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## Review Article

# A Review on all Over Nemours Pharmacological Activity of *Boswellia serrata*

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### ABSTRACT

Indian frankincense, or *Boswellia serrata*, is a significant medicinal herb from the Burseraceae family that is frequently utilized in Ayurvedic medicine. The plant's oleo-gum resin has a number of bioactive components, including polysaccharides, terpenoids, essential oils, and boswellic acids. Among these, acetyl-11-keto- $\beta$ -boswellic acid (AKBA) and keto- $\beta$ -boswellic acid (KBA) are thought to be the main active ingredients in charge of its medicinal properties. These substances primarily function by lowering inflammatory mediators and blocking the 5-lipoxygenase pathway. Numerous pharmacological actions, including as anti-inflammatory, anti-arthritic, analgesic, immunomodulatory, anticancer, anti-asthmatic, hypoglycemic, antibacterial, antifungal, antiviral, anti-ulcer, antidepressant, hepatoprotective, and hypolipidemic effects, are demonstrated by *Boswellia serrata*. Its helpful role in the treatment of rheumatoid arthritis, osteoarthritis, asthma, diabetes mellitus, inflammatory bowel disease, and wound healing has been demonstrated by both experimental and clinical research. *Boswellia serrata* is regarded as a promising natural medicinal agent for the treatment of numerous chronic inflammatory and metabolic illnesses because of its wide therapeutic potential and relatively low adverse effects.

### INTRODUCTION

*Boswellia serrata* Roxb. commonly known as Indian frankincense tree, belongs to Burseraceae family, holding both trees and shrubs of tropical and subtropical geographical distribution, with approximately 700 species originating from 18 genera [1]. The genus *Boswellia* consists of 21 species which grow throughout Africa and South

Asia, as well as in the Arabian Peninsula [2,3]. The most important species of this genus are *Boswellia sacra* (Oman and Yemen), *Boswellia serrata* (India), *Boswellia ovalifoliolata* (India), *Boswellia pirottae* (Ethiopia), *Boswellia carterii* (Somalia), *Boswellia frereana* (Somalia), *Boswellia dalzielii* (West Africa), *Boswellia neglecta* (Ethiopia and Somalia), *Boswellia rivae* (Ethiopia and Somalia),

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*Boswellia papyrifera* (Ethiopia and Sudan), *Boswellia popoviana* (Yemen), *Boswellia nana* (Yemen), *Boswellia dioscorides* (Yemen), *Boswellia bullata* (Yemen), *Boswellia elongate* (Yemen), *Boswellia ameero* (Yemen), *Boswellia socotrana* (Yemen), *Boswellia globosa* (Somalia), *Boswellia ogadensis* (Ethiopia), *Boswellia odorata* (Niger, Nigeria and Cameroon), *Boswellia madagaskariensis* (Madagascar)<sup>[3,4]</sup>.

*Boswellia serrata* (*B. serrata*) is a moderately tall tree found in regions such as the Middle East, North Africa, and India. Its extract contains gum, essential oils, resin,  $\beta$ -boswellic acid, phenolic compounds, terpenoids, and polysaccharides. The resin in *B. serrata* extract is known for its free radical elimination, reduction of pro-inflammatory cytokines, pathogen neutralization, and pain suppression.

Research in animals and humans shows that *B. serrata* gum resin extract helps improve inflammatory diseases like osteoarthritis, asthma, and rheumatoid arthritis. Additionally, it has been documented to reduce peritumoral brain edema related to glioma<sup>[5]</sup>.

The resin of nearly all *Boswellia* species primarily contains boswellic acid (BA) and pentacyclic triterpene. Among these, 11-keto  $\beta$ -boswellic acid (KBA) and acetyl keto  $\beta$ -boswellic acid (AKBA) are the most potent anti-inflammatory agents. They work by selectively inhibiting leukotrienes through the inhibition of 5-lipoxygenase (5-LOX) in a non-competitive, non-redox, and enzyme-directed way<sup>[6]</sup>.

### Traditional Applications:

*Boswellia serrata* (*B. serrata*) is a valued herb in Ayurveda, known as “Gajabhakshya” in Sanskrit, meaning elephants prefer this plant over others as food. It is mentioned in the three main

classical Ayurvedic texts: Charak Samhita, Sushruta Samhita, and Asthang Hridaya and Sangraha. Charak Samhita and Sushruta Samhita describe *B. serrata* resin as a treatment for arthritis and as an anti-rheumatic drug. Besides arthritis, the oleo gum resin is traditionally used for dysentery, skin inflammations, fever reduction, asthma, cough, heart and liver disorders, and diarrhea. Modern medicine primarily focuses on *B. serrata* for arthritis, inflammation, pain relief, and liver disorders<sup>[7]</sup>.

### Geographical Source:

*Boswellia serrata* is commonly found in West Asia, South Africa, Southern Arabia, Oman, and many parts of India. In India, it mainly grows in: Rajasthan, Gujarat, Maharashtra, Madhya Pradesh, Orissa, Western Himalayas, Bihar, Other dry hilly regions<sup>[8]</sup>

### Taxonomical Classification<sup>[9,10]</sup>:

- Kingdom : Plantae
- Subkingdom : Tracheobionta
- Superdivision : Spermatophyta
- Division : Magnoliophyta
- Order : Sapindales
- Class : Angiosperm
- Subclass : Eudicots
- Family : Burseraceae
- Genus : *Boswellia*
- Species : *B. Serrata*

### Vernacular Names<sup>[10, 11, 12]</sup>:

- Hindi : Kundar, Salai, Luban
- English : Indian frankincense tree, Indian olibanum tree
- Kanada : Shallaki, Chitta, Gugul, Dhupa, Adimar, Tallaki, Manddi, Chilakdhupa
- Tamil : Parangisambrani



- Telugu : Anduga, Kondagugi, Tamu, Parang, Sambrani, Phirangisambrani
- Sanskrit : Aswamuthri, Kunduru
- Arabic : Luban, Kunduru
- Urdu : Kundur Saambraani
- Persian : Kunduri
- Bengali : Kundur, Salai
- Gujarati : Dhup, Gugali
- Malayalam : Parangi, Saambraani

### Morphological Description:

*B. serrata* is a medium to large-sized, deciduous, balsamiferous tree that grows up to 18 m in height and 2.4 m in diameter (usually 1.5 m). It is typically found in arid forests in peninsular India and from Punjab to West Bengal [13, 14]. The bark of this tree is often papyracious. Imparipinnate, deciduous leaves alternating with opposing sessile, lanceolate or ovate, crenate, serrated, hairy leaflets. The flowers are tiny, white, and arranged in panicles or axillary racemes. The woody disk subtends the trigonous drupes, which divide into three valves. Seeds are pendulous and compressed. Fruits are grown in the winter and flowers in March and April [15]. Throughout the whole flowering and fruiting season, trees are leafless.

Up to 90 bisexual, actinomorphic flowers can be produced by the terminal raceme inflorescence. A flower typically yields 10,044,1259 starch-filled pollen grains. The pollen to ovule ratio is 3348:1, and about 85% of the fresh pollen grains are viable. The type of stigma is moist papillate. Three flattened stylar canals that are filled with a secretory product make up the hollow style. A layer of glandular canal cells surrounds the stylar canals. The internal tangential Cellulose thickenings are visible in the canal cells' walls. Three ovules, one in each locule, are produced by the trilobular ovary. Flowers reward their guests with nectar and pollen [16].

The tree releases salai guggul, an oleo-gum resin, when it is injured. Turpentine and rosin may only be obtained from this non-coniferous source in India. The olibanum tree produces semi-transparent, pinkish-coloured tears that are brittle in cold weather but become luscious in warm weather. It emits a pleasant smell and burns with a steady, clear flame. It is recommended that tapping begin in November and end prior to the monsoon [13,15,21].

### PHYTOCHEMISTRY OF BOSWELLIA SERRATA:

*Boswellia serrata* oleo-gum resin contains three major fractions: resin, gum, and essential oil. The resin portion is rich in pharmacologically active terpenoids, especially pentacyclic triterpenes such as boswellic acids. The major boswellic acids include  $\alpha$ -boswellic acid,  $\beta$ -boswellic acid, keto boswellic acid (KBA), acetyl-keto boswellic acid (AKBA), and their derivatives, which are mainly responsible for the anti-inflammatory activity of the plant. Standardized extracts generally contain 38.5–66% boswellic acids.

The gum fraction contains sugars such as arabinose, rhamnose, glucose, galactose, fructose, and galacturonic acid. The essential oil contains monoterpenes and sesquiterpenes, with limonene,  $\alpha$ -thujene, E- $\beta$ -ocimene, and E-caryophyllene reported as major constituents. Other important phytochemicals include incensole, serratol,  $\alpha$ -amyrin,  $\beta$ -amyrin, and  $\beta$ -sitosterol. These phytoconstituents contribute to the anti-inflammatory, antioxidant, and therapeutic properties of *Boswellia serrata*.

### Medicinal Use:

*Boswellia serrata* gum resin has long been used as an antiseptic, antifungal, antimicrobial, anti-inflammatory, anti-arthritic, anti-obesity, anti-



asthmatic, anticonvulsant, and cardiotoxic. In the past, *Boswellia serrata* has been used to treat a variety of digestive issues as well as bronchitis, asthma, cough, and poor throat. Rheumatoid arthritis, osteoarthritis, gout, joint pain, skeletal muscle discomfort, and back pain have all Traditionally been treated using *Boswellia serrata* [10].

Because *Boswellia serrata* has astringent and diaphoretic qualities, it is used to treat a variety of pulmonary and syphilitic conditions. One of *Boswellia serrata*'s most significant active ingredients, boswellic acid, has been shown to have stomachic, diuretic, expectorant, and stimulant qualities. A well-known medication for hemorrhoids, dysentery, diarrhea, and jaundice is boswellic acid. Ulcers can be treated with the plant's herbal preparation. The plant is used to stimulate menstruation and improve blood flow by irritating the skin [10,19,20].

## PHARMACOLOGY OF BOSWELLIA SERRATA:

### Anti-inflammatory Activity [22, 23]:

*Boswellia serrata* contains boswellic acids, particularly acetyl-11-keto- $\beta$ -boswellic acid (AKBA), it has strong anti-inflammatory and anti-arthritis properties. These substances reduce inflammation by suppressing leukotriene production and inhibiting the activity of the 5-lipoxygenase (5-LOX) enzyme. Boswellic acids shown anti-arthritis effect in formaldehyde and adjuvant-induced arthritis models and reduced paw edema in rats and mice by 25–46%, according to experimental research. At oral doses of 50–200 mg/kg and intraperitoneal doses of 50–100 mg/kg, *Boswellia serrata* extract provided 39.75–73% reduction of inflammation in carrageenan-induced rat paw edema models, which is comparable to phenylbutazone.

Inflammatory diseases such rheumatoid arthritis, osteoarthritis, chronic polyarthritis, and ulcerative colitis have also shown improvement in clinical investigations with little adverse effects.

Additionally, boswellic acids lower inflammatory mediators such nuclear factor-kappa B (NF- $\kappa$ B), nitric oxide, interleukin-1 $\beta$  (IL-1 $\beta$ ), and tumor necrosis factor-alpha (TNF- $\alpha$ ). Additionally, because of its anti-inflammatory and tissue-regenerative qualities, *Boswellia serrata* has demonstrated positive results in wound healing and burn injury recovery.

### Anti-arthritis Activity [22,24]:

Because boswellic acids lower inflammation and joint swelling, *Boswellia serrata* has strong anti-arthritis properties. Oral dosages of 50 mg/kg and 100 mg/kg inhibited paw swelling by 34% and 49%, respectively, in rats with mycobacterium adjuvant-induced polyarthritis. The extract showed 39.75–73% inflammation inhibition in carrageenan-induced paw edema models, which is comparable to the conventional medication phenylbutazone.

A combination of boswellic acids produced 45–67% anti-arthritis activity in formaldehyde-induced arthritis mice, according to studies by Singh et al. Adjuvant arthritis (35–59%) and established arthritis (54–84%) were both well treated by the extract. Furthermore, *Boswellia serrata* was well tolerated even at large dosages in experimental animals, had antipyretic action, and had no ulcerogenic effects. These results validate the conventional application of *Boswellia serrata* for the management of osteoarthritis and rheumatoid arthritis.

### Analgesic Activity [22,25,26,10]:

Gum resin from *Boswellia serrata* has strong sedative and analgesic effects on test animals. Research has demonstrated that the resin causes ptosis in rats and decreases spontaneous motor activity, suggesting a central nervous system depressive effect. The formalin test, hot plate method, tail immersion method, and acetic acid-induced writhing models in rats have all been used to assess *Boswellia serrata*'s analgesic efficacy. These investigations showed both peripheral and central analgesic effects.

Boswellic acids and terpenoid components like  $\alpha$ -pinene, which lower inflammatory mediators like TNF- $\alpha$  and IL-6, are primarily responsible for *Boswellia serrata*'s analgesic effect. Because of these benefits, *Boswellia serrata* has long been used in Ayurveda, Unani, and homeopathy to treat inflammatory conditions, muscle pain, and arthritic pain.

#### **Immunomodulatory Activity** [27, 28, 29]:

*Boswellia serrata* gum resin extract contains boswellic acids, especially acetyl-11-keto- $\beta$ -boswellic acid (AKBA), it has strong immunomodulatory effect. Research employing passive paw anaphylaxis and compound 48/80-induced mast cell degranulation models in rats has shown anti-anaphylactic and mast cell stabilizing properties. In a dose-dependent way, the extract greatly decreased mast cell degranulation and suppressed edema formation, suggesting its ability to regulate inflammatory and allergic reactions.

Boswellic acids have also been shown to influence the formation of antibodies and increase the phagocytic activity of macrophages, hence modulating humoral immune responses. Through the suppression of C3-convertase activity, in vitro research demonstrated the prevention of complement system activation and consequent reduction of inflammatory responses. These

results point to the potential immunomodulatory, anti-allergic, and anti-inflammatory qualities of *Boswellia serrata*.

#### **Anticancer Activity** [30, 31, 32]:

Boswellic acids, particularly acetyl-11-keto- $\beta$ -boswellic acid (AKBA), are primarily responsible for *Boswellia serrata*'s notable anticancer and antitumor action. Research has demonstrated that alcoholic extracts of oleo-gum resin suppress the growth of tumors in Ehrlich ascites carcinoma and S-180 tumor models by interfering with the manufacture of proteins, RNA, and DNA, which in turn inhibits cell proliferation. Additionally, boswellic acids cause apoptosis, DNA fragmentation, and angiogenesis suppression in a variety of cancer cells, such as glioma, leukemia, breast, colorectal, and prostate cancer cells. According to reports, AKBA inhibits inflammatory cytokines such TNF- $\alpha$ , IL-1 $\beta$ , and IL-6, as well as NF- $\kappa$ B signaling and the vascular endothelial growth factor receptor (VEGFR). By increasing apoptosis and slowing tumor growth, boswellic acid nanoparticle formulations have further increased anticancer efficacy.

While solid lipid nanoparticles of boswellic acids demonstrated enhanced anticancer activity in leukemia cell lines, topical treatment of boswellin dramatically decreased tumor development in mice. According to these results, *Boswellia serrata* has great promise as a natural chemoprotective and anticancer drug.

#### **Anti-asthmatic Activity** [22, 33, 34]:

*Boswellia serrata* gum resin can reduce airway inflammation and prevent leukotriene production, it has strong anti-asthmatic properties. Patients with bronchial asthma were given 300 mg of gum resin extract three times a day for six weeks as part of a double-blind, placebo-controlled clinical trial.



Dyspnea, rhonchi, asthma attack frequency, forced expiratory volume (FEV<sub>1</sub>), forced vital capacity (FVC), and peak expiratory flow rate (PEFR) all improved in about 70% of patients. There was also a decrease in the erythrocyte sedimentation rate (ESR) and eosinophil count. Boswellic acids, which prevent 5-lipoxygenase-mediated leukotriene production and consequently reduce bronchial inflammation and mucus secretion, are primarily responsible for *Boswellia serrata*'s anti-asthmatic action. Because of these qualities, *Boswellia serrata* has long been used to treat respiratory conditions such as bronchitis, asthma, cough, and excessive mucus production.

#### **Hypoglycemic (Anti-diabetic) Activity** [33, 35, 36]:

In experiments, *Boswellia serrata* oleo-gum-resin has shown notable hypoglycemic and anti-diabetic effect. In streptozotocin-induced diabetic rat models, herbal formulations including *Boswellia serrata* as an active ingredient reduced blood glucose levels with results similar to those of the common anti-diabetic medication phenformin. Boswellic acids, which may enhance glucose metabolism and lessen oxidative stress and inflammation linked to diabetes mellitus, are primarily responsible for *Boswellia serrata*'s anti-diabetic action. *Boswellia serrata* gum resin's impact on type 2 diabetic patients has also been assessed in clinical trials. Glycosylated hemoglobin (HbA1c), lipid levels, and fasting blood glucose were all reduced when 250 mg of gum resin was administered twice daily for eight weeks; however, some trials found outcomes that were similar to those of a placebo. According to these results, *Boswellia serrata* may be useful in the treatment of diabetes mellitus and other metabolic diseases.

#### **Antimicrobial Activity** [37, 11]:

*Boswellia serrata* exhibits strong antibacterial activity against oral infections, fungus, and both Gram-positive and Gram-negative bacteria. *Staphylococcus aureus*, *Escherichia coli*, *Proteus mirabilis*, and oral bacteria were all inhibited by essential oils and boswellic acids, particularly Acetyl-11-keto- $\beta$ -boswellic acid (AKBA). Additionally, studies revealed concentration-dependent bactericidal effect and antibiofilm activity, indicating its possible application in mouthwash and antimicrobial compositions.

#### **Antifungal Activity** [38, 39]:

*Boswellia serrata* contains bioactive chemicals and essential oils, it has strong antifungal activity. In comparison to aqueous and chloroform extracts, ethanolic extracts had more potent antifungal activities. Fungal species including *Colletotrichum falcatum*, *Candida albicans*, *Malassezia* spp., and *Trichophyton* spp. were shown to be inhibited in studies employing the agar well diffusion method. The resin's essential oils shown effectiveness against *Phytophthora parasitica* and other plant diseases, indicating the resin's function in natural plant defense and possible medical uses.

#### **Hypolipidemic and Hepatoprotective Activity** [40, 41]:

In rats fed an atherogenic diet, *Boswellia serrata* demonstrated considerable hypolipidemic action by raising HDL levels and lowering total cholesterol levels (38–48%). Additionally, the plant demonstrated hepatoprotective properties. In models of experimentally produced liver damage, alcoholic and hexane extracts of *Boswellia serrata* decreased high levels of liver marker enzymes such as SGOT, SGPT, and aminotransferases, suggesting protection against hepatic injury.

#### **Antiviral Activity** [42, 43, 44]:

Because *Boswellia serrata* contains  $\beta$ -boswellic acids and other active ingredients, it has strong antiviral activity. According to studies, by lowering viral replication and inhibiting NF- $\kappa$ B signaling pathways, *Boswellia serrata* extract and boswellic acids successfully reduced Herpes Simplex Virus-1 (HSV-1). At low dosages, almost total suppression of HSV-1 was seen. Additionally, studies showed antiviral properties against the vesicular stomatitis virus and the Chikungunya virus (CHIKV). One of the most effective antiviral substances was found to be acetyl-11-keto- $\beta$ -boswellic acid (AKBA).

#### **Anti-diarrhoeal Activity** [10, 11, 33]:

In both experimental and clinical trials, *Boswellia serrata* demonstrated encouraging anti-diarrheal activity. Without producing constipation, the extract proved successful in treating inflammatory bowel syndrome-related diarrhea. It demonstrated its protective impact on intestinal smooth muscles and gut motility by inhibiting intestinal contractions induced by acetylcholine and barium chloride and reducing gastrointestinal transit in diarrhea induced by castor oil and croton oil in mice.

#### **Antidepressant Activity** [11, 33, 45]:

In experiments, *Boswellia serrata* has demonstrated strong antidepressant effects. The extract showed antidepressant effects in acute stress models by reducing immobility time in forced swim and tail suspension tests at a level of 100 mg/kg. Additionally, *Boswellia serrata* is utilized in herbal tea preparations and aromatherapy. *Boswellia serrata* (Trans-01) showed dose-dependent antidepressant effect and decreased high corticosteroid levels in a polyherbal formulation, indicating its possible use in the treatment of depression.

#### **Anti-ulcer Activity** [10, 11, 22]:

In both conventional and experimental research, *Boswellia serrata* has demonstrated strong anti-ulcer and wound-healing properties. Gum resin has been used to treat burn wounds, cold fissures, and septic ulcers by reducing inflammation and promoting healing in conjunction with swine fat and honey.

*Boswellia serrata* can reduce intestinal inflammation and limit leukotriene formation, it has also shown positive effects in ulcerative colitis. In clinical trials, people with ulcerative colitis responded better to *Boswellia* extract (350 mg three times daily) than to sulfasalazine. Compared to 75% of individuals treated with sulfasalazine, over 82% of patients receiving *Boswellia* experienced remission. In a different trial, 70% of patients with chronic colitis who received *Boswellia serrata* gum resin experienced remission, compared to 40% of those who received sulfasalazine.

#### **Antioxidant Activity** [46, 47]:

*Boswellia serrata*'s oleo-gum resin contains phenolic chemicals, terpenoids, flavonoids, and boswellic acids, it has strong antioxidant action. These phytoconstituents aid in lowering oxidative stress, scavenging free radicals, and shielding cells from oxidative damage. *Boswellia serrata* extracts have been demonstrated in experiments to suppress lipid peroxidation and increase the activity of antioxidant enzymes such glutathione peroxidase, catalase, and superoxide dismutase (SOD). Boswellic acids, particularly acetyl-11-keto- $\beta$ -boswellic acid (AKBA), lower ROS production and inhibit oxidative stress-related inflammatory mediators.

*Boswellia serrata*'s preventive properties against inflammatory disorders, arthritis, diabetes,



cardiovascular illnesses, neurological ailments, and cancer are partly due to its antioxidant activity. *Boswellia serrata* is regarded as a promising natural antioxidant and therapeutic agent in the treatment of disorders linked to oxidative stress because of these characteristics.

## CONCLUSION

In Ayurveda, *Boswellia serrata* is a significant medicinal herb that is frequently used to treat chronic and inflammatory illnesses. The plant's oleo-gum resin is primarily responsible for its medicinal effects since it includes bioactive substances such as boswellic acids, particularly acetyl-11-keto- $\beta$ -boswellic acid (AKBA) and keto- $\beta$ -boswellic acid (KBA). These substances work by blocking the 5-lipoxygenase pathway and inflammatory mediators. *Boswellia serrata* has been shown in both experimental and clinical research to have anti-inflammatory, anti-arthritic, analgesic, antibacterial, antioxidant, anticancer, anti-asthmatic, hypoglycemic, hepatoprotective, and immunomodulatory properties. It has demonstrated encouraging results in the treatment of diabetes, inflammatory bowel disease, asthma, arthritis, and wound healing. *Boswellia serrata* is regarded as a promising natural medicinal agent for contemporary medicine and next pharmaceutical research because of its extensive pharmacological potential and very moderate side effects.

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