**Oroxylum indicum: A Review**

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**INTRODUCTION**

*Oroxylum indicum* also known as ‘Sonapatha’ is an important herb in Ayurvedic medicine and indigenous medical system for over thousands of years[1]. *Oroxylum indicum* has been used as a single drug or as a component of certain compound drug preparations in the Indian Ayurvedic system of medicine for treatment of various disorders as well as used as a tonic and Rasayana drug. It contains flavonoids like chrysine, baicalein and Oroxylin-A. Various studies indicated that sonapatha possesses anticancer, antioxidant, hepatoprotective and immunomodulatory properties mainly. Various other effects like antibacterial, analgesic and gastro-protective properties of sonapatha have also been reported. It is a tree that is found generally in damp region. In the present review an attempt has been made to compile and critically analyse various published reports on *Oroxylum indicum*.

**BOTANICAL DESCRIPTION**

It is a tree which can attain a height of 12 meter (40 feet). The large leaf stalks wither and fall off the tree and collect near the base of the trunk, appearing to look like a pile of broken limb bones. The tree is a night-bloomer and flowers are adapted to natural pollination by bats. They form enormous seed pods that hang down from bare branches. Those long fruits curve downward and resemble the wings of a large bird or dangling sickles or swords in the night. The seeds are round with papery wings. Bark is off brown in color. Leaves are 2 to 4 inch long, broad, leaflets are 5 inch long and 3 to 4 inch broad having sharp edges. The flowers stalk is one feet long. Flowers are purple in color. Leaves are 2 to 4 inch long, broad, leaflets are 5 inch long and 3 to 4 inch broad having sharp edges. The flowers stalk is one feet long. The flowers are born in rainy season and fruit appears in December to March[2–3, 5].

**GEOGRAPHICAL DISTRIBUTION**

*Oroxylum indicum* is native to the Indian subcontinent, in the Himalayan foothills with a part extending to Bhutan and southern China, in Indo-China and the Malaysia.
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ecozone. It is diversely available in the forest of National Park in Assam, India, reported from Sri Lanka (Ceylon)[5].

**TAXONOMICAL CLASSIFICATION**[4]

Kingdom : Plantae  
Division : Magnoliophyta  
Class : Magnoliopsida  
Order : Lamiales  
Family : Bignoniaceae  
Genus : Oroxylum  
Species : indicum

**SYNONYMS**[9–10]

Sansk : Prthsuimba, Katvanga  
Hindi : Sonapatha, Syonak, Tentoo  
Eng : Indian trumpet flower  
Beng : Sonagachh  
Guj : Tentoo  
Punj : Tatpaling, Talvarphali  
Mar : Tentoo  
Tamil : Peruvaagai

According to Ayurveda it contains[11–13]

Gunna (Properties) – laghu (light), tikshan (sharp) and ruksha (dry).  
Rasa (Taste) – madhur (sweet), tikta (bitter)  
Virya (Potency) – ushan (hot)

**CHEMICAL CONSTITUENTS**

The chemical constituents of Oroxylum indicum are always of an interest for the researcher. A number of secondary metabolites like flavonoids, glycosides, alkaloids, tannins, terpenoids etc. have been reported from various parts of the plant.

> The leaves have been reported containing flavones and their glycosides baicalein and scutellarein.  

Leaves also contain an anthraquinone, aloe-emodin[9, 17].  
> Bark of the root is reported with chrysin, baicalein and oroxylin-A. Bark also gave dihydrobaicalein. Heartwood yielded beta-sitosterol and an isoflavone, prunetin. The bark also contains traces of an alkaloid, tannic acid, sitosterol and galactose[14-15].  
> Its root and stem contains three flavones named oroxylin A (5, 7-dihydroxy-6-methoxyflavone), baicalein (5, 6, 7-trihydroxyflavone) and chrysin (5, 7-dihydroxyflavone). It also contains pterocarpan and rhodoside with p-hydroxyphenylethanols and cyclohexanols[16-18].  
> Four flavonoids, chrysin, baicalein, baicalein-7-O-glucoside, baicalein-7-O-diglucoside (Oroxylin B)
and one unknown flavonoid have also been isolated from the seeds of *Oroxylum indicum*\(^1\). Seeds also contain shiny oil, the yield of which was 20\%\(^2\).

In Indian system of medicine the root, bark, stem and leaf are prescribed for snake bite\(^3\).

Leaves are used externally to treat an enlarged spleen and also to alleviate headaches and ulcers and also reported for its analgesic and antimicrobial activity\(^4\).

In various tribes of India, bark and seeds of the plant are used in fever, pneumonia and respiratory troubles\(^5–9\). It is also used to cure various stomach disorders\(^1\). In Nepal a root decoction is used in diarrhoea and dysentery. Seeds are used as a digestive. A seed paste is applied to treat boils and wounds. The root is used as astringent, anti-inflammatory, aphrodisiac, expectorant, anethelic and tonic. The bark is diuretic and stomachic and useful in diarrhoea and dysentery. Root bark and seeds are carminative, stomachic, tonic, diaphoretic and astringent. Root bark is also used to treat bile problems, cough, diarrhoea, and dysentery\(^6\). It is also used in a formulation used for nootropic activity\(^7\).

### Pharmacological Reports

Although a lot of pharmacological and non-pharmacological investigations have been carried out on the plant and its phytoconstituents. A summary of the findings of these studies is presented below.

#### Anti-Inflammatory Activity

The aqueous extract of leaves of *Oroxylum indicum* has been reported to possess significant anti-inflammatory activity. The anti-inflammatory activity has been studied in vivo in carrageenan induced rat paw edema model and it was reported that aqueous extract of *Oroxylum indicum* leaves exhibited significant anti-inflammatory activity at a dose level of 150mg/kg body weight and 300mg/kg body weight. *Oroxylum indicum* aqueous extract at a dose of 300 mg/kg body weight showed maximum anti-inflammatory activity. However the activity produced by both the dose was less effective than the reference standard diclofenac sodium. Extract at both doses showed significant anti-inflammatory activity at 5 hr. against carrageenan injection suggesting that the extract predominantly inhibit the release of prostaglandin like substances. In conclusion, leaves of *Oroxylum indicum* showed anti-inflammatory activity which may be attributed to the presence of different chemical constituents present within\(^8\). A number of flavonoidal compounds have also been reported previously as anti-
inflammatory agent and flavonoids present in plant may be responsible for this activity.

Aqueous and alcoholic extracts were tested using three different in vitro systems for effects relevant to anti-inflammatory activity of stem bark of *Oroxylum indicum*. The aqueous extracts of *O. indicum* significantly reduced myeloperoxide release. In the rat hind paw edema test, extract also showed significant activity[27]. All these findings suggest, *Oroxylum indicum* may be useful in management of chronic inflammatory conditions like arthritis.

**ANTI-HEPATOTOXIC ACTIVITY**

Leaves of *Oroxylum indicum* are widely used as a prophylaxis for liver disorders in Indian system of medicine. Tenpe et al. reported anti-hepatotoxic activity of various extracts of *Oroxylum indicum* Vent. against CCl₄ induced hepatotoxicity. Pet ether, chloroform, ethanol and aqueous extracts were administered to diseased animals (rats) at a dose of 300 mg/kg body weight and serum enzymes levels were observed. All the test groups showed a significant reduction in SGOT, SGPT, ALP, total bilirubin content and a significant increase in the level of total protein was observed in CCl₄ and *Oroxylum indicum* treated rats. Among all the extracts ethanol extract was found to be more effective[28]. Free redical scavenging activity was also reported and hepatoprotective action of these extracts was likely to be due to its ability to scavenge free radicals and induce microsomal enzymes there by inhibition of the lipid peroxidation induced by CCl₄. The study scientifically proved the folklore use of *Oroxylum indicum* in liver disorders and as an ingredient in various Ayurvedic formulations used in liver disorders.

**ANTHelmINTIC ACTIVITY**

Jessica et al. evaluated the anthelmintic activity of *Oroxylum indicum* against equine strongyle eggs in vitro and compared it to ivermectin, one of the most effective deworming agents. At a dose of 2×10⁻⁴ g/mL and greater, hatching of the strongyle eggs was delayed using *Oroxylum indicum*. 0% hatching was achieved at 2×10⁻¹ g/mL *Oroxylum indicum*. At a dose of 2×10⁻⁴ g/mL and greater, 0% viability of the strongyle eggs and larvae was achieved. The results of the study suggested that *Oroxylum indicum* may be an appropriate anthelmintic against equine strongyles[29].

**ANTIcANCER ACTIVITY**

Various studies have proved anticancer potential of *Oroxylum indicum* using various models. Narisa et al. extracted *Oroxylum indicum* with 95% ethanol and tested for cytotoxic effects determing the anti-proliferative effects on Hep2 cell lines. Cell proliferation was measured using a colorimetric method based on the ability of metabolic active cells to cleave the yellow tetrazolium salt XTT to an orange formazan dye and soluble formazan dye was directly quantified using a scanning multiwall spectrophotometer (ELISA plate reader). Ethanol exhibited cytotoxic activity against the Hep2 cell lines at a concentration of 0.05%[30].

Roy et al. reported the in vitro effects of baicalein on the viability and induction of apoptosis in the HL-60 cell line was investigated. The cell viability after treating with baicalein for 24 h was quantified by counting viable cells using trypan blue staining. The results showed that baicalein caused a 50% inhibition of HL-60 cells at concentrations of 25–30 microM. The inhibition of proliferation of HL-60 cells due to 36–48 h exposure to 10 or 20 microM baicalein was associated with the accumulation of cells at S or G2M phases. However, proliferation inhibition at a higher dose may be associated with induction by apoptosis and terminal deoxynucleotidyl transferase-mediated dUTP nick end labeling (TUNEL). The results indicate that baicalein has anti-tumor effects on human cancer cells, and *Oroxylum indicum* extract could be used in supplementary cancer therapy[31].

Nakahara et al. reported that methanolic extract of *Oroxylum indicum* strongly inhibited the mutagenicity of Trp-P-1 in an Ames test. The major antimutagenic constituent was identified as baicalein with an IC₅₀ value of 2.78±/-0.15 microM. The potent antimutagenicity of the extract was correlated with the high content (3.95±/-0.43%, dry weight) of baicalein. Baicalein acted as a desmutagen since it inhibited the N-hydroxylation of Trp-P-2[32].

Tepsuwan et al. reported the in vivo genotoxic activity and cell proliferative activity in stomach mucosa of male F344 rats by in vivo short-term methods after oral administration of a nitrosated *Oroxylum indicum* Vent fraction, which had been found to be mutagenic without S9 mix to Salmonella typhimurium TA98 and TA100. Administration of the nitrosated *Oroxylum indicum* Vent fraction at doses of 1 and 2 g/kg body weight induced dose-dependent DNA single-strand scission in the stomach pyloric mucosa 2 h after its administration: a dose of 2 g/kg body weight induced an 18-fold increase in the DNA elution rate constant. Administration of the nitrosated *Oroxylum indicum* Vent fraction at doses of 0.7-2.8 g/kg body weight also induced dose-dependent increases, up to 11-fold, in replicative DNA synthesis in the stomach pyloric mucosa 16 h after its administration. Moreover
administration of the nitrosated Oroxylum indicum fraction at doses of 0.25-2.0 g/kg body weight induced dose-dependent increases, up to 100-fold, in ornithine decarboxylase activity in the stomach pyloric mucosa with a maximum 4 h after its administration. These results demonstrate that the nitrosated Oroxylum indicum fraction has genotoxic and cell proliferative activity in the pyloric mucosa of rat stomach in vivo[33].

Leticia et al. reported that extract of Oroxylum indicum showed the toxicity on tumor cell lines tested, with an IC$_{50}$ value 19.6 μg/ml for CEM, 14.2 μg/ml for HL-60, 17.2 μg/ml for 8-B and 32.5 μg/ml for HCT-8. On the sea urchin eggs, it also inhibit the progression of cell cycle since the frist cleavage (IC$_{50}$ = 13.5 μg/ml). On the basis of all these findings it can be concluded that extracts of Oroxylum indicum, could be considered as potential sources of anticancer compounds[34].

**IMMUNOSTIMULATING ACTIVITY**

The immunomodulatory activity and the mechanism of action of the n-butanol fraction (100 mg/kg body weight, per os, once daily for 22 consecutive days) of the root bark of Oroxylum indicum, was reported by Zaveri et al. in rats using measures of immune responses to sheep red blood cells (SRBC haemagglutinating antibody [HA] titer) and delayed-type hypersensitivity (DTH) reactions. In response to SRBC, treatment with the n-butanol fraction caused a significant rise in circulating HA titers during secondary antibody responses, indicating a potentiation of certain aspects of the humoral response. The treatment also resulted in a significant rise in paw edema formation, indicating increased host DTH response. Additionally, the antioxidant potential of the drug was exhibited by significant reductions in whole blood malondialdehyde content along with a rise in the activities/levels of superoxide dismutase, catalase and reduced glutathione. Furthermore, histopathologic analysis of lymphoid tissues showed an increase in cellularity, e.g., T-lymphocytes and sinusoids, in the treatment group. In a triple antigen-mediated immunological edema model, the extent of edema raised in drug-treated rats was greater compared to that in control rats, thus confirming enhanced DTH reactions in response to the drug treatment. Based on the all these findings, the reported immunomodulatory activity of an active fraction of O. indicum might be attributed to its ability to enhance specific immune responses (both humoral and cell-mediated) as well as its antioxidant potential[35]. This study also justifies the use of plant in various immunomodulatory formulations of Ayurveda like Chyavanprash etc.

**ANTIMICROBIAL ACTIVITY**

The anti-microbial activity of various extracts of Oroxylum indicum has been screened against fourteen pathogenic bacteria (five gram-positive and nine gram-negative) and seven pathogenic fungi by Kawsar et al. using disk diffusion method. The crude ethyl acetate extract showed mild to moderate activity against all bacteria and fungi whereas the methanolic extract showed little activity against bacteria but moderate activity against fungi. The minimum inhibitory concentration of two isolated flavonoid compounds from O. indicum were determined against Bacillus subtilis, Staphylococcus aureus, Escherichia coli and Shigella dysenteriae and the values were found to be between 64–128μg/ml. A study by Thatoi et al. further confirmed the activity by using different strains[36–37]. Ali et al. (1998) studied the effect of dichloromethane extract of Oroxylum indicum against dermatophytes and wood rot fungi and reported a strong antifungal activity in dichloromethane extract of Oroxylum indicum[38].

**GASTRO-PROTECTIVE ACTIVITY**

Zaveri et al. reported the gastroprotective activity of 50% alcoholic extract of root bark of Oroxylum indicum and its different fractions viz. petroleum ether, chloroform, ethyl acetate and n-butanol fractions in ethanol-induced gastric mucosal damage. n-butanol fraction was also studied in Water Immersion Plus Restraint Stress (WIRS)-model. Alcoholic extract (300 mg/kg) and its different fractions (at a dose of 100–300 mg/kg) showed significant reduction in gastric ulceration against ethanol-induced gastric damage. Out of all these fractions, n-butanol fraction showed significant maximum inhibition of gastric lesions. In WIRS-model, pretreatment with n-butanol fraction showed significant antulcer and antioxidant activity in gastric mucosal homogenates, where it reversed the increase in ulcer index, lipid peroxidation and decrease in superoxide dismutase, catalase and reduced glutathione levels induced by stress. This study reveals significant gastroprotective effect of n-butanol fraction against both ethanol and WIRS-induced gastric ulcers in rats[39]. Flavonoids present in Oroxylum indicum Vent. was found to be responsible for its gastro-protective activity[40].

**CONCLUSION**

Oroxylum indicum is a highly placed drug in the Ayurvedic medicine. It is one of the most versatile plants having a wide spectrum of medicinal activities. This medicinal plant is the unique source of various types of compounds having diverse chemical structure and
nature. Quite less scientific work has been conducted on the possible medicinal applications of these compounds and hence extensive investigation is desirable to exploit their therapeutic utility. Although crude extracts from various parts of *Oroxylum indicum* have been assigned various medicinal applications from time immemorial, the probability of converting these promising activities into modern drugs can be explored further only after extensive investigation of its bioactivity of responsible constituents, mechanism of action, and toxicity and after proper standardization. As this approach would be in line with the global scenario which is now changing towards the use of plant products, that are backed by ethnotraditional medicinal use, which are comparatively nontoxic than currently available marketed drugs of other systems.

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