

Medicinal use of *Solanum Xanthocarpum*

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ABSTRACT

Solanum xanthocarpum is used in Ayurveda to treat many health issues. It is a thorny plant that grows on the ground and is abundantly found in open areas, roadsides and wastelands. It is commonly known as choti kateri or Ringini and its English name is Wild eggplant, Yellow berried nightshade. All the parts of this plant keep the medicinal value and have the potential to treat a large no. of diseases such as common cough and cold, fever, muscle ache, kidney stone, liver enlargement etc. This review aims to widen the use of *Solanum xanthocarpum* in the field of medicine. There are three species of *Solanum xanthocarpum* known they are *Solanum virginiannum* Linn (chota kateri), *Solanum Bangui lam* (bada kateri), and *Solanum lasiocarpum* (white kateri). It has many properties like antiasthmatic, hepatoprotective, anticancerous, antifertility, anti-inflammatory, hemolytic activity, antibacterial and antifungal antifungal. It possesses minimum hemolytic properties and also has antidiabetic and antioxidant properties. They can also be utilized as an alternative method to combat bacterial infections because they are a significant source of phytochemical compounds with significant curative applicability against the human pathogen. The fruit extract possesses antimicrobial and antifungal activity and the chemical used for extraction are ether, petroleum, chloroform, dichloromethane, ethyl acetate, acetone, methanol and water.

Keywords: *Solanum xanthocarpum*; Antibacterial; Antifungal activity; Phytochemical; Hemolytic; Antioxidant.

INTRODUCTION

Solanum xanthocarpum is also known as the Choti kateri or Ringini as its vernacular name. It is a thorny herb that is found growing in open areas and near the roadside. It is about 2-3 m in height and the branches are spread on the ground. The flowers are cymes and bluish-violet. It is a nontoxic plant and is safe for human use [1]. *Solanum xanthocarpum* has a wide range of medicinal importance. Roots, leaves, stems, and flowers are useful parts of the Ayurvedic medicinal herb. The different parts of the plant are used to treat many diseases like colds, coughs, fever, kidney stones and bladder stones, etc. The fruit paste is known to treat pimples and swelling. The roots are one of the major constituents of the ayurvedic preparation “*Dasmula Ashva*” [2,3].

The plant is rich in many components such as alkaloids, phenolics, flavonoids, steroids, saponins and their glycosides and also carbohydrates, fatty acids, tannins and amino acids [4]. Its fruit contains campestral, glucose, galactose, potassium chloride, several steroids and alkaloids mainly in the form of glycoalkaloids. *Solanum xanthocarpum* possesses antifertility, antipyretic, anticancer, antiallergy, antihistamine, anti-inflammatory, antifungal, antibacterial, antioxidant, and hemolytic properties. This property is due to the bioactive compound produced during the secondary metabolism in plants. The majority of the phytochemical component is known to produce therapeutic activity like antibacterial, antifungal and antioxidant. The presence of alkaloids, phenolics and flavonoids in the leaves of *Solanum xanthocarpum* is the reason for showing antibacterial activity. It shows minimum hemolytic activity.

The alcoholic and aqueous extract of the plant show hypotensive effect and antiviral activity against Ranikhet disease virus and Sarcoma-180 in mice [5]. The aqueous solvent of all the parts of the plant extract shows that it has a biological inhibition effect. The plant possesses this antimicrobial substance for protecting them from microbial infection and deterioration.

LITERATURE REVIEW

Medicinal properties

Solanum xanthocarpum is major constituent of the Dasmoola in Ayurveda. Dasmoola means combination of ten plant roots together it comprises of roots of five major or big trees known as Brihat panchmoola and roots of minor or small herbs known as laghu panchmoola [6].

Solasodine is an alkaloid extracted from *Solanum xanthocarpum* have anti-spermatogenic activity [7]. It inhibits testosterone but has no effect on estrogen [8,9]. Excessive free radicals may produce oxidative stress that can damage, lipids, proteins and DNA resulting in various chronic and degenerative diseases or disorder such as cancer, cardiovascular Alzheimer and aging, etc.

Many biological activities such as lipoprotective, antiplatelet and anti-inflammatory are related to antioxidative effect of flavonoids includes radical scavenging, reducing ability, metal ion chelation and inhibition of enzymatic system responsible for free radical generation. Solanidine, α -solanine and α -chaconine are having anti-inflammatory effect. Compounds such as carp-sterol, diosgenin and stigmasterol are also found to have anti-inflammatory action. Lupeol is a constituent of *solanum xanthocarpum* have immense anti-inflammatory potential which act as a multi targeting agent. Lupeol is a non-toxic when administered at its therapeutic dose to normal cells and tissues. It may be employed to the therapeutic and chemo preventive agent.

Solamarfine, lapel and apigenin found in *Solanum xanthocarpum* show anticancer property. The cell treated by solamergine show DNA fragmentation and chromatin condensation in DNA histogram suggest that apoptosis was induced [10]. The powder of plant is anti-tussive it helps in the depletion of histamine from the lungs and its expectorant action due to the inorganic nitrogen content and help in curing asthma and non-specific cough and cold.

Antibacterial activity of *Solanum xanthocarpum*

It has been found that the *Solanum xanthocarpum* possess antibacterial property. There are many research conducted to confirm the antibacterial activity of *solanum xanthocarpum*. There was a study conducted to find the antibacterial activity of various part (stem, leaves, and roots) of solvent extract of *Solanum xanthocarpum* against *E. coli*. 5% w/v solution of each extract of the different part of plant was prepared by dissolving 250 gm of each extract in 5 ml sterile Dimethyl Formamide (DMF). Organisms were inoculated on the agar medium with help of swab. Sterile filter paper disc coating sample were immersed in plant extract and were placed on the solidified agar and the plates were incubated. The zone of inhibition was measured for the study of the antibacterial property of *Solanum xanthocarpum*. The antibacterial activity can be categorise by measuring the values of the complete inhibition diameter of the circle including the disc in millimetre as reported by Arora and Bharadwaj [11]. Udayakumar et al. collected different part of *S. xanthocarpum* such as stem fruit and leaf and prepared its extract with petroleum ether, alcohol, acetone and measured zone of inhibition with different bacteria.

Escherichia coli are a gram-negative bacterium normally lives in the intestines and also found in the guts of many animals. They are rod shape responsible for the digestive and gastrointestinal infections some strains of *E. coli* cause diarrhoea while some causes food poisoning in their host. Petroleum ether, alcoholic and acetone extract of stem were isolated and the zone of inhibition observed were 7 mm, 13 mm and 11 mm respectively. Evaluation of leaf with petroleum ether, alcohol and acetone was done and it show 7 mm, 8 mm, 8 mm of zone of inhibition whereas the petroleum ether, alcohol and acetone with fruit show 13 mm, 8 mm, 11 mm of zone of inhibition. Solvent control does not produce any zone of inhibition.

Bacillus cereus: They are toxin-producing gram-positive bacteria and are facultative anaerobic. They are commonly found in the environment and can contaminate food. They are able to quickly multiply at room temperature. They cause serious intestinal illness with nausea. Vomiting and diarrhoea also cause serious infection in immunocompromised hosts and can cause septicemia as well as endophthalmitis which causes vision loss. The zone of inhibition was measured as 9 mm for petroleum ether and shows no zone of inhibition for alcoholic and acetone extract of stem. The petroleum ether and alcoholic extract of leaf gives 8 mm and 10 mm of zone of inhibition whereas the acetone extract of leaf show no zone of inhibition. Evaluation of fruit extract using petroleum ether show 8 mm of zone of inhibition and no zone of inhibition was shown by alcoholic and acetone. No zone of inhibition is produced by solvent control.

Klebsiella pneumoniae: These are gram negative bacteria which are non-motile in nature. They are lactose fermenting and encapsulated. Klebsiella bacteria have developed antimicrobial resistance against antibiotics known as carbapenems. They are normally found in the human intestine and human stools. They can cause different type of health care associated infections, including pneumonia, bloodstream infections, wound or surgical site infections, and meningitis. The zone of inhibition for the petroleum ether, alcoholic, and acetonic stem extracts were 18 mm, 21 mm, 17 mm respectively. Zone of inhibition was measured for leaf extract using petroleum ether, alcohol and acetone

and they were 20 mm, 21 mm and 20 mm respectively. Zone of inhibition were measured for the fruit using petroleum, alcohol and acetone they were 23 mm, 24 mm and 28 mm. solvent control results in the absence of a zone of inhibition.

Salmonella typhi: They are responsible for typhoid fever and are gram negative bacteria. It is a strain of bacteria that lives in humans. It causes a bacterial infection of the intestinal tract and occasionally of the bloodstream. Symptoms of *salmonella typhi* infections typically start within 6 to 30 days after exposure but may take up to 60 days develop. For the stem petroleum ether, alcoholic and acetic extracts, the zone of inhibition was measured at 12 mm, 11 mm and 14 mm respectively. Using petroleum ether, alcohol, and acetone to evaluate the leaf revealed inhibition zones of 13 mm, 11 mm and 12 mm. The petroleum extract of fruit shows no zone of inhibition but the alcoholic and acetone extract show zone of inhibition of 12 mm and 13 mm respectively. Solvent control does not produce zone of inhibition.

Solanum xanthocarpum showed high sensitivity to *Klebsiella pneumoniae* and *Salmonella typhi*, moderate sensitivity to *Escherichia coli* and less sensitivity and resistance to *Bacillus cereus*. The same kind of result was seen in a study conducted by Binutu. It also shows its bacterial activity against gram positive bacteria *Mirococcus varians*, *Mirococcus luteus*, *Staphylococcus aureus*, gram negative bacteria *Salomonella typhi*, *Pasteurella maltocida*. When doses of 5 mg/ml, 10 mg/ml, 15 mg/ml prepared through methanolic extract of each plant, powdered fruit material displayed significant zone of inhibition against three species of gram-negative bacteria (*Salomonella typhi*, *Pasteurella maltocida*, *E. coli*) and 3 species of gram-positive bacteria (*Mirococcus varians*, *Mirococcus luteus*, *Staphylococcus aureus*).

The methanolic and acetone extract of *Solanum xanthocarpum* are quite effective against *Staphylococcus aureus* which is considered as a serious human pathogen causing infection in wounds. Methanolic and aqueous extract of leaf give maximum inhibition against the growth of *E. coli* whereas the methanolic extract of fruit give maximum inhibition of growth against *Bacillus cereus*. The presence of alkanoids, phenolics and flavanoids may be the reason of the antibacterial activity.

Antifungal activity of *Solanum xanthocarpum*

In a study alcoholic extract of the plant was tested show the antifungal activity but the inhibition of the dermatophytic fungi is found to be different specific plant extract [12]. The 5% ethanol extract of *S.xanthocarpum* root show 70% inhibition of *Candida albicans* followed by 32.14% for *Candida tropicalis* and 25% for *Penicillium marneffe* and least sensitivity for *Trichophyton rubrum* 15.4%. The 5% ethanol extract of *S.xanthocarpum* fruit show high sensitivity for *C.albicans* by 72.5% and moderate sensitivity toward *P.marneffi* by 41.66% and least inhibition was observed for *T.rubrum* and *C.Tropicalis* by 38.46% and 28.75% respectively. The research for the antifungal activity for the root and the fruit has been successfully done by the researchers against many fungi like *Alternaria*, *Aspergillus spp* and *Trichoderma* [13].

DISCUSSION

Some other properties of *Solanum xanthocarpum*

Haemolytic activity: The hemolytic activity was performed in order to study the hemotoxic activity of the samples on the hemocytes. The plant shows less hemolytic activity. The well diffusion method was used to check the haemolytic

property [14]. 5 ml of the blood was collected and was centrifuged at 2000 rpm for 2 minutes. The pellet was suspended in 5 ml of PBS. Agarose was prepared by using PBS at pH 7.5, the solution was cooled at 50°C and to this 0.25 ml egg yolk and 0.25 ml RBC was added and the solution was poured in the petri plates using a sterile borer 3 mm diameter and about 2 cm apart wells are made and 200 µl plant extract was added and incubated for 30 minutes at 37°C. Methanolic extract of leaves of *S. xanthocarpum* gave 10.48 ± 2.14 and 24.95 ± 4.29 respectively which is high in comparison to the aqueous extract of leaves and fruits. This means that the methanolic extract of *S.xanthocarpum* contain possess good hemolytic activity.

Antioxidant properties: It has been studies that oxidative stress and generation of free radicals play an important role in the development of liver diseases. Therefore, some natural product with antioxidant property has functional ingredient to protect liver injury [15].

The present study show the antioxidant and hepatoprotective effect *S.xanthocarpum* on the basis of the *in vitro* antioxidant properties. The methanol extract of *S. Xanthocrpum* leaves (SXAF) through the active fraction from column chromatography. The antioxidant property was determined by 2, 2'-azino-bis, 2, 2-Diphenyl-1-Picrylhydrazyl (DPPH) and reducing power assay. The Rats were given pre-treatment for 14 days with 100 mg/kg and 200 mg/kg of methanolic extract of *Solanum xanthocarpum* and a single dose of CCl₄ in the last day.

The method of Re et al. was adopted for ABTS [16]. The solution was taken which have 7 mM ABTS solution (2, 2'-Azino-bis (3-Ethylbenzothiazoline-6-Sulfonic acid) and 2.45 mM potassium persulfate solution. Both the stock solution were mixed in equal quantity and they were allowed to react at room temperature in dark for 12 to 16 hours for preparing working solution. Dilution of the mixture was done by mixing 1 ml ABTS solution with 60 ml methanol so that the absorbance of 0.706 ± 0.001 units at 734 nm is obtained by using spectrophotometer. The reaction of plant extract about 10 µl and 1 ml of ABTS solution was done and the absorbance was noted at 734 nm after 7 min of reaction by using spectrophotometer. The extract's ability to scavenge ABTS was compared to that Trolox, and the percentage inhibition as measured by ABTS radical scavenging activity was computed where Abs sample is the absorbance of ABTS radical+sample extract/standard and Abs control is the absorbance of ABTS radical+methanol.

SXAF exhibit significant antioxidant activity in scavenging free radicals with IC₅₀ values of 11.72 µg (DPPH) and 17.99 µg (ABTS) [17]. The raw fruit and seeds of *S.xanthocarpum* possess antioxidant property. Phenolic compounds or alkaloids are likely to be the Active Pharmaceutical Ingredients (API) [18].

Anti-inflammatory properties: Inflammation is characterized by the redness, heat, swelling and pain which is the response to the injury or a trauma. It is a protective response to the tissue injury caused by the physical trauma, chemicals or microbial agents. It is the response which is generated by the body to inactivate the invading organisms to remove the irritation and set the stage for tissue repair [19]. The leaves and the fruits of the *S.xanthocarpum* showed the anti-inflammatory activity reported by careenage induced in mice [20]. The ethanol extract was evaluated at dose 10, 30 and 100 mg/kg p.o in rats by using pharmacological screening model carrageenan induced rat paw edema, histamine induced rat paw edema and cotton pellet granuloma in rats. As a result, acute treatment did not show anti-inflammatory activity against carrageenan and histamine induced paw edema. However, administration of 100 mg/kg p.o for 7 days reduced the granuloma formation of cotton pellet granuloma model which show that the present result support the traditional use of plant for anti-inflammatory activity [21].

Anticancerous properties: *Solanum xanthocarpum* has been used for the treatment of many infectious diseases in traditional medicine. The present study show the medicinal potential of *S.xanthocarpum* fruit as anticancer agent.

Cell lines of lungs (HOP-62) and leukemia (THP-1) were procured from national Centre for cell sciences, Pune, India. The cell lines were grown and maintained in RPMI-1640 medium, pH 7.4 with 10% FCS, 100 units/ml penicillin, 100 µg/ml streptomycin and 2 mM glutamine. Cells were grown in CO₂ incubator at 37°C in the presence of 90% humidity at 5% CO₂. The Sulforodamine-B (SRB) assay was used to determine the *in vitro* cytotoxicity of fruit extracts [22]. The cell suspension was incubated for 24 hours. 100 µl test extract in DMSO was then add to the wells and it was allowed to incubate for 48 hours more. The growth of the cell was arrested is arrested by layering 50 µl of 50% TCA and it was incubated at 4°C for an hour. It was then washed with distilled water and was air dried. In each well SRB was added and plated were incubated for 30 minutes at room temperature for 30 minutes. To remove unbounded SRB, dye the plates were washed with 1% acetic acid and plates were air dried. Bounded dye was dissolved in Tris- Hcl buffer of 100 µl, and molarity 0.01 M and pH 10.4. On ELISA reader the absorbance was recorded at 540 nm. Also included suitable banks and positive controls.

The extract was prepared by using Soxhlet apparatus and partially characterized by thin layer chromatography. The extract show cytotoxic activity against HOP-62 (lung) and THP-1 was depicted. Anticancer potential was exhibited by the non-polar extract showing 85-91% growth inhibition of THP-1 cell line while BZ and CH fractions show 70% of cytotoxicity against lung cancer line (HOP-62). Low amount of cytotoxicity was depicted by polar solvent [23].

Anti-fertility activity: The alkaloid solasodine possess anti-spermatogenic activity. In the study performed by Dixit VP 1980 the chronic administration of solasodine render male rats and dogs infertile and cause testicular lesions which lead to severe spermatogenic impairment. Epididymides lack spermatozoa [24]. 87% of infertility in rats was seen in mating test. This becomes normal after 60 days cessation of drug feeding. The spermatogenesis and sperm motility were inhibited by solasodine. There was no change in the accessory sex organ and the weight of testes. The amount of RNA, protein, sialic acid and glycogen contents were reduced significantly, but the serum proteins, triglycerides, serum enzymes level were in normal range [25]. Solasodine inhibits testosterone release from dispersed mouse Leyding cells but it is oestrogen free. Solasodine can be used to develop as a male pill of plant origin. By treating an individual with castration followed by solasodine causes epididymal degeneration.

CONCLUSION

There are no. of studies done on the antibacterial and antifungal activity of the plant *Solanum xathocarpum* and it is found that the methanolic extract of leaves, root and the fruit of *solanum xanthocarpum* possess antibacterial as well as antifungal property. In addition to this minute amount of haemolytic activity was seen. The plant also possesses some other type of properties like anti-inflammatory, antioxidant, anticancer and antidiabetic property. The pills made from this plant can be used for antifertility in males. The plant contains medicinal value. Hence the plant can be used to treat a different type of diseases in human. It does not have any harmful effect on humans therefore it can be used as a medicine. Further study can be done on the plant to know its more properties.

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