

Review on *Oroxylum Indicum*

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Abstract:

Oroxylum indicum which is also known as midnight horror, “Indian calosanthes” belongs to family bignoneaceae found in Indian subcontinent. Scientific explorations of traditional belief of medicinal properties of *Oroxylum indicum* have got momentum mostly after the middle 20th century. In the present review, efforts have been made to sum up different aspects of scientific studies on this medicinal plant. It was found that it has great importance in medicinal aspects i.e., possess antimicrobial, antidiabetic, hepato-protective, anti-inflammatory, anti-carcinogenic, immunomodulatory, nephroprotective, anticancer and antimutagenic properties.

Keywords: *Oroxylum indicum*, bignoneaceae, Indian calosanthes.

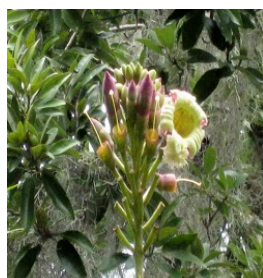
INTRODUCTION:

During the past decade, the traditional systems have gained importance in the field of medicine. In many developing countries, a large proportion of the population relies heavily on traditional practitioners, who are dependent on medicinal plants to meet the primary healthcare needs. Although modern medicines are available, herbal medicines have often retained popularity for historical and cultural reasons. The present attempt is to review and compile updated information in various aspects of *Oroxylum indicum*, a plant used in Indian system of medicine for variety of purposes.

PLANT PROFILE:

Taxonomical Classification

Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Division	Lamiales
Family	Bignoniaceae
Genus	<i>Oroxylum</i>
Species	<i>indicum</i>



Synonyms:

Bignonia indica L
Calosanthes indica blume.

Vernacular Names

English	Broken bones plant, Indian calosanthes, Indian trumpet flower, Midnight horror
Chinese	Handy pinyin, Mud huddle
Bengali	Sona, Khona, Krong-sa-bang (Marma tribe)
Hindi	Bhut-vriksha, Patrorna, Manduk (the flower)
Kannada	Tattuna
Konkani	Davamadak
Nepalese	Tatelo
Telugu	Manduka- Parnamu, Pampena, suka-nasamu

DISTRIBUTION

Oroxylum indicum is native to the Indian subcontinent, in the Himalayan foothills with a part extended to Bhutan and southern China, in Indo-China and the Malaysia ecozone. It is visible in the forest biome of Manasa National Park in Assam, India. It is also found in Phillipines, Indonesia and Srilanka

MICROSCOPICAL FEATURES

Microscopic studies of the roots of *Oroxylum indicum* revealed that the root cork consists of polyhedral cells with the fragments of pitted stone cells lying underneath the cork cell. The outer layer of cork is lignified while as the inner layer of is non-lignified. Cortex is wide and made up of thin walled parenchymatous cells. Abundant crystal of calcium oxalate are scattered as such in parenchymatous cells of cortex. Phloem consists of thin walled radially arranged phloem parenchyma cells showing narrow tangential segments of sclerenchyma. The microscopic carried out on the root bark of *Oroxylum indicum* revealed that the transverse section of the plant consists of cork, cortex, phloem and medullary rays. Cork consist of about 30 to 35 layers of tangentially running, polyhedral cells with the fragments of groups of tangentially running rectangular to oval, thick wall pitted stone cells lying underneath the cork cells. The outermost cork layer was consisting of about 15 to 20 rows of lignified parenchymatous cells. In the cortex stone cells and abundant lignified sclerides isolated or fairly in large groups showing a in considerable variation in size and shape, walls of most of them were moderately thickened, striated and pitted. The abundant acicular crystals of calcium oxalate scattered as such in parenchymatous cells of cortex. Phloem forms the major part of the bark and was composed of broad radial strips separated by medullary rays. Phloem consists of about 25 to 30 layered, thin walled radially arranged phloem parenchyma cells showing narrow tangential segments of sclerenchyma. The phloem region is traversed by medullary rays, which are bi-seriate to tetra seriate and made up of thin walled cells`

PHYTOCHEMISTRY

Oroxylum has specific aromatic odor because of the presence of essential oils. The aromatic essential oil mainly contains phenols, fatty acids and aldehydes. Besides oil,

the plant also contains polyphenolics, flavonoids and alkaloids.

The leaves of this plant are reported to contain flavonoids namely chrysin, oroxylin-A, scutellarin, baicalein. Leaves are also found to contain quercetin-3-o-alpha-L-arabinopyranoside, 1-(2-hydroxyethyl) cyclohexane-1,4-diol, apigenin.

Seeds of this plant are reported to contain ellagic acid.

Root bark is reported to contain ellagic acid, chrysin, oroxylin-A, scutellarin, baicalein, 5-hydroxy 8-methoxy 7-o-beta-D-glucopyranuronosyl flavone, stigma-5-en-3-ol, pratensol, 3-(4-hydroxy phenyl) 2-propenoic acid and flavonoid 3,4',5,7 -tetrahydroxy-flavonol, 5-hydroxy 4',7-dimethoxy flavone, 7-o-methyl chrysin, dihydrooroxylin-A, methyl-3,4,5-trihydroxy-6-(5-hydroxy-6-methoxy-4-oxo-2-phenylchroman-7-yloxy)-tetrahydro-2H-pyran-2-carboxylate, 5-hydroxy-7-methoxy-2-(2-methoxy-6-(3,4,5-trihydroxy-6-(hydroxymethyl)tetrahydro-2H-pyran-2-yloxy)phenyl)-4H-chromen-4-one. Other chemical constituents contain prunetin and sitosterol from wood.

Fruits are reported to contain oroxylin-A, chrysin and ursolic acid, aloe-emodin.

The seed oil contains caprylic, lauric, myristic, palmitic, palmitoleic, stearic, oleic, and linoleic acids.

USES

The tree is often grown as an ornamental for its strange appearance. Material used include the wood, tannins and dyestuffs. It is also a plant with edible leaves and stems. Young shoot and unripe fruits are eaten as vegetables. The tree is also frequently lopped for fodder. Wood of the tree is used to make match boxes. Stem bark and fruits of the tree are used as mordant and yield color dye.

PHARMACOLOGICAL ACTIVITIES:

Antibacterial Activity

Oroxylum indicum is reported to possess antibacterial activity. The methanolic, ethyl acetate, and ethanolic extracts of stem bark of *Oroxylum indicum* were tested on three different species of gram-positive and gram-negative bacteria viz. *Bacillus subtilis*, *E. coli*, and *Pseudomonas aeruginosa* of the extracts were found to possess remarkable antibacterial properties.

The crude petroleum ether, methanolic and ethyl acetate extracts of root bark of *Oroxylum indicum* and the two compounds isolated from them. 2,5-dihydroxy 6,1-tetramethoxyflavon and been found to have moderate to good antimicrobial and antifungal activity. The results of the study justified the use of this plant in the management of microbial infection.

The three fractions, hexane, CCL₄ and chloroform obtained from methanolic stem bark extract of *Oroxylum indicum* were tested for antibacterial and antifungal activity by standard disc diffusion method against various gram-positive and gram-negative bacteria and some fungi such as *Bacillus cereus*, *Bacillus megaterium*, *Bacillus subtilis*, *Staphylococcus aureus*, and *Sarcina lutea*, *E. coli*, *Pseudomonas aeruginosa*, and *Salmonella paratyphili*, *Salmonella typhi*, *Shigella boydii*, *Shigella dysenteriae*, *Vibrio mimicus*, *Saccaromyces cereviceae*, *Candida*

albicans and *Aspergillus niger*. All the extracts have been effective against both gram positive and gram-negative bacteria as well as fungi and the properties were comparable with the effectiveness of standard antibiotic ampicillin.²

The antifungal activity of dichloromethane extract of *Oroxylum indicum* has been studied against dermatophytes and wood rot fungi. The di chloromethane extract was found to have significant antifungal activity. The antimicrobial activity been studied against different strains. The antibacterial activity of *Oroxylum indicum* has also been studied *staphylococcus aureus* and *E. coli*. In acute toxicity test, antibacterial activity of acetone, water and ethanolic extracts was compared. Ethanolic extract possessed maximum activity against both strains of bacteria free radicals due to stress leads to adverse effect on various vital organs and tissues of body. Antioxidants are now standing on the mainstay of the treatment and prevention of several diseases. Current research is directed towards finding naturally occurring antioxidants particularly of plant origin.

Anti-inflammatory Activity

The root bark of *Oroxylum indicum* has been shown to inhibit chronic inflammation in rats. In the acute test conducted on experimental Wistar rats, carrageenan was used to induce rat paw edema in one group of animals and cotton pellet was used to induce chronic inflammation in second group. Pre-treatment with n-butanol fraction showed significant [p<0.05] anti-inflammatory activity at 3 hours when compared with control group. Further, it also significantly [p<0.05] reduced the increase in weight of diclofenac treated group of animals.

The anti-inflammatory activity of stem bark of *Oroxylum indicum* has also been studied against the ear swelling in mice. Water extract was found to have obvious anti-inflammatory effects of lowering ear swell in mice.

Aqueous extract of leaves of *Oroxylum indicum* has been found to provide the relief to rats against carrageenan induced rat paw edema. To confirm the protective activity, an experiment was performed in which the inflammation was induced in the paws of rat by carrageenan injection. These experimental rats were administered with water extract of leaves of *Oroxylum indicum* at two dose levels of 150mg/kg BW and 300 mg.kg BW/day. Both the doses exhibited significant anti-inflammatory activity has been attributed to the presence of different polyphenolic and flavonoid constituents present.

The aqueous and alcoholic extracts of *Oroxylum indicum* were also found to have significant anti-inflammatory activity.

Analgesic Activity

Oroxylum indicum has been used since ages as analgesic agent. Pharmacologically, the activity was reported in the butanol extract of root bark of *Oroxylum indicum*. Two assay models, viz. tail flick and acetic acid induced writhing response, were employed to detect analgesic activity. For tail flick method, Wistar albino rats of either sex 200-250 kg were selected. One group of animals was administered 100 mg/kg BW, p. o., and another group was administered standard drug morphine [10 mg/kg BW,

I.P.). One hour after the administration, tail of the rat was placed on nichrome wire of an analgesiometer and the time taken by the animal to flick its tail was taken as reaction time. Analgesic activity was measured at 0 and 30 min. for acetic acid induced writhing; Swiss albino mice 20-25 g were selected. The n-butanol fraction was administered 100 mg/kg BW p.o. in one group. Another group received standard aspirin [25mg/kg BW, I.P.]. one hour after the administration, the injection of acetic acid 0.6 %v/v [10ml v/v/kg BW, I.P.] was given and thereafter, the number writhing was observed for upto 30 minutes. Reduction in number of writhing by any treatment as compared to vehicle treated animal was considered as positive analgesic-response, oral administration of n-butanol fraction significantly prolonged the reaction time in rats. Oral administration of n-butanol fraction also significantly reduced the number of writhing by 75.93% as compared to aspirin 87.05%. the analgesic activity has been attributed to the presence of flavonoids such as baicalein, ellagic acid, biochanin -A present in the roots of *Oroxylum indicum*.

Hepatoprotective activity

Oroxylum indicum has been found to offer liver protection against various experimentally induced damages. Different extracts of leaves of *Oroxylum indicum* showed significant hepato protective activity against CCL4 induced hepatotoxicity in Wistar albino rats. Carbon tetrachloride injection lead to the significant increase in the level of SGPT, ALP, SGOT and total bilirubin. Pet ether, ethanol, water and chloroform extracts administered orally at a dose of 300 mg/kg bw/day significantly altered the level of SGPT, ALP, SGOT and total bilirubin towards the normal. Ethanolic extract was found to be more effective than all other extracts.

The aqueous extract of *Oroxylum indicum* root has been found to have protective effect against paracetamol induced liver damage in experimental rats. This has been evident by significantly altered levels of serum enzymes (SGPT, ALP, SGOT and total bilirubin) towards normal in experimental rats.

The hepatoprotective activity of stem bark of *Oroxylum indicum* against CCL4 induced liver damage in mice has also been confirmed. Pet ether, chloroform, methanolic acid and aqueous extracts of stem bark of *Oroxylum indicum* were examined against carbon tetrachloride induced liver damage in mice using silymarin as control. Enzyme activities of SGPT, ALP and SGOT were analyzed. All the extracts were shown to have significant hepatoprotective activity, with the methanolic extract being more efficient.

The hepatoprotective effect of root bark of *Oroxylum indicum* has also been evaluated against CCL4 induced hepatotoxicity in experimental animals. Pre-treatment with ethyl acetate and chloroform extracts prior to CCL4 induced liver damage, exhibited the liver protective action. CCL4 treatment produced alterations in the activities of serum enzymes and antioxidant status of histopathology. Pre-treatment with *Oroxylum indicum* restored all these changes upto normal. All these studies confirmed the

traditional uses of this plant as a potential hepatoprotective agent.

Nephroprotective activity

Root decoction and leaves of *Oroxylum indicum* are widely used as prophylaxis for kidney disorders and to remove kidney stones in Indian system of medicine. The ethanolic extract of roots of *Oroxylum indicum* has shown protective effect against cisplatin-induced renal injury in Wistar male albino rats. Nephrotoxicity was induced by cisplatin (6 mg/kg BW I.P.) as evidence by significant increase in BUN, serum creatine clearance level. On administration of ethanolic extract at two dose levels 200 and 400 mg/kg BW for 3 days starting one hour prior to cisplatin administration significantly restored all the parameters towards normal. Histological studies also substantiated the results.

The nephroprotective activity of *Oroxylum indicum* has also been evaluated in experimental rats. It has been considered as a great discovery that several flavonoids have been found to possess nephroprotective activity. In an experiment, chrysin isolated from roots of *Oroxylum indicum* was evaluated for protective activity against cisplatin-induced nephrotoxicity. Animals which received chrysin reversed all the effects induced by cisplatin.

Antihyperlipidemic Activity

The antihyperlipidemic activity of *Oroxylum indicum* total bark extract has been examined in cholesterol induced hyperlipidemic albino Wistar rat model. The root extract exhibited significant reduction in total cholesterol, total triglycerides, LDL-C, VLDL-C levels and remarkable increase in the levels of HDL-C when index and LDL-C: HDL-C risk ratio was also reduced to significant extent in the group treated with extract. The levels of SGOT and SGPT were also estimated and found to be significantly less than that of hyperlipidemic control group. The study scientifically proved the folklore use of *Oroxylum indicum* in cardiovascular disorders and as ingredient in various Ayurvedic formulations used in cardiovascular diseases.

Antidiabetic Activity

Anti-diabetic properties of *Oroxylum indicum* have been evaluated in experimental animal models. The hypoglycemic activity of extracts of *Oroxylum indicum* vent roots has been studied in Wistar albino rats. In one study, the diabetes was induced in Wistar albino rats by a single intraperitoneal injection of Alloxan (120mg/kg BW). In other study, the diabetes was induced as a result of insulin resistance by the single subcutaneous injection of dexamethasone (10mg/kg BW). Oral administration of ethanolic and water extracts of roots of *Oroxylum indicum* at the dose levels of 300 and 500 mg/kg BW for 21 days and 11 days respectively in two different studies showed a significant reduction in the serum glucose, triglyceride, total cholesterol levels and a significant increase in the liver and muscle glycogen levels, when compared with diabetic control groups. Sufficient reduction in serum glucose concentration was shown by aqueous and alcoholic extracts at 500 mg/kg BW after 21 days and 11 days by 50.92% and 49.59% respectively.

The methanolic and aqueous extracts of leaves of *Oroxylum indicum* have also been found to have

antidiabetic activity against alloxan-induced diabetes in rats. Administration of methanolic and aqueous extracts at a dose level of 300mg/kg BW for 21 days to Alloxan (120mg/kg BW) induced diabetic rats significantly restored the serum biochemical parameters, viz., fasting blood glucose level, lipid profile, biomarker enzymes, serum SGOT, SGPT and ALP to normal. Methanolic extract induced more significant antidiabetic effect than aqueous extract.

Anti-helminthic Activity

Anti-helminthic activity of *Oroxylum indicum* has been studied under in-vitro conditions. In in-vitro experiment, *Oroxylum indicum* was evaluated for anti-helminthic activity against equine strongyle eggs and compared to that of ivermectin, one of the most effective deworming agents. *Oroxylum indicum* was found to have significant anti-helminthic activity by 0% hatching of eggs at a dose of 0.2 g/L *Oroxylum indicum*. The results were quite comparable to the standard drug.

Immunomodulatory Activity

The fresh root of *Oroxylum indicum* is consumed with the traditional belief that it enhances immunity. This claim has been investigated in experimental animals. Rats treated with n-butanol fraction (100mg/kg BW) of *Oroxylum indicum* root bark for 22 consecutive days when challenged with sheep red blood cells (SRBC hemagglutinating antibody [HA] titer) and delayed-type hypersensitivity [DTH] reactions, showed a significant rise in antibody titer during secondary antibody responses, indicating a potentiating of certain aspects of the humeral response. The treatment also resulted in a significant rise in paw edema formation indicating increased host DTH response. Furthermore, histopathological analysis of lymphoid tissues showed an increase in cellularity such as T-lymphocytes and sinusoids, in the treatment group. The plant was also found to have significant antioxidant activity. The reported immunomodulatory activity might be attributed to its ability to enhance specific immune responses (both humeral and cell-mediated) as well as its antioxidant potential.

Gastro Protective Activity

Oroxylum indicum has been used for ages for the treatment of various gastric disorders. The protective effect of alcoholic extract of root bark of *Oroxylum indicum* and its different fractions viz. pet ether, chloroform, ethyl acetate and n-butanol fraction was also studied in water immersion plus restraint stress (WIRS) model. Alcoholic extract (300 mg/kg BW) showed significant reduction in gastric ulceration against ethanol induced-gastric damage, with the n-butanol fraction being more effective. In WIRS model, pre-treatment with n-butanol fraction showed significant antiulcer and antioxidant activity in gastric mucosal homogenates. The study also showed the presence of certain flavonoids such as baicalein. The mechanism of gastro protective activity might be attributed to a decrease in gastric acid secretory and antioxidant activities leading to gastric cyto-protection, because of the presence of flavonoids.

Certain flavonoids isolated from stem bark of *Oroxylum indicum* have also been confirmed to have gastro protective activity.

Anticancer and antimutagenic Activity

The anticancer property of *Oroxylum indicum* has been evaluated in the experimental animals induced by indicum was found to have antiproliferative effect on Hep 2 cell lines. Ethanol extract exhibited cytotoxic activity against the Hep 2 cell lines at a concentration of 0.05%.

Baicalein, the most abundant flavonoid present in the leaves of *Oroxylum indicum* has been isolated and tested on the viability and induction of apoptosis in the HL-60 cell line. Pretreatment with baicalein for 24 hours caused a 50% inhibition of HL-60 cells at concentrations of 25-30 micrometer. Exposure of HL-60 cells to 10-20 micrometer baicalein for 36-48 hours caused the cells to accumulate at S or G2M phases. The result of the study indicated the baicalein has anti-tumor effect on human cancer cells.

The antimutagenic activity of methanolic extract of *Oroxylum indicum* has been evaluated in Trp-p-1 by ames test. Baicalein was found to be the major antimutagenic component with an IC50 value of 2.78 +/- 0.15 micrometer. the antimutagenicity mechanism was attributed to the presence of baicalein which acted as desmutagen and inhibited N-hydroxylation of Trp-p-2.

The toxicity study on tumor cells has revealed that *Oroxylum indicum* is having significant activity in the destruction and apoptosis of tumor cells. *Oroxylum indicum* has been found to have an IC50 value of 19.6 microgram/ml for CEM, 14.2 microgram/ml for HL-60, 17.2 microgram/ml for B-16 and 32.5 microgram/ml for HCT-8. On the sea urchin eggs, it also inhibit the progression of cell cycle since the first cleavage (IC50=13.5 microgram/ml).

CONCLUSION

By this we conclude that *Oroxylum* has greater importance in treating several diseases. Hence it is treated as medicinal herb in Indian subcontinent.

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Authors Contribution

All authors had equally contributed in the recitation of article.

Conflicts Of Interest

Authors have declared no conflicts of interest.

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