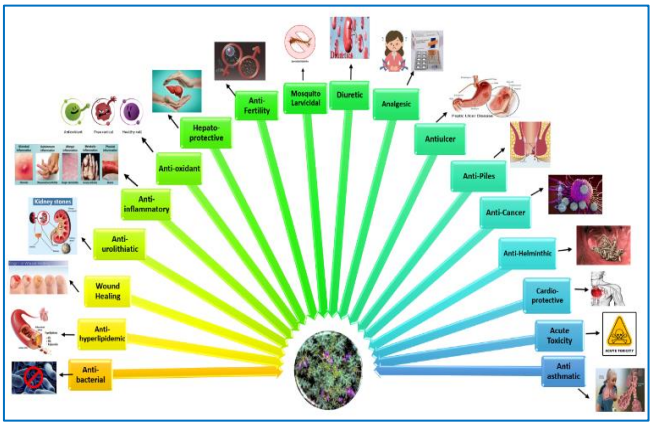

Figure 2: Graphical representation of Pharmacological Activities in *Kantakari*

DISCUSSION

The word *Ayurveda*, which means "knowledge of life", serves as a reminder of the deep interdependence of

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all living things. The art and science of *Ayurveda* aim to balance our internal and external environments with a special emphasis on holistic well-being. Numerous chronic illnesses react well to *Ayurvedic* treatment, which is why it is growing in acceptance around the world. Even though conventional medicine predominates in many areas of this market, *Ayurvedic* practices do not necessarily perform better. Frequently, patients become dependent on lifetime medications used in conventional care. Many medications have unwanted side effects and withdrawal symptoms that can be troublesome if the medication is later stopped. In these situations, *Ayurveda* has a lot to offer. *Ayurvedic* therapies often have positive effects on patients, resulting in a decrease and perhaps even a cessation of their symptoms. *Ayurvedic* remedies are often used in conjunction with and/or after traditional medical techniques as the majority of patients start taking conventional pharmaceuticals as soon as their diagnoses are made. By lowering the use of cortisone and analgesics, *Ayurveda* can help people feel better by improving their quality of life.

Before prescribing internal remedies, dietary changes, and behaviour limitations, *Ayurveda* attempts to identify patients' ailments. The *Ayurvedic* healing procedure heavily relies on plant-based remedies. In general, no material on earth cannot be utilized as a possible medication. *Kantakari* is one such plant that is frequently cited in *Ayurveda* for treating various medical conditions. For cough and asthma, seeds work as expectorants; for catarrhal fever, coughs, asthma, and chest discomfort, roots work as expectorants and diuretics. After a thorough search of the various *Ayurvedic* classics, it was discovered that *Kantakari* is used both as a stand-alone medication and as an ingredient in compound formulations for several diseases, including *Kasa, Swasa, Jwara, Swarabeda, Hiddma, Karnamoola Sotha, Gulma, Kushta, Sopha*, and *Hridroga*, etc. One of the key ingredients of the *Ayurvedic* remedy *Dashmularishta*, which is used as a tonic for nursing women, is the root of *S. surattense*.

Solanum virginianum L. (Kantakari) is advantageous for curing bronchial asthma. Alkaloids, polyphenols, steroids, flavonoids, terpenoids, and coumarins are only a few examples of the many secondary metabolites that give medicinal plants their therapeutic properties. The anti-accelerator cardiac action of solasodine and some of its derivatives have also been reported. Both natriuretic and antiurolithiatic properties are present in the plant. For the treatment of diabetes, a decoction of the plant's fruit is utilized. Leprosy, itchy scabies, hair loss, chest discomfort, vomiting, skin conditions, edematous heart disorders, and coughing are among the conditions that can be helped by *Kantakari*. The plant has been described as having antifertility, anti-diabetic, analgesic, beneficial in piles, anti-cancerous properties, etc.

CONCLUSION

About 90% of *Ayurvedic* remedies are made from plants. Unlike food or spices, *Ayurvedic* herbs have a larger effect on the body. These plants can stabilize the *Doshas* - *Dhatus* and reverse various pathophysiological processes in the body. Since ancient times, the common roadside weed-like plant, *Solanum surattense/virginianum/xanthocarpum* or *Kantakari*, has been used in traditional Indian medicine (*Ayurveda*) to treat a variety of illnesses. In India, the plant is frequently found in waste areas, along the side of the road, and in open areas. A lot of people use *Kantakari* to cure different kinds of *Jwara* (fever), *Tamaka Swasa* (bronchial asthma), *Kasa* (cough), and *Hikka* (hiccough). Several formulations are using *Kantakari* as a component in different dosage forms. For the treatment of *Shwasa*, it is used as a single medicine in the form of *Swarasa* (fresh juice) and as a decoction. The existence of secondary metabolites such as flavonoids, alkaloids, phenols, saponins, glycosides, steroids, and triterpenoids was discovered by phytochemical analysis of roots, leaves, and fruits. In-depth analyses of the phytochemical components of *S. surattense* revealed the existence of the steroidal alkaloids solanocarpine, solasonine, solamargine, carpesterol, and diosgenin as well as the glycoalkaloid solasonine. Numerous studies have looked deeply into pharmacological effects such as antimicrobial, antihelminthic, antihyperglycemic, hypolipidemic,

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cardiovascular protective impact, antiulcer, wound healing, uriolithiatic, and antifertility. Systematic research and clinical testing support the claims made in the traditional application of *Kantakari* for its many medicinal properties. Numerous chemicals have been identified from this multitherapeutic medicinal plant, but only a few numbers have been examined for their powerful biological action by thoroughly studying the literature. According to the current review, the pharmacological activities of *Kantakari* prove it to be a multifarious medicinal plant in recent times. Thus, the potential to harness and create innovative treatments from active components of *Kantakari* promises further study of its compounds and their confirmation for benefitting mankind.

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How to cite this article: Vanya Gupta, Om Prakash Gupta, Priyanka, Aditi Yadav. Exploring the Medicinal Importance of Kantakari: A Review. J Ayurveda Integr Med Sci 2023;04:194-206.
http://dx.doi.org/10.21760/jaims.8.4.33

Source of Support: Nil, **Conflict of Interest:** None declared.

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