

Pharmacognostical Studies and Pharmacological Activities of *Crossandra Infundibuliformis*

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Abstract

Crossandra Infundibuliformis plant is very well known for its therapeutics benefits in Indian systems of medicine including Ayurveda and Siddha and in other forms of traditional medicine worldwide for the treatment of several ailments. It observed that many traditional utilities of *Crossandra Infundibuliformis* got their authentication when tested using different disease-based pharmacological models taking various extracts of roots, leaves, and stem as test samples. Our review article focusses to Pharmacological studies, phytochemical screening pharmacological activities are hepatoprotective, anti-bacterial, anti-mycobacterial, anti-ulcer, anti-diabetic, anticancer, anti-microbial, anti-oxidant, anti-solar, anti-fungal, insecticidal, aphrodisiac, anti-arthritis, anti-candidal, anti-yeast, anthelmintic, anti-cancer. This article can give potential research areas to explore next, and to formulate new formulation in allopathy and some traditional medicine system.

Keywords: *Crossandra Infundibuliformis*; Antisolar; Aphrodisiac; Antidiabetic; Anticancer; Antiulcer

Introduction

Crossandra infundibuliformis, the firecracker flower, is a species of flowering plant in the family Acanthaceae, native to southern India and Sri Lanka. It is most often found in south Indian region Malenadu and Kerala. It is an erect, evergreen subshrub growing to 1 m with glossy, wavy-margined leaves and fan-shaped flowers, which may appear at any time throughout the year. The flowers are unusually shaped with 3 to 5 asymmetrical petals. They grow from four-sided stalked spikes, and have a tube-like 2 cm stalk. Flower colours range from the common orange to salmon-orange or apricot, coral to red, yellow and even turquoise. This plant requires a minimum temperature of 10 °C, and in temperate regions is cultivated as a houseplant. It is usually grown in containers but can be attractive in beds as well. The flowers have no perfume but stay fresh for several days on the bush. A well-tended specimen will bloom continuously for years. It is propagated by seeds or cuttings. This plant has gained the Royal Horticultural Society's Award of Garden Merit. The tiny flowers are often strung together into strands, sometimes along with white jasmine flowers and therefore in great demand for making garlands which are offered to temple deities or used to embellish women's hair [1].

Pharmacognostical Studies

Crossandra infundibuliformis(L.) Nees. (Family -Acanthaceae) Vernacular name English- Firecracker flower, unarmed orange nail dye, Gujarati -Aboli, Hindi - Priyadarshani, Kannada-Abbolige, Marathi -Aboli, Nepali -Priyadarshini, Malayalam -Priyadarshini.

Macromorphology

Erect under shrub, 60-90 cm tall; stem terete, pubescent at that top, leaves in apparent whorls of 4. Ovate- oblong 3-12 x 1.5-5 cm narrowed at base and decurrent on petioles, entire and undulate, acute or sub obtuse, glabrous above thinly pubescent beneath; petioles 1-3 cm long flower in terminal, peduncles. Erect, 4 sided 10 - 15 cm long spikes, peduncles 4 - 10 cm long thinly pubescent; bracts ovate- oblong 1 - 1.5 cm long, acute, keeled; bracteoles much shorter and narrower, calyx deeply 4 - partite sepals unequal. Imbricate 6 - 10 mm long. Corolla bright arrange with yellow throat tube paler, densely pubescent above the widened base, narrow, 1.5 - 2.5 cm long. bent forward; limb flat, 5

lobed (Lobes 2 + 1 f 2 all forward; limb flat, 5 - lobed (lobes 2 + 1 f 2 all arranged on one side). stamens 4 included; anthers celled, villous, capsule, oblong 12. 15 mm long subacute, 4-gonous. glabrous. seeds 4. flat, orbicular, densely covered with hygroscopic fimbriate scales.

Micromorphology

T. S. of root

T.S of *Crossandra infundibuliformis* root shows upper most layers are cork which is thick protective layer. The cork is measured about 30-40 µm. The cork is followed by epidermal or hypodermal cells. The epidermal cells were compactly arranged & measured about 30-35 x 35-40 µm. The epidermis is followed by cortex. The cortical zone was further divided into outer, middle & inner cortex. The cortex is composed of elongated parallel arranged cells. The cells of outer cortex are measured about 25-30 x 40-55 µm. the outer cortex is followed by middle cortex. The cell of middle cortex is measured about 30-35 x 45-50 µm & the cells of inner cortex is measured about 25-30x35-40 µm. The cortical zone is followed by centrally located stele. The stele was delimited by endodermis. The endodermis is followed by vascular strand. The vascular composed phloem parenchyma. The phloem parenchyma is measured about 12 - 14 x 13-14 µm. The phloem parenchyma interrupted by xylem patches. The xylem cells were measured about 15-20 x 30-35 µm.

T.S. of stem

The T.S. of stem of *Crossandra infundibuliformis* shows the circular outline and outermost is thick walled barrel shaped & compactly

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arranged epidermis. (Cuticle is present) The epidermal cells were interrupted by trichomes the epidermal cells were measured about 20-25 x 25-30 μm . There is no collenchyma in Stem. The epidermis is followed by cortex. The cortex is of two type. i.e. - outer and Inner cortex the outer cortex is composed of small compactly arranged parenchyma were inner cortex is composed somewhat larger inner parenchymatous cells them outer cortex. The outer cortical cells were measured about 10-15 x 15-20 μm . The cells of cortex is measured about 30-35 x 35-40 μm . The cortex is followed by stele. The Setle is composed of vascular strand. The dictyostele is present in Stem. The vascular strand shows ring like appearance in T.S. The ring like arrangement of phloem parenchyma is interrupted by xylem elements. The phloem parenchyma & xylem element were measured about 15-16 x 16-20 μm . The xylem elements shows thick walled cells then phloem parenchyma. The vascular tissue is followed by centrally located pith. Pith is of 6-7 layers. This is composed of pith parenchyma. The Pith parenchyma were interrupted by schlerenchymatous cells. The pith cells were measured about 30-40 x 45 – 50 μm .

T. S. Leaf

The leaf lamina dorsiventral the T.S of leaf of *Crossandra infundibuliformis* shows upper & lower epidermis. Upper epidermis is upper most layer of T.S shows barrel shaped cells which thick walled and compactly arranged cells. The upper epidermis is interrupted by trichome the cuticle is present about the epidermis. The upper epidermal cells were measured about 30-40 x 45 – 50 μm . The upper epidermis is followed by single layer of palisade cells. The palisade cells were measured about 15-17 x 50-70 μm . The palisade cells are followed by spongy parenchyma which is loosely arranged. The spongy parenchyma measured about 15-20 x 20-25 μm . The palisade cells & spongy parenchyma were rich in chlorophyll. The T.S of leaf shows central single vascular strand globular in shape. The vascular tissue is delimited by bundle sheath cells. The bundle sheath cells are compactly arranged & shows ring like appearance surrounding to the vascular strand. The bundle sheath cells were measured about 12-13 x 13-14 μm . The bundle sheath cells followed by phloem parenchyma. The phloem parenchyma cells interrupted by xylem patches. The phloem parenchyma measured about 25-30 μm . In diameter while xylem element measured about 25-30 x 30-35 μm . The T.S shows lower most layer is Lower Epidermis, which is also covered by cuticle. The lower epidermis is composed of compactly arranged having slightly thinner & smaller cells than upper epidermis [2].

Pharmacological Activities

Antimicrobial activity

Elamadhi describe about the medicinally active substances were isolated from leaves of *Crossandra infundibuliformis* by Soxhlet extractor and identified by phytochemical tests. The soxhlet extraction in powdered form was performed using aqueous and methanol. The results of each extracts confirm the active substances such as carbohydrates, alkaloids, steroids, tannins, phenols, saponins, fixed oils and fats, gums and mucilage, proteins, flavonoids and volatile oils. The evaluation of the leaf powder was supported by the physico-chemical analysis. The *C. infundibuliformis* showed potential antimicrobial activities against some selected strains and a maximum inhibition zone 37 mm was recorded from 200 mg of methanol extract of *C. infundibuliformis* against *Staphylococcus aureus* and minimum (10 mm) by *Salmonella typhi* at 50 mg of the above extract. The methanolic extract showed a maximum antifungal activity 32 mm inhibition zone was recorded from 200 mg of extract against *Aspergillus flavus* and minimum 9 mm by 50 mg of aqueous extract against *Rhizopus indicus* [3].

Wound healing activity

Rohit gundamaraja describe about the *Crossandra infundibuliformis* belonging to family Acanthaceae is well known medicinal plant in various region of India. This plant is one of the most chosen variety for folk medicine. Flower extract used in various conditions like fever, headache, aperitif, pain etc. Present study is concern mainly with evaluation of wound healing activity of flower ethanolic extract in Wistar rats using excision wound model in the form of ointment using two concentrations (2 and 4% w/w ointment) of flower extract in simple ointment base. Both concentration of ethanolic extract showed significant response in both the wound type tested when compared with control group. 4% w/w concentration has showed better significant value than the standard drug. Nitrofurazone ointment (0.2% w/w) was used as standard drug [4].

Hepatoprotective Activity

Madhumitha describe about the hepatoprotective effect of the *Crossandra infundibuliformis*. Hepatotoxicity was induced by carbon tetrachloride. Petroleum ether extract of dried leaves was administrated to mice for 7 days. The hepatoprotective effect of petroleum ether extract was evaluated by the assay of liver function biochemical parameters. The result clearly indicates that petroleum ether extract showed significant hepatoprotection when compared with standard Silumarin. The petroleum ether extract of the leaves of *Crossandra infundibuliformis* possess significant acute hepatoprotective activity. Thus further investigation on this species would bring a promising drug for liver disorders [5].

Aphrodisiac Activity

Kumar describe the *Crossandra infundibuliformis* (L.) belonging to the family (Acanthaceae), were used for treating male sexual disorders since ancient times. Aim of this study to evaluate the phytochemical constituents and the aphrodisiac potential of the petroleum ether extract of leaves of *Crossandra infundibuliformis* (L.) on ethanol induced testicular toxicity in albino wistar rats. Phytochemical screening revealed the presence of alkaloids and saponins. All the doses resulted in significant increase in mount frequency, intromission frequency and significantly prolonged the ejaculatory latency ($P < 0.05$) and reduced mount and intromission latency ($P < 0.05$). There was also a significant increase in serum testosterone concentrations in all the groups in a manner suggestive of dose-dependence ($P < 0.05$). Results of this study concluded that the petroleum ether extract of *Crossandra infundibuliformis* (L.) increased the blood testosterone concentrations and this may be the mechanism responsible for its aphrodisiac effects and various masculine behaviors. It may be used to modify impaired sexual functions in animals, induced testicular toxicity in albino wistar rats [6].

Antibacterial activity

Sowjanya pulipati. et. al describe about the present study is designed to determine the tannin content and evaluation of antibacterial activity of *Crossandra infundibuliformis* (Acanthaceae) flower extracts against pathogens associated with urinary tract infections. The Urinary Tract Infections represent one of the most common diseases occurring from the neonate to the geriatric age groups encounters in medical practice today. The chloroform, ethyl acetate, acetone and aqueous extracts for the plant material were prepared. The extracts contained appreciable levels of tannin content (2.7 to 8.6 mg of GAE/gm extract). Among all the extracts acetone extract possess higher concentration of tannins. Leading etiological agents of UTI's include *Escherichia coli*, *Enterococcus faecalis*, *Pseudomonas aeruginosa*, *Klebsiella*

pneumoniae and *Proteus vulgaris*. The susceptibility patterns of these UTI pathogens against extracts were tested. The antibacterial activity was prominent against *Escherichia coli* (16.20 ± 0.25 mm) by acetone extract. The results indicated that natural tannin from flowers of *Crossandra infundibuliformis* has a notable antibacterial activity against tested microorganisms. The results are compared with commercial antibiotic nitrofurantoin [7].

Tuberculosis Activity

Satheesh Kumar describe about the present work was to extract and screen the leaves and flowers of *Crossandra infundibuliformis* against *Mycobacterium tuberculosis*. *Crossandra infundibuliformis* is distributed in India, Srilanka and other Asian countries. It has wide range of pharmacological and antimicrobial potentials. In present study, the leaf and flower extracts of *Crossandra infundibuliformis* were prepared based on polarity of solvents such as petroleum ether, ethyl acetate and methanol. The leaf and flower extracts were screened against *Mycobacterium tuberculosis* using Alamar blue TB assay method. Phytochemical investigation revealed the presence of secondary metabolites such as phenols, glycosides, alkaloids, tannins. The minimum inhibitory concentration of methanolic extract of flower and ethyl acetate extract of leaf is sensitive at $3.12 \mu\text{g/ml}$ against *Mycobacterium tuberculosis*. This study reveals the first report of the anti-mycobacterial perspectives of leaf extracts of *Crossandra infundibuliformis* [8].

Antisolar Activity

Swapna Kandagaltla describe about the Sun light is the major source of U. V radiation; it extends to the earth's atmosphere and helps our body to synthesize vitamin D, which promotes the bone growth. But due to high exposure to UV radiation from sun may cause sunburns, wrinkles etc. The UV-A penetrates the skin and causes premature ageing of skin, UV-B mostly causes sunburns and damage to DNA in skin. The present study was aimed to evaluate the UV absorption ability of aqueous extracts of fresh and dry leaves of *Crossandra infundibuliformis* as an Anti-solar agent. UV visible spectrophotometer is used to perform this method. The results shown that aqueous fresh leaves extract of *C. infundibuliformis* has better Anti-solar activity than dry leaves extract. As it contains natural flavanoids and polyphenols they are considered as excellent sunscreen agents. Therefore it was concluded that *C. infundibuliformis* leaves extract can be used in preparation of various highly effective sunscreen formulations as it provides the better advantage of avoiding the harmful effects of synthetic sunscreen preparations [9].

Antioxidant Activity

Kumar G patil describe about the present study was aimed to investigate the phenolic content and antioxidant property of *Crossandra infundibuliformis* leaves. Shade dried leaves were successively extracted and determined phenolic and flavonol content of the extracts. Six different in vitro antioxidant assays such as 1, 1'-diphenyl-2-picrylhydrazyl (DPPH), lipid peroxidation (LPO), nitric oxide, hydrogen peroxide radical scavenging, reducing power of the extracts and total antioxidant capacity (values were expressed as mg ascorbic acid (vitamin C) equivalent antioxidant capacity per gram of extracts) assays were followed to determine the antioxidant capacity of the extracts. The results of this study indicated that methanol extract possess higher level of phenolic (98.52 mg of gallic acid/g of extract) and flavonol (84.59 mg of rutin/g of extract) constituents. The antioxidant property of ethyl acetate extract was significantly higher than other extracts in DPPH method. Moreover, methanol extract

has significantly higher antioxidant activity in LPO inhibition (IC_{50} value of $70.66 \mu\text{g/ml}$), hydrogen peroxide (IC_{50} value $130.33 \mu\text{g/ml}$) and reducing capacity of the extract (1.19) than other chloroform and ethyl acetate extracts. The strong correlation was observed for phenolic content and antioxidant activities of the extracts ensuring the involvement of phenols in antioxidant activity. However, results suggests that *Crossandra infundibuliformis* leaves possess antioxidant activity [10].

Antiarthritic Activity

Sanakattula Sreevani describe about the present study have been designed to evaluate the In-vitro Anti-Arthritic activity of herbal plant *Crossandra infundibuliformis* belonging to the family Acantheaceae. The leaves were collected, dried and extracted by soxhlet with solvents like Methanol, Petroleum Ether. The inhibition of protein denaturation by Egg-Albumin method was taken as a measure of the in-vitro anti-arthritic activity. The percentage inhibition of protein denaturation is obtained as 89.4%, 91.2% and 94.3% for petroleum ether extract and 81.8%, 84.3%, 88.5% for methanol extract respectively at a dose of 100, 250, 500 $\mu\text{g/ml}$. The percentage inhibition of standard diclofenac sodium was found out to be 91.2%, 94.5% and 96.4% respectively at a dose of 100, 250, 500 $\mu\text{g/ml}$. Pet. ether extract was found to be more effective than Methanolic extract [11].

Antidiabetic Activity

Galanki Vasantha describe about the prevalence of diabetes is growing in the world's population. The epidemic of disease is rising in the population of India and other countries. Many herbal plants are in use for the management of diabetes till today. They are being advantageous with the lesser side effects and high therapeutic potential than the standard antidiabetic drugs. The present research is to investigate the antidiabetic activity and antioxidant effect of ethanolic extract of *Crossandra infundibuliformis* leaves and stems (ECILS) in alloxan induced diabetic rats. Diabetes is induced in the experimental animals by the administration of alloxan (150 mg/kg ip) for a week. The total treatment period was about 30 days. Blood glucose levels were tested using standard blood glucometer. This activity also includes the estimation of biochemical parameters and in vivo antioxidant parameters such as lipid peroxidation, reduced glutathione, and catalase. Histopathological studies were performed on liver and kidney. The diabetic+ ECILS rats experienced a significant reduction in glucose, total cholesterol, triglycerides, and increase in high-density lipoproteins compared to disease control. These results demonstrate that *C. infundibuliformis* possess antidiabetic activity, potent antioxidant activity, and can be used in future studies for the estimation of distinct phytochemicals with the antidiabetic activity [12].

Antifungal and Anticandidal Activity

Madhumitha describe about the investigate the phytochemical, antibacterial, antifungal and anticandidal activity of successive extracts of *Crossandra infundibuliformis* (Acanthaceae) leaves. Preliminary screening on the presence of alkaloids, saponins, phytosterols, phenolic compounds, flavanoids, tannins, carbohydrates, terpenoids, oils and fats were carried out by phytochemical analysis. The antibacterial, antifungal and anticandidal activities were done by agar well diffusion technique. The successive extracts have an array of chemical constituents and the MIC values of antibacterial activity ranges from 0.0078 to 0.0150 $\mu\text{g/mL}$. In case of antifungal and anticandidal activities the MIC values were between 0.125 and 0.250 $\mu\text{g/mL}$. These findings demonstrate that the leaf extracts of *C. infundibuliformis* presents excellent antimicrobial activities and thus have great potential

as a source for natural health care products [13].

Antihyperlipidemic Activity

Vasantha describe about the Hypercholesterolaemia is the state been depicted by an expanded greasy substances called lipids, rise in plasma TCs and TGs levels it is additionally called hyper lipoproteinemia. The present study was designed to investigate the hypolipidemic effect of ethanolic extract of *Crossandra infundibuliformis* leaves and stem (ECILS) in high fat diet (cholesterol 2%, sodium cholate 1%, sucrose 48%, peanut oil, methionine 4%, and 47% normal laboratory feed). The rats feed with High-fat diet containing (cholesterol 2%, sodium cholate 1%, sucrose 48%, peanut oil, methionine 4%, and 47% normal standard laboratory feed) for 1 month, and then they are checked for the blood parameter levels like TC, TGs, LDL, VLDL, and HDL. Ethanolic extracts at low dose (100 mg/kg), significantly reduced the levels of TC, TGL, LDL, VLDL & increased the levels of HDL and reduced the body weights on 30st day, and at medium, high doses it reduced the levels of TC, TGL, LDL, VLDL & increased the levels of HDL and reduced the body weights [10].

Anticancer and Insecticidal

Vadivel describe about the *Crossandra infundibuliformis* is a popular tropical flower known as "Firecracker", It is a species of flowering plant in the family Acanthaceae, native to southern India and Sri Lanka. It is traditionally used for the treatment against various ailments in tropical and subtropical parts of India without any scientific knowledge. In the present study the anticancer and insecticidal activity of the ethanolic extract of the leaves of *Crossandra infundibuliformis* were investigated. Anticancer activity evaluated against human breast cancer cell line (MCF-7) by MTT assay method and the insecticidal activity was evaluated against Wheat weevil (*Sitophilus oryzae*). Both the activities were dose dependent. IC50 value of anticancer activity against MCF-7 cell line was found to be 404.66 µg/ml. Maximum insecticidal activity (100%) was attained at the concentration of 0.16% and 0.2% ethanolic extract of *Crossandra infundibuliformis*. Our results confirm that the ethanolic extract of *Crossandra infundibuliformis* exhibited significant effect against MCF-7 cell lines and Wheat weevil. Anticancer and Insecticidal activity lead some support to the use of *Crossandra infundibuliformis* for various ailments in the traditional medicine of India [11].

Anthelmintic Activity

Panduraju describe about the Helminthic infections are a major cause of morbidity and mortality worldwide and are prominent among the so called Neglected tropical diseases (NTDs). The NTDs include 'Schistosomiasis and the soil transmitted helminthes' (STH), a group of parasite whose life cycle usually depends on a period of development outside the human host, typically in moist, worm soil. An anthelmintic drug can act by causing paralysis of the worm, or by harmful its cuticle, which lead to partial absorption or rejection by immune mechanisms. Most of the existing synthetic anthelmintic drugs produce serious side effects. In order to reduce the harmful side effects of these synthetic anthelmintic drugs, it is significant for us to promote the studies of traditionally used anthelmintic plant based drugs. The methanol leaf extract of *Crossandra infundibuliformis* was prepared with distilled water by soxhlation method. The methanol leaf extract is used to evaluate the presence of phytoconstituents and anthelmintic activity. The anthelmintic activity was investigated on *Pheritima posthuma* (Indian earth worm). Anthelmintic activity was performed in three different concentrations such as 20 mg/ml, 50 mg/ml and 100 mg/ml. Albendazole (10 mg/ml) was used as reference standard drug whereas

distilled water as control. Determination of paralysis time and death time of the worms were recorded. Methanol extract exhibited more noteworthy anthelmintic activity at the concentration of 100 mg/ml. The results reported in the present work shows evidence that the leaf extract of *Crossandra infundibuliformis* possess anthelmintic activity [12].

Antiulcer Activity

Narasimha Rao describe about the present study is aimed at investigating the antiulcer effects of flowers methanol extract against aspirin induced ulcer in albino rats. Anti ulcer activity was evaluated by measuring the ulcer index and percentage of ulcer incidence. The standard drug and the extract at 200mg/kg has shown almost similar action as that of ranitidine should be replaced with the standard drug and the extract at 400mg/kg has shown almost similar action as that of ranitidine[13].

Conclusion

This review paper shows the Pharamacognostical studies and the pharmacological activities like anti-bacterial, anti-cancer, anti-ulcer, antisolar,anthelmintic etc. Extract of *Crossandra infundibuliformis* plant contains more bioactive principles, which act against the representative human pathogens. Moreover, this reviewed article showed more pharmacological applications and Pharmacological studies helps to developing the allopathy and traditional formulations.

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