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OROXYLUM INDICUM: AN OVERVIEW

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ABSTRACT: *Oroxylum indicum* (*O. indicum*), commonly known as the Indian trumpet tree, belonging to the family Bignoniaceae, is a medicinally important, small, or medium-sized plant used to treat various diseases and also has its importance in the traditional system of medicine. Various parts of the plant have been proved to possess useful pharmacological activities. It is native to the Indian subcontinent, extending to Sri Lanka, China, and Malaysia. A variety of experimental studies has been performed both *in-vitro* and *in-vivo* to determine the various uses of the plant. Also, various important chemical constituents have been isolated, which act as a source of medicinally important compounds. Flavonoids, the most abundant and important constituents, are found in almost all parts of the plant. Several studies have been performed to reveal information on *O. indicum*. The aim of writing this review is to compile information from published materials on various aspects of the plant.

INTRODUCTION: *Oroxylum indicum*, popularly known as Sonapatha, belonging to the family Bignoniaceae or Trumpet Creeper family, is a medicinally important plant that was used traditionally for thousands of years. All parts of the tree are used in indigenous medicine. In English, it is also known as 'Tree of Damocles' and 'Shyonak', 'Bhut-vriksha' in Hindi¹. Particularly, the plant is known as Midnight Horror in Malaysia because the flowers open at night, emitting a powerful stink to attract bats, which help in pollination. The plant is sometimes referred to as a broken bones tree because, when the flowers and leaves dry and fall off, their accumulation beneath the tree resembles the pile of broken bones.

Oroxylum indicum is also known as the 'Indian trumpet tree' because it relates to trumpet². It has been used as a single drug or as a poly-herb drug preparation in Ayurveda³. It is also used as a mixture in many oils used for joint pain and in formulations such as Chyavanprash and Dashmularistha. The plant is widely distributed throughout Asian regions, including India, Thailand, Vietnam, Malaysia, Indonesia, Philippines, China, Taiwan and Japan⁴. In India, the plant is reported to be vulnerable in Karnataka. The leaves are very large, about 90-180cm in length.

Almost all parts of the plant have been reported to possess a wide range of pharmacological activities especially the seeds are of utmost importance. The plant is used in Traditional systems of medicine in the Asian continent to prevent and treat several diseases⁵. The plant also possesses anti-mutagenic, anti-aging⁴, neuro-genesis, anti-adipogenesis⁴, immunomodulatory, cardio-protective and

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nephroprotective properties. The plant is traditionally used to treat asthma, biliousness, bronchitis, fever, vomiting, inflammation, leukoderma, skin diseases, wound injury, and deworm intestine¹. The seeds of *Oroxylum indicum* have found their uses as an analgesic, anti-tussive and anti-inflammatory agent for the treatment of cough, bronchitis, and other diseases. The plant is reported to possess anti-inflammatory, diuretic, anti-fungal and anti-bacterial activity. It has also been reported that the plant contains various chemical constituents which act as free radical scavengers; hence it is a potent antioxidant. Due to significant medicinal properties and continuous increasing demand, this plant has been endangered by the International Union for Conservation of Nature (IUCN)⁶.

Description: *Oroxylum indicum* is a small or medium-sized deciduous tree attaining a height of 12-16m with light or greyish brown spongy bark⁷. The root is soft and juicy, having a greyish brown color. It is often associated with numerous corky lenticels⁸. Initially, the taste is sweet and gets bitter on storage. On drying, the bark shrinks adhere closely to the wood and become faintly fissured². The leaves are quite large, appear to be approximately 1 meter in length and pinnately compound. The leaflets are ovate, wavy and acuminate, having 2-4 leaflet pairs and are evergreen⁴.

The flowers appear reddish-purple on the outside and pinkish yellow on the inside⁷. The flowers open at night, emitting a powerful stink to attract bats, which help in pollination. Hence, it is also known as 'Mid-night Horror'. The flowers are large, fleshy and violet-colored. Flowers are bisexual and zygomorphic⁶. They have a characteristic foul smell with 2.5cm long pedicle and bloom in the month of June-July and bear fruits in November. The fruits are up to 1.5 m long that hang down from bare branches, which resembles the wings of a large bird. The fruits show a curved appearance towards the apex. The calyx is 4cm long, leathery, oblong-campanulate and glabrous⁸. Corolla is usually bright-purple, reaching 10cm long, fleshy lobes about 4cm long with crisped margins. The seeds are flat, round with white papery wings all around except at the base⁷.

Taxonomical Classification³:

Kingdom: Plantae

Division: Magnoliophyta

Class: Magnoliophyta

Order: Lamiales

Family: Bignoniaceae

Genus: *Oroxylum*

Species: *Indicum*



FIG. 1: SEEDS OF *OROXYLUM INDICUM*



FIG. 2: 4 WEEKS OLD PLANT OF *OROXYLUM INDICUM*



FIG. 3: FLOWERS OF *OROXYLUM INDICUM*



FIG. 4: FRUITS OF *OROXYLUM INDICUM*

Vernacular Names: *Oroxylum indicum* is commonly known as Tetu. Its regional names include Bhatghila, Tona, Bhut-vriksha, Shyonaka, and Hanyu pinyin⁸. The classical names according to Ayurveda include Shyonaaka, Shoshana, Tuntuka, Kutunnata, Mandukparna, Patrorna, Bhalluka, Prthushimba, Sonaapaathaa, Nata.

Sanskrit: Prthsuimba, Katvanga, Dirghavrnta.

Hindi: Sonapatha, Shyonak, Tentoo

English: Indian Trumpet flower, Broken bones tree, Mid-night Horror, Indian calosanthos

Bengali: Sonagachh

Gujrati: Tentoo

Punjabi: Tatpaling, Talvarphali

Marathi: Tentoo, Tayitu, Tetu

Tamil: Peruvaagai

Assam: Kering⁹

Kannada: Tigudu

Malayalam: Palagripayanni

Oriya: Pamponiya

Telugu: Dundilumu, Gumpena, Pampini, Manduka-parnamu.

Konkani: Davamadak

Singhala: Totila, Thotila⁸

Sundanese: Pongporang⁵

Distribution: *Oroxylum indicum* is a small or medium-sized deciduous tree indigenous to the Indian subcontinent, the Himalayan foothills, with a part extending to Bhutan and southern China, Sri Lanka, Philippines, Indochina, and Malaysia regions. In India, the plant is widely distributed throughout Assam and in some parts of Andaman and Nicobar Island, Gujrat, Madhya Pradesh, Andhra Pradesh, and Odisha. Particularly, it is found widely distributed in Eastern and Western ghats and North East India. It is also found throughout the tropical forests of India up to the elevation of 1000-1200 m¹⁰.

This valuable tree has become vulnerable in Karnataka and Andhra Pradesh and endangered in Kerala, Maharashtra, M. P. and Chhattisgarh¹¹. Therefore, it is included in the endangered list of India¹⁰. It is found in Taiwan, Yunnan, Cambodia, Indonesia (Java, Sumatra), Myanmar, Nepal, and Vietnam⁸. It grows wild in Bangladesh in Chittagong, as well as other hill tract districts⁵. It is a tree that is found generally in the damp region and is mostly sighted along the river banks or slopes of the hills.

Chemical Constituents: Phytochemical investigations of the different parts of the plant resulted in the identification of approximately 111 compounds, among which flavonoids, naphthalenoids, and cyclohexylethanoids are the predominant groups¹². Various secondary metabolites are present such as flavonoids, glycosides, alkaloids, tannins, terpenoids, etc. Flavonoids are the major chemical constituents of all the parts of the plant. The bark especially is rich in tannins. The heartwood of *Oroxylum indicum* contains prune tin, isoflavone, and β -sitosterol.

• **Leaves:** The leaves have been reported to contain anthraquinones, flavonoids, and their glycosides, namely baicalein, baicalein 6-O-glucuronide, baicalein 7-O-glucuronide, and scutellarein, it's 7-rutinoside, and aloe-emodins³. Among these flavonoids, baicalein is the most abundantly found and an important active constituent of the plant. Several studies were conducted on the phytochemical investigations of *Oroxylum indicum* how the abundance of baicalein isolated from various parts of this plant, including the stem bark, root bark, leaves, fruits and seeds also⁴.

Baicalein has historically been used in antioxidant, anti-viral, anti-bacterial, anti-cancer, anti-inflammatory, and anti-allergic allergies¹³. They also contain oxxyloside methyl ester and chrysin-7-O-methyl glucoside⁸, chrysin-7-O-diglucoside¹². Leaves are also found to contain quercetin-3-O-alpha-L-arabinopyranoside, 1-(2-hydroxyethyl) cyclohexane-1,4-diol and apigenin¹⁴. The constituents which are reported to be isolated from leaves are chrysin, Oroxylum-A, baicalein 7-O-glucoside, baicalein 7-O-diglucoside, chrysin-diglucoside, chrysin 7-O-glucuronide, ar-tumerone,

methyl hexadecanoate, laurenan-2-one, isopropyl butanoate¹.

• **Root:** Bark of the root contains flavonoids such as chrysin, baicalein, and Oroxylin-A, dihydro iso- α -lapachone, 7-O-methyl chrysin, 5-hydroxy-4',7-dimethoxy flavone, dihydro Oroxylin A¹⁵. Bark also contains dihydrobaicalein. The root bark is reported to contain ellagic acid, scutellarin, 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-tetrahydro-flavonol, 5-hydroxy-4',7-dimethoxy flavones¹⁴.

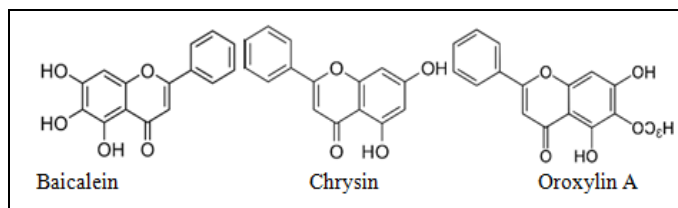
• **Stem:** Stem contains flavones, namely Oroxylin A, baicalein, its 7-glucuronide, scutellarein, its 7-rutinoside, p-coumaric acid, and chrysin. It also contains pterocarpan, rhodioside, p-hydroxyphenylethanols and cyclohexanols³.

The stem, seeds, and root bark of *Oroxylum indicum* contain many flavones, weak acids, and traces of alkaloids. The chloroform and ethanol extracts of stem bark possessed phenols and flavonoids whereas, the aqueous extract contained saponins. The alkaloids were present in benzene, chloroform, and ethanol extracts.

The hydro Bamehanolic extract of stem and root bark contains glycosides, terpenoids, phenols, and alkaloids. The constituents isolated from the stem of *Oroxylum indicum* are chrysin, oroxyloside, hispidulin, apigenin, ficusal, balanophonin, salicylic acid, p-hydroxybenzoic acid, protocatechuic acid, isovanillin, oroxylin, pinostrobin, kaempferol, and lapachol¹.

• **Seeds:** The seeds contain various chemical constituents, including terpenes, alkaloids, saponins, and flavonoids. They are abundant in flavonoids containing chrysin, baicalein-7-O-diglucoside (Oroxylin B), apigenin⁶ and one unknown flavonoid has also been isolated. Seeds contain one more flavone, oroxidin. Also, contains ellagic acid. Seeds contain various oils such as caprylic, lauryic, myristic, palmitic, palmitoleic, stearic, oleic and linoleic acids¹⁴.

• **Fruits:** Fruits are reported to contain Oroxylin-A, chrysin, orlumin A¹, ursolic acid, and aloe-emodin¹⁴.



Traditional uses of Various Plant Parts: Charaka and Sushruta prescribed *Oroxylum indicum* internally for persistent dysentery, non-healing ulcers, gynecological disorders, antiseptic, antitoxic, astringent, and styptic. The drug was also administered for promoting the adhesion of fractured bone.

• **Roots:** In Ayurvedic medicine, roots are used fresh, as they lose their vitality after a couple of months. The root bark of the plant is bitter, pungent, astringent to the bowels, cooling, aphrodisiac, tonic, increased appetite, biliousness, fever, bronchitis, intestinal worms, vomiting, dysentery, leukoderma, asthma, inflammation, and anal troubles³. Roots have been reported to treat tuberculosis. The main chemical constituents found in roots are ellagic acid which is used as an astringent, stomachic, anodyne, sudorific, and also for treating otorrhoea. Also, roots are used to treat dropsy. The root bark has anti-allergic properties and is used in treating allergic diseases, urticaria, jaundice, asthma, sore throat, laryngitis, hoarseness, gastralgia, diarrhea, dysentery, infantile, erythema, and measles³. The root bark is used in a formulation having nootropic activity³. Decoction of root bark is effective in curing nasopharyngeal cancer. The root bark acts as a blood purifier and tonic and hence is used to treat stomach complaints.

The paste of root bark is hepatoprotective. Also, a decoction of dried root bark has its uses in treating Jaundice⁵.

• **Bark:** An alcoholic maceration of the bark helps to be useful in treating allergic dermatitis. The bark of the plant is used to treat various stomach disorders. The bark is used externally in veterinary medicine. A report proposed that a decoction of bark showed good diuretic activity in rats, comparing favorably in potassium acetate and being more potent than urea. An infusion of bark powder is diaphoretic.

A paste made of bark powder is applied for mouth cancer, scabies and other skin diseases ⁶.

- **Stem:** Stem contains various flavones, alkaloids, tannic acid, sitosterol, and galactose, used to treat rheumatism. The roots and stem bark of *Oroxylum indicum* has been used for centuries to treat various gastric disorders ¹⁵. Dichloromethane extracts of stem bark and root bark have antimicrobial activities against a range of gram-positive and gram-negative bacteria and against the *Candida albicans* yeast ¹⁰.

- **Fruits:** Tender fruits act as carminative, stomachic, and spasmolytic. The fruits are sweet, anthelmintic, and good in diseases of the heart and throat, piles, bronchitis, used as an expectorant, improve appetite, and are useful in leukoderma ³. The fruits are used in treating bronchitis, leukoderma, helminthiasis. 50% ethanolic extract of fruit showed spasmogenic action on isolated-guinea pig ileum, whereas the root, stem, and stem bark extracts had no such effects. Fruits possess anti-mutagenic activity ⁸. They are also used in tanning and dyeing ¹⁰. Mature fruits are useful in pharyngodynia, cardiac disorders, gastropathy, hemorrhoids, cough, jaundice, dyspepsia, smallpox, and cholera ⁶.

- **Leaves:** Leaves contain anthraquinone and aloemodin and are used as emollients. Leaves are used to treat enlarged spleen and also to alleviate headaches and ulcers ³. A paste of leaves has its use in hair fall and baldness. They are also prescribed for snakebite ⁸. Young leaves and flowers are eaten uncooked as a side dish ¹⁰. A decoction of the leaves is employed externally to treat cholera, fever, childbirth, and rheumatic swellings.

- **Seeds:** Seeds mainly contain flavones, terpenes, alkaloids and saponins and act as purgative. The extract possesses antimicrobial activity. The seeds are proven to be useful in chronic cough and gastralgia ³. They are also reported to treat hypertension. Also, in some tribes of India, the seeds are used as digestive. Extract of seeds exhibits analgesic, anti-tussive and anti-inflammatory properties. A seed paste is applied externally to treat boils and wounds. The seeds and bark are used medicinally for reducing body pain, especially during fevers.

They act as expectorants and laxatives ¹⁰. A paste of the seed is applied to the neck for quick relief of tonsil pain ⁶. The dried powder is used by women to induce conception ⁶.

Therapeutic uses:

- **Anti-inflammatory Activity:** It is reported that ethanol extract of stem bark of *Oroxylum indicum* has been shown to possess anti-inflammatory as well as analgesic activity *in-vivo* ¹⁶. These activities may be due to its ability to neutralize free radicals as well as suppress the activation of proinflammatory cytokines including NF- κ B, TNF α , IL-1 β , INF- γ , and the activity of cyclooxygenase enzyme involved in inflammation. Also aqueous extract of leaves of *Oroxylum indicum* have shown to possess anti-inflammatory activity ³. Baicalein, the flavone aglycone of baicalin is a product widely used in Chinese clinical medicine as a treatment for inflammation, fever, and allergic diseases. Dichloromethanolic extract of stem bark and root of *Oroxylum indicum* showed anti-inflammatory activity *in-vitro* ⁵. The root bark of *Oroxylum indicum* has been shown to inhibit chronic inflammation in rats ¹⁴. Chemical constituents responsible for anti-inflammatory effects are found to be flavones and their glycosides, including baicalein, scutellarein, and aloemodin ¹⁷. A study concluded that the root extracts of *Oroxylum indicum* can inhibit 5-lipoxygenase and cyclooxygenase, the enzyme involved in the pathogenesis of inflammation. Inhibition of enzymes was due to the presence of flavonoids such as baicalein, chrysin, and Oroxylin-A. They were also reported to inhibit arachidonic acid's peroxidation, which explains their observed anti-inflammatory effects.

- **Anti-hepatotoxic Activity:** The methanol-dichloromethane (MDM) extract of *Oroxylum indicum* whole plant on carbon tetrachloride-induced hepatotoxicity in rat liver explant cultures *in-vitro* and chronic liver damage in rats *in-vivo* were evaluated. The results concluded the hepatoprotective activity of MDM extract of *Oroxylum indicum* whole plant *in-vitro* and *in-vivo* ¹⁸. Also, leaves are widely used as a prophylaxis for liver disorders in the Indian system of medicine. *Oroxylum indicum* has been found to protect the liver against various experimentally induced damage. Another study revealed the alcoholic (300

mg/kg), petroleum ether (300 mg/kg), and n-butanol (100 and 300mg/kg) extracts significantly lowered serum glutamic oxaloacetic transaminase (SGOT), serum glutamic pyruvate transaminase (SGPT), alkaline phosphatase (ALP) and total bilirubin (TB) levels as compared to the control group⁷.

- **Anthelmintic Activity:** Anthelmintic effects of *Oroxylum indicum* stem bark extract on juvenile and adult stages of *Hymenolepis diminuta* were evaluated. The extract possessed effects against the larval and adult stages and thus held promise in the control of intestinal helminthiasis¹⁹. Jessica et al. assessed the anthelmintic activity of *Oroxylum indicum* against equine strongyle eggs and concluded it to be one of the most effective deworming agents³. In an uncontrolled study on²¹ confirmed patients of intestinal amoebiasis, the oral administration of concentrated aqueous extract powder of *Oroxylum indicum* led to symptomatic improvement as well as the absence of *Entamoeba Histolytica* cysts in the stool of¹⁹ patients.

- **Anti-cancer Activity:** It is reported that *Oroxylum indicum* possesses properties that inhibit tumor cell proliferation and migration. Results indicated the presence of baicalein, a flavonoid, to be a potent anti-furin and anti-tumor agent isolated from *Oroxylum indicum*²⁰. It is used to check the proliferation of human breast cancer cell line MDA – MB – 43511. Also, ethanol extract of *Oroxylum indicum* proved to possess anti-proliferative effects on Hep2 cell lines. Ethanolic extract of stem bark of *Oroxylum indicum* was found to possess anti-cancer activity *in-vivo*⁵. In 2018, Chassagne et al. used a scoring approach to select traditional plants which are frequently used in liver disorders and tested them for anti-cancer activity on liver cancer. Out of these¹⁰ plants were tested which included *Oroxylum indicum*, *Andrographis paniculate*, *Willughbeia edulis*, *Senna alata*, *Cananga latifolia*, *Salacia Chinensis* L., *Orthosiphon aristatus*, *Boerhavia diffusa* L., *Gomphrena celosioides* and *Melastoma saigonense*. Interestingly, when compared to the other plants evaluated in the study, the Ethanolic extract of *Oroxylum indicum* showed the highest anti-proliferative effect on the HepG2 model⁴. Another study concluded that the aqueous and methanol extracts of *Oroxylum indicum* stem bark induced apoptosis in MDA-MB-435S (human

breast carcinoma), Hep3B (human hepatic carcinoma), and PC-3 (human prostate cancer cells) cells¹.

- **Immunostimulating Activity:** Immunostimulant activity of n-butanol fraction of root bark of *Oroxylum indicum* was investigated. The immune response to sheep red blood cells (SRBC hemagglutinating antibody [HA] titer) in rats was measured and evaluated. Treatment with an n-butanol fraction of *Oroxylum indicum* caused a significant increase in circulating HA titers, indicating potentiation of certain aspects of the humoral response. Also, the antioxidant potential of the drug was exhibited by a significant reduction in whole blood malondialdehyde (MDA) content along with a rise in activities/levels of superoxide dismutase (SOD), catalase (CAT), and reduced glutathione (GSH). Baicalein, a major flavonoid found in almost all plant parts, is reported to have immunomodulatory potential.

- **Anti-microbial Activity:** The antimicrobial activity of stem bark extract of *Oroxylum indicum* was evaluated. In-vitro antimicrobial susceptibility testing was performed, and the activity of different extracts of *Oroxylum indicum* towards the three strains of Gram-positive and Gram-negative bacteria was investigated. The results showed that in many cases, the plant could be the source of a potent antibacterial medicine²¹. Ethanolic extract of leaves of *Oroxylum indicum* showed moderate antibacterial activity against *Acinetobacter baumannii in-vitro*⁵. The extracts of methanol, ethyl acetate, and ethanol 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 properties¹⁴.

- **Gastroprotective Activity:** Flavonoids present in the stem bark of *Oroxylum indicum* are responsible for their gastroprotective nature. It is reported that all the flavonoids were tested for their ulcer protective effects against various gastric ulcers inducing models in rats¹⁵. Also, 50% alcoholic extract of root bark of *Oroxylum indicum* was reported to possess gastroprotective activity³. Another study reported the anti-ulcer effects of root bark of *Oroxylum indicum* against experimental

gastric ulcers. This study concluded that the n-butanol and petroleum ether fractions of *Oroxylum indicum* possess significant anti-ulcer activity. There was an inhibitory effect on acid secretory mechanisms and free radical scavenging activity and a significant rise in gastric mucin activity. With the help of HPLC-based profiling techniques, the anti-ulcer activity could be linked to a significant extent to the presence of baicalein.

- **Anti-viral Activity:** The flavonoid baicalin, which is found abundantly in seeds of *Oroxylum indicum* has shown inhibitory effects against the human T cell leukemia virus type 1 and the human immunodeficiency virus (HIV-1)¹⁰. Another study was conducted using *Oroxylum indicum* extracts on Chikungunya virus infection. The study concluded that the extract possessed some anti-viral activity against CHIKV. The anti-chikungunya activity was between low to moderate, suggesting it is a potential candidate for anti-viral drugs²². Recent research revealed a molecular docking study of eighteen *Oroxylum indicum* molecules with the main protease responsible for the replication of the SARS-CoV-2 virus. The outcome of their molecular simulation and ADMET properties reveal four potential inhibitors of the enzyme (Baicalein-7-O-diglucoside, chrysin-7-O-glucuronide, Oroxindin, and scutellarein) with the preference of the ligand Chrysin-7-O-glucuronide that has the highest binding energy (-8.6 kcal/mol) and obeys the Lipinski rule of five²³.

- **Anti-arthritic Activity:** Ethyl acetate extract of root bark of *Oroxylum indicum* was found to possess anti-arthritic activity *in-vitro*⁵. Another study was conducted using the root bark of *Oroxylum indicum* against adjuvant-induced arthritis. Several extracts were tested for the activity, out of which chloroform and ethyl acetate extracts had significant anti-arthritic potential. The study concluded that the root bark extracts of *Oroxylum indicum* have significant anti-arthritic potential²⁴.

- **Radioprotective Activity:** A study was conducted on the protection of radiation-induced DNA damage in Albino Rats by *Oroxylum indicum*. *In-vitro* experiments on the protection of DNA from radiation-induced (5 and 10 Gy) damages were done using pBR322 plasmid DNA.

Albino rats injected intra-peritoneally with 1-2g/kg of 60% ethanol extract and exposed 1, 3, and 5 Gy were screened for radioprotective effects using the comet assay. Treatment with 60% ethanol extract significantly decreased radiation-induced DNA damage in pBR322. A significant reduction of comet tail DNA and length in rat bone marrow cells was also observed. The results demonstrated that *Oroxylum indicum* fruits have a potent antioxidant property and can protect DNA from radiation-induced damages in both *in vitro* and *in vivo* models without recognizable side effects²⁵.

- **Anti-diabetic Activity:** The anti-diabetic activity of extracts of *Oroxylum indicum* roots has been studied in Wistar albino rats. Oral administration of ethanolic and aqueous 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 groups¹⁴. Another study demonstrated the effect of methanolic extract of heartwood of *Oroxylum indicum*. It was concluded that the extract reduced the activity of α -glucosidase, indicating its anti-diabetic potential¹¹.

- **Analgesic Activity:** *Oroxylum indicum* has been used for ages as an analgesic agent. The analgesic activity of *Oroxylum indicum* was studied by the hot plate, tail immersion, and acetic acid tests to evaluate central and peripheral nervous system acting analgesics. The administration of *Oroxylum indicum* extract showed a significant analgesic activity, indicating that it has some analgesic effect as indicated by reduced pain by hot plate method and suppression of acetic acid-induced writhing¹⁶.

- **Nephroprotective activity:** Root decoction and leaves of *Oroxylum indicum* are widely used as prophylaxis for kidney disorders and to remove kidney stones in the Indian System of Medicine¹⁴. The effect of chrysin isolated from dried roots of *Oroxylum indicum* was evaluated against cisplatin-induced acute renal failure. The nephroprotective activity was evaluated in male Albino rats. Cisplatin caused acute renal damage characterized by elevation of blood, urine nitrogen, and serum

creatinine. Animals that received chrysin reversed all the effects induced by cisplatin in a dose-dependent manner. Thus, the study reveals that chrysin attenuated the nephrotoxic effects of cisplatin in rats ²⁶.

- **Anti-hyperlipidemic Activity:** The anti-hyperlipidemic activity of *Oroxylum indicum* total bark extract has been examined in the cholesterol-induced hyperlipidemic albino Wistar rat model. The root extract exhibited a significant reduction in total cholesterol, total triglycerides, LDL-C, VLDL-C levels, and a remarkable increase in HDL-C levels when the index and LDL-C: HDL-C risk ratio was also reduced to a significant extent in the group treated with the extract ¹⁴.

- **Wound Healing:** Wound healing is quite a complex process. It starts immediately as the injury occurs but might take years for the epidermal layer to form. Methanolic extract of root bark of *Oroxylum indicum* has been reported to possess partial healing properties of burn wounds in mice receiving the topical application of 1 and 2.5% extract containing ointment ¹. Another study investigated the wound healing properties of methanolic extract of *Oroxylum indicum*. The extract had significant wound healing property, as evident from the rate of wound contraction. Significant wound contraction was observed from day 20 onwards in *Oroxylum indicum* treated animal groups. The period of epithelization also decreased significantly and higher hydroxyproline content in treated groups suggested higher collagen re-deposition than the control group ⁴. The result showed that the extract had significant wound healing activity. Also, histopathology studies confirmed the wound-healing activity of *Oroxylum indicum*. This study provided a scientific rationale for the traditional use of *Oroxylum indicum* in the management of wounds ²⁷.

- **Antiobesic Effect:** Obesity is itself associated with many diseases, including cardiovascular risk, diabetes, and cancer. *Oroxylum indicum* has been reported to reduce obesity up to a satisfactory level. The 3T3-L1 adipocytes, when treated with hexane, dichloromethane, ethyl acetate, and methanol extracts of *Oroxylum indicum* bark, inhibited the lipid accumulation and lipase activity, and the ethyl acetate extract was found to be most effective ¹.

Research revealed that *Oroxylum indicum* extract inhibits adipogenesis and lipase activity *in-vitro*. The results revealed that *Oroxylum indicum* extract exhibited a dose-dependent reduction of lipid accumulation compared to the control. The extract also had a dose-dependent inhibitory effect on lipase activity as compared to control. It was further concluded that *Oroxylum indicum* extracts of the fruit pod could inhibit lipid and carbohydrate accumulation in adipocytes and also had the potential to inhibit an enzyme associated with fat absorption ¹².

- **Antioxidant Activity:** In a study, free radical scavenging activity of different extracts of *Oroxylum indicum* was evaluated in vitro using DPPH (diphenyl-picryl-hydrazyl) assay. Antioxidants present in the plant extract converted DPPH to 1, 1-diphenyl-1,2-dipicryl hydrazine. The scavenging effect of the plant extracts and standard (L-ascorbic acid) on the DPPH radical decreases in the following order: L-ascorbic acid > Ethyl acetate > Methanol > Water and it was found to be 97.4%, 61.4%, 40.8% and 29.2% at a concentration of 100 µg/ml respectively. Another study revealed the *in-vitro* antioxidant activity of bark extracts of *Oroxylum indicum*. The study concluded that this plant may be used for mitigating the detrimental effect of oxidative stress and reactive oxygen species-mediated disease ²⁸. Also, the leaves of *Oroxylum indicum* possessed antioxidant activity in vitro. Further, investigations on the in vitro antioxidant capacities of methanol extract, fractions, and flavones from *Oroxylum indicum* bark were performed ²⁹.

CONCLUSION: *Oroxylum indicum* is used in Ayurvedic and traditional systems of medicine to treat numerous human diseases. It has been reported to possess anti-inflammatory, anti-hepatotoxic, anthelmintic, anti-cancer, immunostimulating, antimicrobial, gastro-protective, antiviral, anti-arthritic, radioprotective, anti-diabetic, analgesic, nephroprotective, anti-hyperlipidemic, wound healing and many more properties which are yet to be reported. Research carried out using different *in-vivo* and *in-vitro* techniques of biological evaluation support most of these claims.

Research reveals the enormous work done on this plant, yet some of the properties are still not

reported. The attempt was to compile the available information on *Oroxylum indicum*, including its traditional and therapeutic uses.

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REFERENCES:

- Ethnomedicinal T, Sonapatha P and Jagetia GC: A Review on the Medicinal and Pharma Properties of 2021; 71–89.
- Ahad A, Aa G, Sareer O, Mz N, Ma K and Mohd M: Therapeutic potential of *Oroxylum indicum*: A Review 2012; 10: 163–72.
- Dev LR, Anurag M and Rajiv G: *Oroxylum indicum*: A Review. Pharmacogn J 2010; 2(9): 304–10.
- Tan SC, Othman FA and Kamarudin NA: The Biological Activities and Therapeutic Potentials 2020; 1–23.
- Dinda B, Silsarma I, Dinda M and Rudrapaul P: *Oroxylum indicum* (L.) Kurz, an important Asian traditional medicine: From traditional uses to scientific data for its commercial exploitation. J Ethnoph 2015; 161: 255–78.
- Neelu J, Alok S and Tapan KN: Taxonomic and phytomedicinal properties of *Oroxylum indicum* (L.) Vent: A wonderful gift of nature. J Med Plants Res 2014; 8(38): 1148–55.
- Singh HV and Chaudhary AK: A Review on the Taxonomy, Ethnobotany, Chemistry and Pharmacology of *Oroxylum indicum* Vent. Indian Journal of Pharmaceutical Sciences 2011; 483-490.
- Deka DC, Kumar V, Prasad C, Kumar K, Gogoi BJ and Singh L: *Oroxylum indicum* – a medicinal plant of North East India: An overview of its nutritional, Remedial and Prophylactic Properties 2013; 3(1): 104–12.
- The Ayurvedic Pharmacopoeia of India, Government of India, Ministry of Health and Family Welfare, Department of ISM and H, Part 1, Volume III: 210-211.
- Behera LK, Gunaga RP, Thakur NS, Mehta AA, Sukhadiya M and Dholariya CA: *Oroxylum indicum*: detail on a medicinally important and rare tree species of India. MFP News 2019; 3: 9-12.
- Hengpratom T, Lowe GM, Thumanu K, Suknasang S, Tiomyom K and Eumkeb G: *Oroxylum indicum* (L.) Kurz extract inhibits adipogenesis and lipase activity *in-vitro*. BMC Complement Altern Med 2018; 18(1): 1–14.
- Bhusari S, Morey S, Nikam K and Wakte P: Comparative Evaluation of Baicalein from *Oroxylum indicum* by using Conventional and Non-Conventional Extraction Methodology 2019; 12: 1817–22.
- Srilakshmi S: Review on *Oroxylum indicum* 2019; 11(8): 2905–9.
- Babu TH, Manjulatha K, Kumar GS, Hymavathi A, Tiwari AK and Purohit M: Bioorganic & Medicinal Chemistry Letters Gastroprotective flavonoid constituents from *Oroxylum indicum* Vent. Bioorg Med Chem Lett 2010; 20(1): 117–20.
- Gokhale M and Yogendra K: Bansal: Somaclonal variation in *Oroxylum indicum* (L.) vent- an endangered tree species. Journal of Phytology 2010; 2(6): 01–07.
- Vikrant A and Arya ML: A review on anti-inflammatory plant barks. Int J Pharm Tech Res 2011; 3(2): 899–908.
- Mishra S and Sahoo S: *In-vitro* and *in-vivo* antihepatotoxic activity of *Oroxylum indicum* against carbon-tetrachloride induced hepatic damage. Int J Pharm Sci Res 2013; 4(8): 3202–7.
- Deori K and Yadav AK: Anthelmintic effects of *Oroxylum indicum* stem bark extract on juvenile and adult stages of *Hymenolepis diminuta* (Cestoda), an *in-vitro* and *in-vivo* study. Parasitol Res 2016; 115(3): 1275–85.
- Lalou C, Basak A, Mishra P, Mohanta BC, Banik R and Dinda B: Inhibition of Tumor Cells Proliferation and Migration by the Flavonoid Furin Inhibitor Isolated From *Oroxylum indicum*. Curr Med Chem 2013; 20(4): 583–91.
- Das S and Choudhury MD: Antimicrobial Activity of Stem Bark Extracts from the Plant *Oroxylum indicum* Vent. Assam Univ J Sci Technol 2010; 5(1): 95–9.
- Aini S, Rafidah M, Shueb H, Fazila N and Mat C: Anti-viral Activities of *Oroxylum indicum* Extracts on Chikungunya Virus Infection. Indian J Microbiol 2017; Available from: <https://doi.org/10.1007/s12088-017-0695-8>
- Shah S, Chaple D, Arora S, Yende S, Moharir K and Lohiya G: Exploring the active constituents of *Oroxylum indicum* in intervention of novel coronavirus (COVID-19) based on molecular docking method. Netw Model Anal Heal Informatics Bioinforma 2021; 10(1). Available from: <https://doi.org/10.1007/s13721-020-00279-y>
- Karnati M, Chandra RH, Veeresham C, Kishan B. Anti -arthritic activity of root bark of *Oroxylum indicum* (L.) vent against adjuvant - Induced Arthritis 2013; 5(2): 121–9.
- Vent OL, Thokchom DS, Shantikumar L and Sharma GJ: Protection of Radiation-induced DNA Damage in Albino Rats by 2014; 6(3): 514–23.
- Adikay S, Usha U and Koganti B: Effect of chrysin isolated from *Oroxylum indicum* against cisplatin-induced acute renal failure. Recent Researches in Modern Medicine 302-307.
- Singh H, Singh V, Kumar DK and Chaudhary A: Wound Healing and Antimicrobial Potential of *Oroxylum indicum* Vent. in Albino Mice. Nat Prod J 2012; 1(2): 128–34.
- Saha P, Choudhury PR, Das S, Talukdar A Das and Choudhury MD: *In-vitro* antioxidant activity of bark extracts of *Oroxylum indicum* (L) vent. Asian J Pharm Clin Res 2017; 10(8): 263–6.
- Trang DHT, Son H Le and Van Trung P: Investigation on the *in-vitro* antioxidant capacity of methanol extract, fractions and flavones from *Oroxylum indicum* Linn bark. Brazilian J Pharm Sci 2018; 54(1): 1–7.

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