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# Phytochemistry and potential therapeutic actions of Boswellic acids: A mini review

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ABSTRACT

The pentacyclic triterpenic acids isolated from the oleo gum resin of various Boswellia species are collectively called as Boswellic acids (BA). The oleo gum resin obtained from Indian variety i.e. *Boswellia serrata* (Family – Burseraceae) is commonly known as Salai guggal. The resin fraction of Salai guggal is rich in Boswellic acids and its essential oil is composed of a mixture of mono, di and sesquiterpenes while gum fraction chiefly contains pentose and hexose sugars. This oleo-gum resin is quite popular among traditional practitioners of traditional Chinese and Indian Systems of medicine owing to their wide range of useful biological properties such as anti-inflammatory, anti-arthritic, anti-rheumatic, anti-diarrheal, anti-hyperlipidemic, anti-asthmatic, anti-cancer, anti-microbial anti-fungal, anti-complementary and analgesic activity, etc. It has been used as a herbal medicine since the prehistoric time to cure acute and chronic ailments including inflammatory diseases. Phytochemical investigation of this herbal medicine lead to identification of Boswellic acids which are found to be novel, potent, specific anti-inflammatory agents due to non-redox inhibition of 5-lipoxygenase (5-LO) enzyme. However, the other important targets of Boswellic acids also include topoisomerases, angiogenesis, and cytochrome p450 enzymes. This review is a sincere attempt to discuss and present the current status of therapeutic potential, phytochemical as well as pharmacological profile of Boswellic acids primarily obtained from *B. serrata*.

## 1. Introduction

The herbal extracts prepared from various species of Boswellia (family Burseraaceae) tree have been used for couple of centuries in traditional medicine worldwide for the treatment of several diseases [1]. Boswellia genus comprises of nearly 25 distinct species and some of the important species of this genus include *Boswellia serrata*, *Boswellia sacra*, *Boswellia carterii*, *Boswellia papyrifera*, *Boswellia neglecta*, *Boswellia rivae*, *Boswellia frereana*, and *Boswellia ovalifoliolata*, etc [2–5]. The tree is commonly grown in gulf countries viz. Oman, Yemen and Southern Saudi Arabia, in East Africa (Somalia and Ethiopia), South Asia and abundantly grows in dry hilly tracts of India [6–9]. The Indian states where it is grown widely include Rajasthan, Gujarat, Maharashtra, Madhya Pradesh, Bihar, Orissa and some parts of Western Himalayas [10]. The dried exudate from the bark of *B. serrata* tree is an oleo-gum-resin which is commonly known as Indian Frankincense, Indian olibanum, Incense or Salai guggal. The dried gum appears in form of lumps or tears which are white-yellow in color. The word frankincense meaning "pure incense" is derived from the ancient French name [11]. In Arabic language, frankincense is also known as "al-luban," which means "white" or "cream and is a basis for its other name, olibanum [10,12–15]. It is known by the name of Ru Xiang in Chinese [16]. In Ayurveda, an Indian traditional system of medicine, the gum is used to treat a number of inflammatory diseases affecting skin, eye, gums, gastrointestinal tract (GIT) in addition to the respiratory inflammatory disorders such as asthma, bronchitis, laryngitis etc [15].

Salai guggal or oleo gum resin is a mixture of essential oil, gum and resin. The essential oil is chiefly a mixture of monoterpenes, diterpenes and sesquiterpenes. Its essential oil also contains

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phenolic compounds and a diterpene alcohol (serratol). Gum portion contains pentose and hexose sugars with some oxidizing and digestive enzymes. Though, the biologically active phyto-constituent boswellic acid is found in resin of almost all species of Boswellia which is chemically a pentacyclic triterpene acid [10,16].

A number of review and research articles focusing on pharmacological studies have highlighted the usefulness of boswellic acids in the management of several chronic inflammatory diseases including chronic ulcerative colitis, rheumatoid arthritis, crohn's disease, and bronchial asthma; in addition to its anti-depressive and anti-anxiety effects and beneficial effects in brain tumor patients [17]. The two most potent anti-inflammatory boswellic acids of Boswellia are acetyl-11-keto-beta-boswellic acid (AKBA) and 11-keto-beta-boswellic acid (KBA) [18]. In this review, we have summarized the chemistry, pharmacokinetic, clinical outcomes and therapeutic uses of boswellic acids (BA).

## 2. Pharmacognostical characteristics of Indian Boswellia

*B. serrata* belonging to the family Burseraaceae is a deciduous tree which usually grows up to a moderate height (4–5 m). Like any other medium to large size branching tree, it has a circumference of 2.4 m (av 1.5 m). The thin bark changes its color from greenish gray, yellow or reddish to ash color which can be easily peeled off. The papery barks upon peeling or incision exudates translucent lumps, tears or droplets of white to yellow color gummy oleoresin [19]. The gum is aromatic with balsamic odor and bitter in taste.

Leaves: Odd pinnate, Length: 30–45 cm long, ex-stipulate, variable in shape, Crowded at the end of the branches.

Leaflets: 8–15 in number, 2.5–6.3 × 1.2–3.0 cm, ovate or ovate-lanceolate, rounded base, nearly sessile with short toothed, mostly pubescent.

Flowers: Bisexual, small, white in axillary racemes or panicles at the tip of the branches.

Calyx: 5–6 lobed and small copular.

Petals: 0.5–0.8 cm oblong-ovate with basal disk, white pink color.

Fruits: Cotyledous, trifed, 1.25 cm long, trigonous, obovoid type.

Seeds: Heart-shaped and attached to the inner angle of the fruit, compressed, pendulous.

## 3. Phytochemistry

The different species of Boswellia have about 200 phyto-chemicals in oleo-gum-resin mixture. These compounds include essential oil, pure resin and mucus. The content and composition of oleo gum resin may vary from species to species depending upon age, quality of resin, geographical conditions. The resins of Boswellia species chiefly contain higher terpenoids i.e. pentacyclic triterpenes and tetracyclic triterpenes but the former are mainly considered to be responsible for its pharmacological effects [20,21]. Chemically BA is 3-hydroxyurs-12-ene-23-oic acid. The BAs are common chemical characteristic feature of all species of genus Boswellia. The six major BAs are; α and β-Boswellic Acids (BA, 10–21%), Acetylated α and β-Boswellic Acids (ABA, 0.05–6%), 11-keto-β-Boswellic acid (KBA, 2.5–7.5%) and 3-O-acetyl-11-keto-β-Boswellic acid (AKBA, 0.1–3%) are present in all Boswellia species but in varying quantities (Table 1) [10]. The content of Boswellic acids in commercially available standardized extracts vary from 37.5 to 65% [22]. AKBA ($\lambda_{max}$ 250 nm) is white crystalline powder, soluble in chloroform, methanol and almost insoluble in water.

Among all the BAs of Boswellia, the two most active, potent and promising anti-inflammatory agents are AKBA and KBA. Some other BAs isolated from Boswellia are 9,11-dehydro-α-Boswellic acid and its isomer (9,11-dehydro-β-Boswellic acid) and their respective acetylated forms (Acetyl-9,11-dehydro-α-Boswellic and Acetyl-9,11-dehydro-β-Boswellic acids). The other chemical contents found in Boswellia are Lupeolic acid and Acetyl-Lupeolic Acid, Incensole acetate, Incensole oxide and Isoincensole oxide. Some authors have also reported the occurrence of a pentacyclic triterpenediol mixture of 3α,24-dihydroxyurs-12-ene and 3α,24-dihydroxyolean-12-ene, Serratol, α-Thujene, Tirucall-8,24-dien-21-oic acids, oilbanumols D-G, α-pinene and octyl acetate in the crude extract [23–29]. The presence or absence of 11-keto group in BA affects its potency [30]. Conversion of 11 keto group to 11 methylene group leads to reduction in 5-LO activity, however reduced form became more efficient toward induction of apoptosis and inhibition of topoisomerases [31]. Removal of Acetyl group or reduction of 11 keto group to alcohol in AKBA produces slight decrease in activity of 5-LO inhibition suggesting that backbone of pentacyclic triterpene along with 11 keto group is required for binding to the receptor site to exert anti-inflammatory activity [32].

The essential oil of Salai guggal mainly contains monoterpenoids (pinene, cis-verbenol, trans-pinocarveol, borneol, myrcene, phallendrene, cadinene, verbenone, limonene, thuja-2,4(10)-diene and p-cymene) and small amount of diterpenes. α-pinene (73.3%) is the major chemical constituent of monoterpenoids [33].

## 4. Pharmacokinetics properties of Boswellic acids

As the KBA and AKBA are highly lipophilic drugs, they have relatively poor absorption through GIT but high retention [34,35]. The elimination half-life of 11-Keto β-Boswellic acid (KBA), is reported to be approximately 6 h. This implies that boswellic acids should be taken every 6 h p.o. to achieve maximum plasma levels [36]. Further, it has been reported that BAs should be taken along with fatty meal as it significantly increases their plasma concentration [37].

Some studies have proved that administration of Boswellia extract in a lecithin delivery form markedly enhance the serum levels and subsequent tissue deposition of BAs [38]. The study noted that the use of phospholipid-based delivery system enhanced the absorption while reduces variability [39]. Sharma

**Table 1**
Properties of different boswellic acids (BAs).

| Name | M.Wt | Melting Point (°C) | Specific Rotation [α] D |
|---|---|---|---|
| α and β-Boswellic Acids (BA) | 456.71 | 226–274 | +138° |
| Acetylated α and β-Boswellic Acids (ABA) | 498.75 | 252–255 | +138° |
| 11-keto-β-Boswellic acid (KBA) | 470.70 | 195–197 | +78.5° |
| 3-O-acetyl-11-keto-β-Boswellic acid (AKBA) | 512.73 | 771–274 | +88.5° |

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