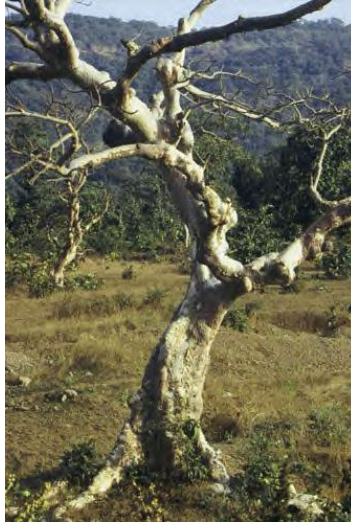


*Boswellia* spp.  
Frankincense  
Plant Monograph



*Boswellia serrata*



*Boswellia sacra* Flueck.  
Image processed by Thomas Schoepke  
[www.plant-pictures.de](http://www.plant-pictures.de)



*Boswellia sacra*



*Boswellia carterii*

Shelowann Dawson  
Herbal Medicine, Class of September, 2003  
April 2006

## NOMENCLATURE

### **Botanical Nomenclature**

*Boswellia* spp.

### **Botanical Family**

Burseraceae

### **Common names**

Latin: *B. serrata*, *B. carterii*

Sanskrit: shallaki, gajabhakshya

Arabic: zarw

Bengali: luban

Chinese: ru xiang (*B. carterii*), Fan Hun Hsiang

English: frankincense, Indian olibaum

French: baswellie-den telee, arbre à encens

German: salaibaum

Hindi: luban, salai guggul (*B. serrata*), sallaki guggul

Nepalese: gobahr shalla

Persian: husn-e-lubban

Sinhalese: kundirikkam

Tamil: kunthreekan

Uhani: luban (Kapoor, 2001, Jayaweera, 1981, Sharma, 2004, and Tillotson, 2001)

## DEFINITION

The oleo-gum-resin and the bark are used. Oleo-gum-resin is a term used to describe *ole* (looks fat or oily in nature), *gum* (parts are soluble in water), and *resin* (whole or partly soluble in alcohol). (Felter & Lloyd, 1898)

*Please note: Many primary sources have not agreed on what species of boswellia are the standard names. Herbs of Commerce recognizes B. sacra Flueck. and B. serrata Roxb., while the USDA recognizes 4 species of Boswellia:*

*B. frereana Birdw. (elemi frankincense)*

*B. papyrifera (Del. Ex Caill.) Hochst.-elephant tree*

*B. serrata (Roxb. Ex Colebr.)- Indian frankincense*

*B. sacra Flueck.- frankincense*

The word frankincense derived from the Old French word *frank-encens* and it means the true, authentic, pure, or “free lighting” incense. The word olibanum derived from the Arabic *al-luban* and it means the milk or authentic incense (SEPASAL database).

## IDENTIFICATION

### **Habitat**

Valleys, cliffs, hillsides/slopes, gullies, crevices/fissures/fractures, woodlands, and shrub lands. *Boswellia spp.* prefers alkaline soil (SEPASAL Database, Menninger, 1995 and Miller, 1988).

### **Botanical Description**

When the bark is cut it yields a translucent and brittle oleo-gum-resin that looks like irregular droplets/or tear-shaped lumps or globs. These lumps or globs are a dusty, whitish-yellow color. (Felter & Lloyd, 1898 and Evans, 1996)



*Boswellia spp.* is papery and peeling. It is a moderate-large branching tree that has odd-pinnate leaves, variable in shape, with leaflets serrate and a rounded base. The flowers are small in racemes, 10-stemmed, with long, ovate, white-pink colored petals from September-November. Following the flowers are 3 celled, drupe-like capsules or obovoid type fruits. *Boswellia spp.* grows to a height of 4-5 m and has a circumference of 1-1.5 m. (Miller, 1988, Jayaweera, 1981, and Felter & Lloyd, 1898)

There may even be more than one trunk base growing from the tree. They have added cushion or support by possessing a wider than usual trunk or disk-like base. This allows them to cling to the side of boulders and steep embankments where they grow. The wide trunk is important in stabilizing the tree. Occasionally, *Boswellia spp.* may grow in gravel or plant specimens. (SEPASAL Database)

Edwin A. Menninger, author of the book entitled: *Fantastic Trees* divides odiferous trees such as *Boswellia spp.* into two categories: the stinkers and the bouquets. Within the book on pages 161 and 162 is what he says about *Boswellia spp.*:

*“The frankincense tree looks like a decomposing animal. It has stiff, low branches. The leaves are scant, curly, and indented. A thick bark and a tiny whitish peel cling closely round the trunk of a peculiarly blotchy color. The woody fiber of the tree, distended with sap, look like rotting animal flesh, and the clear, yellowing-white resin comes from incisions with a strong aroma. The fruit is*

*a berry size of a marble and the flowers are few, red and germanium-like on the end of short spikes."*

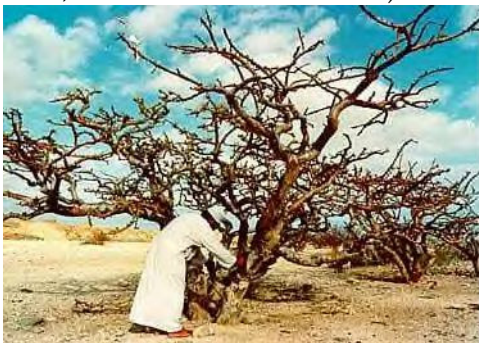
## COMMERICAL SOURCES & HANDLING

*Boswellia spp.* come from India, East Africa (Ethiopia and Somalia), and the Southern Middle East (Yemen and Oman). More specifically, *B. sacra* comes from Southern Saudi Arabia, Yemen and Oman. *B. carterii* Birdwood and *B. frereana* Birdwood are from Somalia. *B. serrata* Roxburgh (syn. *B. glabra* Roxbury.) is from Western India (Rajasthan). *B. serrata* is listed in the USDA Database/Plants Profile as Indian frankincense, which was not considered true frankincense by traditional standards. It produces a soft, odorous resin that hardens in a year. As a result, it is used as incense solely by the natives. *B. papyrifera* Richard comes from Western Ethiopia. (Miller, 1988, Menninger, 1995 and Felter & Lloyd, 1898)

### **Harvesting**

To access the resin, a deep and deliberate vertical incision (tapping) into the bark of the tree is made with a regular axe or a specifically made tool called a mengaff. Afterwards, a narrow strip of bark, 4-5 inches in length is peeled away, resulting in the exudation of oleo-gum-resin or milky white liquid. This substance hardens upon exposure to air. (Miller, 1988, Felter & Lloyd, 1898 and SEPASAL Database)

In Somalia, two periods of tapping occurs where each lasts 3-4 months with tapplings taking place every 15 days. The tapping depends on the beginning and length of the rains. Thereafter, the resin is stored for 12 weeks to get hard. Then it is sorted and graded according to size and color by the local merchant, bought by large companies, and sent to home countries to be processed. The resin that collects, or falls, at the bottom of the tree is collected, separated and considered inferior. This is the *Boswellia spp.* used in churches and rituals. (Holmes, 1998, Miller, 1988, Felter & Lloyd, 1898, Menninger, 1995, and SEPASAL database)





### **Oil Processing**

The majority of the resin is processed into oil by distillation or solvent extraction in Europe, the U.S. and India. The solvent extraction process may produce a resinoid or viscous substance. Thereafter, resinoids may be dissolved in odorless, high grade alcohols, which can be used in perfume manufacturing. (Holmes, 1999 and Mikhaeil, et al., 2003)

One kilogram of the oil is acquired from 10 kg. of the resin. Steam distilled oil is the preferred type of *Boswellia* extract used in aromatherapy. Solvent extraction is also utilized for the perfume industry to produce a resinoid absolute. Two kg of the resin yields 1 kg. of resinoid absolute. Since this is a much higher yield, alcohol dissolved resinoids are sometimes sold as distilled oils in trade (Groom, 1981, Holmes, 1999 and Miller, 1988).

### **TASTE/ODOR/ENGERGETICS**

#### **Taste**

Sub-acrid, terebinthinate (having the qualities of turpentine; terbinthine), bitter, pungent, sweet (Felter & Lloyd, 1898, Evans, 1996 and Dabur Research Foundation & Dabur Ayurved Limited, 2002).

#### **Odor**

*Boswellia spp.* possesses a pleasant, sweet and deep balsamic, fresh resinous aroma. It is camphoraceous with fruity and citrus notes of lemon and green apple, and spice notes (Felter & Lloyd, 1898, Holmes, 1999).

#### **Energetics**

**“Rasa (taste):** Astringent, bitter, sweet

**Guna (quality):** Light and dry

**Veerya (strength or effect):** Hot

**Vipaka (post digestive effect):** Pungent

**Dosha:** Balances *kapha* and *pitta*” (Dabur Research Foundation & Dabur Ayurved Limited, 2002)

### **SUMMARY OF PHYSIOLOGICAL ACTIONS**

***Actions Supported by Clinical Trials***

anti-inflammatory  
 anti-antiarthritic  
 analgesic  
 anti-tumor  
 antiasthmatic  
 aromatic

***Actions Supported by Animal and In-Vitro Research***

antinflammatory  
 analgesic/antihyperalgesic  
 immunomodulator  
 anticarcinogenic  
 antihyperlipidemic  
 antifungal  
 antipyretic  
 aromatic

***Historical or Theoretical Actions That Lack Appropriate Evidence***

anticatarrhal/mucolytic, expectorant  
 uterine stimulant/emmenagogue  
 diuretic  
 anti-depressant  
 demulcent  
 aperient  
 alterative  
 amenorrhea  
 syphilis/STDs  
 uterine infections  
 anticancer

**KEY CONSTITUENTS**

Volatile oils: 4-8%  
 Acid resin: 56-65%  
 Gum: 20-36%

The volatile oils contain alpha thujene and p-cymene. The resin (guggals) contains a mixture of terpenoids made up of four pentacyclic triterpene acids:  $\beta$ -boswellic acid (the most abundant), 3-O-acetyl  $\beta$  (ABA), 11-keto- $\beta$ -boswellic acid, and 3-O-acetyl-11-keto- $\beta$ -boswellic acid (AKBA). The triterpenoids are the active constituents and are collectively called boswellic acids. The gum resin of *B. serrata* usually contains 43% boswellic acids. Standardized extracts from commercial sources usually contain 37.5-65% boswellic acids. (DerMarderosian, 2002, Holmes, 1998 and Schauss, 2000)

The gum contains arabinose, galactose, xylose, galacturonic acid and digitoxose. The main constituents extracted from the leaves are: D-fructose, D-lactose, D-glucose, L-sorbose, raffinose, raminose, and D-galactose. (DerMarderosian, 2002, Holmes, 1998 and Schauss, 2000)

## **PHARMACOLOGY**

### **Pharmacokinetics**

No acceptable data was found.

### **Pharmacodynamics**

#### ***Immunomodulatory Activity***

A study to determine the chemistry and immunomodulatory activity of frankincense oil (*B. carterii*) showed contraction of the phrenic-nerve diaphragm muscle and inhibition of the twitch response to nerve stimulation. It also showed a spasmogenic effect on smooth muscle *in vitro*. These effects may be due to the action on the sarcoplasmic reticulum to increase intracellular calcium and post-junctional block of neuromuscular transmission. (Mikhaeil, et al., 2003)

During a lymphocyte proliferation (mitogenesis) assay, the oil of *B. carterii* in dimethyl sulfoxide (DMSO) induced a mitogenic response (90% lymphocyte proliferation) that Mikhaeil and colleagues are comparing to *Echinacea purpurea* aqueous extract (85%) and levamisole(85%). (Mikhaeil, et al., 2003)

Animal studies done in India and the United States suggest that ingesting defatted alcoholic extract of *B. serrata* decreases polymorphonuclear leukocyte infiltration and migration, decreases primary antibody synthesis and causes almost total inhibition of the classical complement and alternate pathway system. (Kimmatkr, et al., 2003 and Monograph, *Alternative Medicine Review*, 2001)

#### ***Anti-inflammatory Activity/ Rheumatoid Arthritis***

Boswellic acids (BAs) effect the production of antibodies and cell mediated immunity (Safayhi, et al., 1996). *B. serrata* is rich in BAs (Kimmatkar, et al., 2003). Keto-boswellic acids (AKBA, acetyl-11-keto- $\beta$ -boswellic acid, and KBA, 11-keto- $\beta$ -boswellic acid) are orally active, direct, and nonredox and non-competitive blockers of 5-lipoxygenase, which is the key enzyme of leukotriene biosynthesis (Gupta, et al., 1998 and Safayhi, et al., 1996). These BAs decrease the pro-inflammatory 5-lipoxygenase products including 5-hydroxyeicosatetraenoic acid (5-HETE) and leokotriene B4 (LTB-4) levels. This increases permeability, therefore a lesser amount of WBCs are needed at the site of inflammation and trauma. As a result, the inflammatory response is dampened, thus allowing for quicker healing. (Kimmatkar, et al., 2003)

Further, non-steroidal anti-inflammatory drugs (NSAIDS) can cause disturbance of glycosaminoglycan synthesis and this may speed up articular damage in arthritic

conditions. It is claimed that *B. serrata* extract may decrease the glycosaminoglycan degradation (Kimmatkar, et al., 2003).

The BAs of the gum resin of *B. serrata* have a chemical structure that is similar to other pentacyclic triterpenes, hence their resemblance to anti-inflammatory drugs. AKBA and ABA have been shown to have apoptotic effects on malignant glioma cells, cancer cells, human melanoma, neurodermal tumors, and leukemia cells (Altmann, et al., 2000. Xiq, et al., 2005, Syrovets, et al., 2000 and Huang, et al., 2000).

A randomized, blind study done by Fan and colleagues included testing the effects of *B. carterii* Birdw. gum resin on persistent hyperalgesia and edema in rats with peripheral inflammatory pain. They found that *B. carterii* manifested significant hyperalgesia and anti-inflammatory effects. They also assert that the antihyperalgesia could manifest by suppressed inflammation induced Fos protein in the spinal horn neurons of these rats. (Fan, et al., 2005). Also important to note is *B. serrata* being shown to inhibit TNF $\alpha$  in human microvascular endothelial cells (Roy, et al., 2005).

It was shown that mice that were given 12-O-tetradecanoylphorbol-13-acetate (TPA) to induce an increase in inflammation, epidermal proliferation, epidermal cell layers, and tumors had an inhibitory effect after being administered boswellin (methanol extract of the gum resin of *B. serrata*). After 7, 12-dimethylbenz[a]anthracene (DMBA) was used to induce tumors in these mice and it was found that the skin tumors decreased by 59-92% (with 1.2-3.6 mg of the extract being applied topically, twice weekly for 16 weeks). The researchers are saying boswellic acid and its derivatives may be cancer chemopreventive and anti-hyperlipidemic agents. (Huang, et al., 2000).

#### ***Anti-tumor, Anti-cancer/Apoptosis Activity***

When conventional chemotherapy is given for acute myelocytic leukemia (AML) with cytarabine or daunorubicin administered as single agents, remission is usually provoked. When both substances are used, total remission is seen in 50% of individuals, while 30-40% of individuals go into remission on a single substance. Long term survival that is disease free is only seen in 25-50% of individuals that reach total remission. Most individuals with AML die, hence the researchers desire to study the mechanism of the cytotoxic effect of boswellic acid acetate (BC-4). (Xia, et al., 2005)

The boswellic acid and their acetates of *Boswellia serrata* and *Boswellia carterii* Birdw. were separated from their gummy exudates (a 1:1 mixture of  $\alpha$ - and  $\beta$ -boswellic acid acetate). This study was done on six myeloid leukemia cell lines. DNA and morphological fragmentation assays showed that the cytotoxic effect of BC-4 was moderated by the induction of apoptosis. Over 50% of the cells went through apoptosis after treatment with 20  $\mu$ g/ml of boswellic acid for 24 hours. The data suggests that BC-4 causes myeloid leukemia cell apoptosis by increasing levels of death receptors, thereby activating capsase-8. (Xia, et al., 2005)

Another study done also purified BC-4 from *Boswellia carterii* Birdw. The researchers compared the growth inhibition and differentiation induction of BC-4 in myelocytic

leukemia and erythroleukemic cell lines. The study shows BC-4 induced monocyte differentiation of myeloid leukemic cells at a dose under 12.5 µg/ml. (Jing, et al., 1999)

Jing and colleagues show that BC-4 was a strong inducer, with 90% of the cells showing morphological changes and 80-90% of the cells showing nitroblue tetrazolium (NBT) reduction. BC-4 also increased non-specific and specific esterase (an enzyme that accelerates the hydrolysis or synthesis of esters). BC-4 inhibited growth of all cell lines tested and the growth inhibition effect was dose and time dependent. In HL-60 cells, 20 µg/ml of BC-4 lowered viable cell numbers by 60% at 24 hours. At 3 days there were no viable cells. (Jing, et al., 1999)

Again, DNA and morphological fragmentation proved that BC-4 induced cell apoptosis. BC-4 specifically induced myelocytic leukemia cell differentiation at low concentration, and inhibited the growth of all leukemia cell lines tested at high concentration. (Jing, et al., 1999) Jin, Xia, and their colleagues agree that BC-4 is a potent ally in the fight against leukemia.

As stated, boswellic acids have been shown to inhibit leukotriene synthesis via 5-lipoxygenase (Hostanska, et al., 2002 and Huang, et al., 2000). Hostanska and colleagues tested the ethanolic extract of *B. serrata* gum resin containing boswellic acids (3.68% AKBA, 3.29% KBA, and 5.39 % acetyl BA), for their cytotoxic, cytostatic, and apoptotic activity on five leukemia and two brain tumor cell lines by WST-1 assay and flow cytometry.

It was found that the *B. serrata* extract induced dose-dependent anti-proliferative effects on all of the human malignant cells tested. Morphological changes after 24-27 hours, as well as the detection of apoptotic cells confirmed that apoptotic cell death. (Hostanska, et al., 2002).

### ***Inhibitor of Human Topoisomerases I and II a***

Topoisomerases are key enzymes that modify and control the arrangement and topological state of DNA (Syrovets, et al., 2000). These key enzymes act by sequential breakage and reunion of either one DNA strand (topoisomerase I) or both DNA strands (topoisomerases II).

Replication, recombinant repair, and transcription is allowed to take place by topoisomerase mediated strand passing, which lead to the lowering of DNA twists and supercoiling relief. Rapidly proliferating and transformed cells have a greater level of topoisomerases, hence pharmacological inhibition of these enzymes have gotten special appeal after the realization that they are the aim of different anti-tumor and antimicrobial drugs. (Syrovets, et al., 2000)

The researchers' goal in this study was to investigate the mechanism of action of acetyl-BA and show that these compounds are very strong inhibitors of human topoisomerases

(Syrovets, et al., 2000). It was found that the inhibitory effect of acetyl-BA on topoisomerase I and II  $\alpha$  can be compared to camptothecin and amsacrine or etoposide.

Further, their research found that acetyl-BA neither stimulates the organization of DNA-strand breaks in the presence of topoisomerases nor insert into DNA. Their findings show that acetyl-BA impairs the activity of topoisomerases I and II  $\alpha$  through specific interaction with these enzymes and very much suggest that these compounds compete with DNA for binding to topoisomerase. Therefore, Syrovets and colleagues identified acetyl-BA as a unique dual catalytic inhibitor of human topoisomerases.

## HISTORY/TRADITIONAL USE

*“And when they had come into the house, they saw the young Child with Mary, His mother, and fell down and worshiped Him. And when they had opened their treasures, they presented gifts to Him: gold, frankincense, and myrrh.” –Matthew 2:11(2) page 150.*

*“And the Lord said to Moses: “Take sweet spices, stacte and onycha and galbannum, and pure frankincense with these sweet spices, there shall be equal amounts of each. You shall make of these an incense, a compound according to the art of the perfumer, salted, pure, and holy.”  
–Exodus 30:34-38, page 1671.*

In Sanskrit, gajabhakshya suggests that *Boswellia spp.* has been ingested by elephants in Ayurvedic medicine since antiquity. Interest in this plant was aroused due to elephants being capable of carrying their weight over a long period of time, yet still outliving humans. Therefore, the elephants were studied to find out what was in their diet, and *Boswellia spp.* was found to be one ingredient. (Sharma, 2004).

*Boswellia spp.* was a part of the resin trade and was imported from Sudan, the coast of Somalia, and regions south of Egypt. This resin trade also went through Palestine in the middle of the 2<sup>nd</sup> millennium B.C.E. From the Southern Arabian coast, *Boswellia spp.* came on the great frankincense route through the Arabian Peninsula to Syria.

Large amounts of it were needed in Egypt for the daily cult temples and in the funerary rituals. Internally, it served in the treatment of the abdomen, as a purgative, as a stimulus to take food, liver and bladder ailments, for coughs, poisons, worms, and skin diseases, pain in the arms, and sores. It was known as a skin irritant, which caused better flow of blood, hence its use to stimulate menstruation.

Externally, it served in the treatment of stiffness, vessels, joints, wounds of different kinds, inflammatory conditions, pain in the legs, demons, pus, stomach problems, pressure in the ear, and to stimulate birth. The oil was used as an ingredient in embalming liquids for mummification.

*Boswellia spp.* was also used to treat various diseases of the eyes, toothaches, tongue problems, prevention of infection of the birth canal, and it was chewed. The smoke was considered helpful for women’s problems, and to eliminate odor in the house, clothing,

or body. It was known as a disinfectant in general. Mixed with pomegranate juice it found use as an astringent.

Aside from pharmaceutical applications, it had a strong placebo effect. The patient believed if it was being offered to the Gods, then it would surely help her/or him. Traditionally, the various species were not differentiated medicinally.

*Boswellia spp.* was burned before the statues of the Gods and the ancient Egyptians burned it at sunrise to honor the sun God, Ra. Burning frankincense was said to enhance spirituality, mental perception, prayer, and consciousness. Burning it is said to produce a psychoactive substance-trans-hydrocannabinol.

Chinese Herbalists used frankincense for moving qi/blood, rheumatism, menstrual pain, and as an external wash for sores and bruises.

(Jacob, 1993, Manniche 1989, Basch, et al., 2004, Schauss, 1999, Jayaweera, 1981, Kapoor, 2001 and Duke, 2006 )

## **TRADITIONAL AYURVEDIC USE**

Asthma, rheumatism, chronic ulcers, diseased bones, dysentery, skin ailments, blood purification, bronchial conditions, would treatment, nervous diseases, cervical tuberculosis, lymphadenitis, urinary tract disorders, amenorrhea, dysmenorrhea, sore nipples, ringworm, jaundice, diarrhea, dyspepsia, and hemorrhoids. It was also used to perfume clothes, hair, rooms, and at traditional festivities or religious celebrations. (Dabur Research Foundation & Dabur Ayurved Limited, 2002 and DerMarderosian, 2002)

## **CLINICAL TRIALS**

### ***Anti-tumor, Anti-cancer/Apoptosis Activity***

There are studies that assert boswellic acids as being anti-tumor and anti-carcinogenic (Park, et al., 2002, Huang, et al., 2000, Jing, et al., 1999, USPTO Patent Full-Text and Image Database, 2001, Hostanska, et al., 2002, Syrovets, et al., 2000, and Xia, et al., 2005). A document found on the USPTO Patent Full-Text and Image Database found that an ethanolic extract from the gum resin of *B. serrata* was efficient in reducing a peritumoral brain edema 22-48% in one individual. The treatment was given over seven days and thereafter; the treated tissue of the tumor did not show a tendency of proliferation after two weeks. (Simmet & Ammon, 2001) The researchers used a product by the name of H 15, which was a standardized extract of *B. serrata*.

### ***Asthma***

*Boswellia spp.* may be able to be used as a potential chronic therapy based on its known properties as an inhibitor of leukotriene biosynthesis. Gupta and colleagues performed another trial that was a 6 week, double-blind, placebo controlled study with 80

individuals. They were given either 300 mg powdered *B. serrata* or 300 mg of lactose as a placebo, orally, three times daily.

Mean improvements were seen in both groups but improvements in the *Boswellia* group were greater. The median improvement in forced expiratory volume in 1 second (FEV1) was 25% in the *Boswellia* group vs. 5% in the placebo group. The mean forced vital capacity (FVC) improved by 21% in the *Boswellia* group vs. 9% in the placebo group. There was an obvious reduction of dyspnea, eosinophilia, and an absence of rhonchi after treatment in the *Boswellia* group. The number of asthma exacerbations reduced also.

(Gupta, et al., 1998 and Gupta et al., 2001).

## Inflammation

### *Chronic Colitis*

Gupta and colleagues conducted a study on the effects of the gum resin of *B. serrata* in individuals with chronic colitis in 1997 and 2001. Each study was a non-randomized. In the recent study, individuals between the ages of 18-48 were treated for six weeks with either *B. serrat*, 900 mg daily in three divided doses or sulfasalazine, 3 g daily in three divided doses. It was found that 18 of the 20 *Boswellia* individuals entered remission while 6 of 10 in the sulfasalazine group did not. Histological improvement of biopsies was noted in 75% of *Boswellia* individuals vs. 40% of sulfasalazine individuals. (Gupta, et al., 1998 & Gupta, et al., 2001).

In the earlier study, Gupta and colleagues gave encapsulated powdered *B. serrata* gum resin, 350 mg three times a day or sulfasalazine; 1 g three times daily for six weeks to 42 individuals with ulcerative colitis. Interestingly enough, individuals were allowed to choose their therapy.

Outcomes measured included improvement in symptoms of abdominal pain, diarrhea (90% of *Boswellia* subjects and the entire sulfasalazine group), sigmoidoscopic examination, rectal biopsy, histopathology (both groups 75%), stool characteristics, and serum values. It was reported that 82.4% of *Boswellia* individuals and 75% of sulfasalazine subjects went into remission.

A randomized, double-blind placebo controlled crossover study was performed to test *B. serrat's* anti-inflammatory potential (Kimmatkar, et al., 2003). The study included 30 individuals, male and female; 45-72 years of age, with a mean age of 59. These individuals had clinicoradiological osteoarthritis of the knee and were taking NSAIDS and receiving physiotherapy.

There were two groups of 15 individuals that got *B. serrata* extract (BSE) of Salki Guggul (Cap Wokvel™, which is manufactured by Pharmanza India) that had 333 mg of BSE(65% organic acids or minimum 40% BAs) in each capsule, or a placebo that had starch powder. Kimmatkar and colleagues did two interventions (four weeks each)

where those receiving BSE for the first intervention were crossed over to receive the placebo for the second intervention, and vice-versa. A washout period of 21 days was given before the two groups crossed over. (Kimmatkar, et al., 2003)

The researchers reported statistically and clinically significant improvement in the BSE group compared to the placebo group as it relates to flexion, knee pain, being more capable of climbing stairs, kneeling, bending, squatting and sitting crossed legged. In general, the knee range of motion was better, there was a decrease in swelling in the knee joint though radiologically there was no change. (Kimmatkar, et al., 2003) Kimmatkar and colleagues assert that BSE may help in the treatment of RA, JRA, degenerative diseases of the spine, spondylosis and other arthritis of the joints.

### ***Rheumatoid Arthritis***

Two studies (Kulkarni, et al., 1992 and Chopra, et al., 2000) did clinical trials to test *Boswellia's* anti-inflammatory properties, although they tested combination products that included *Withania somnifera*, *Zingiber officinale* and *Curcuma longa*. For this reason, it is difficult to uncover further, the isolated effects of *Boswellia* on RA.

## **PREPARATION & DOSAGE**

*Boswellia spp.* is taken as a capsule/or tablet, decoction of the bark, or the oil is used. Most of the research had people taking oral capsules/or tablets. The recommended dosage is based on historical practice or available trials. Presently, it is not clear what the optimal dose is to balance safety and efficacy. The manufacturing of *Boswellia spp.* products varies from one produce to the next and this makes it even more difficult for standardization to happen. It is important to note that most of the trials I found used various products made by various manufacturers, so clinical effects may not be comparable. (Basch, et al., 2004, Dabur Research Foundation & Dabur Ayurved Limited, 2002).

In aromatherapy, the preferred type of *Boswellia* is the steam distilled oil that is also prepared to put in topical aids (Holmes, 1999, SEPASAL Database, Cuesta, et al., 2004).

Gum resin: 2-3 g

Dried powder: 2-3 g, 2-3 times a day; 250-400 mg, 2-3 times a day; 200-400 mg standardized

to 37.5% BAs per dose

Powdered extract: 4:1 concentrate

Bark decoction: 56-112 ml

Oil: 1-1.5 ml

(Tillotson, 2001, Dabur Research Foundation & Dabur Ayurved Limited, 2002, Alternative Medicine Review, 3:4 306-307, 1998, and Basch, et al., 2004).

For the full anti-inflammatory effects it is recommended that individuals take *Boswellia* with other enzymes such as papain, bromelain, trypsin, chymotrypsin, and lysozyme (Weisman, 1999).

### **Pediatric Dosing**

Children should be monitored closely by the appropriate healthcare professional if *Boswellia spp.* is used. No literature exists that shows any adverse outcomes while using *Boswellia spp.* in children. Some experts believe that using it regularly may hide the symptoms of asthma in children and possibly slow down a diagnosis (Basch, et al., 2004).

## **SAFETY ISSUES**

### **Toxicity**

Rats, mice, and monkeys fed with ethanolic extract of gum resin for over 6 months had no adverse effects observed. Maximum tolerated doses in rats of the 50% ethanolic extracts of root, fruit, and stem were 50 mg/kg, 500 mg/kg, and 250 mg/kg body weight given IP, with no exhibition of toxic effects. (Tillotson, 2001 and Dabur Research Foundation & Dabur Ayurved Limited, 2002) DerMarderosian, in an article in The Review of Natural Products reported that *B. serrata* is without side effects; no cytotoxic effect, no effects on the cardiovascular system, respiratory, or CNS function, and no ulcerogenic effects that called for a cease in treatment. It has been reported that when buying *B. serrata* as a dietary supplement, to make sure it does not have citric acid as the flow agent, as it may negatively affect the potency and activity of BAs (Schauss, 1999).

### **Side Effects/Contraindications/Warnings**

#### **Skin Reactions**

*Boswellia spp.* used in adhesive plasters and perfumes has caused dermatitis in sensitive people. *Boswellia* gum applied to intact or abraded rabbit skin for 24 hrs. under occlusion was found to be moderately irritating. Closed patch tests with 8% *Boswellia* were found to be non-irritant to human skin. The fragrance raw material *Boswellia* absolute, which was prepared by ethanol extraction of *Boswellia* gum, then followed by evaporation of the ethanol, was found to be non-irritant, non-sensitizing, and non-phototoxic in various tests on mice, pigs, and human subjects. (Botanical Dermatology Database)

Applying *B. serrata* to the skin may cause contact dermatitis, allergic contact dermatitis, or phytodermatitis (Acebo, et al., 2004 and Basch, et al., 2004). A case report published by *Contact Dermatitis* asserts: "A 28-year-old woman with atopic background had a 2<sup>nd</sup> degree burn from hot water on her thigh in September 2001. She was initially treated with topical antiseptics, antibiotics and antihistamines; some days later, she stopped these treatments and went to a naturist, who prepared and sold her a cream made with natural plant extracts. After 5 days of application, an intense eczematous local cutaneous reaction with bullae developed on her thigh, requiring systemic and topical corticosteroids to heal...The patient then went back to the naturopath, who gave her the composition of the cream: resin extract of *B. serrata*, rosemary oil,

olive oil, and virgin beeswax. Patch tests with *B. serrata* were performed on 12 healthy volunteers and no reactions were observed. A diagnosis of allergic contact dermatitis from *B. serrata* resin extract was then made. Some months later, the patient applied the same cream to her husband...developing a fresh allergic contact dermatitis on her own hands.”(Acebo, et al., 2004 p. 91).

### **Gastrointestinal Reactions**

*Boswellia* extract has been connected with mild GI upset (Wallace, 2002) in a randomized controlled trial of patients with osteoarthritis (Kimmatkar, et al., 2003). In a study of patients with ulcerative colitis, abdominal fullness, epigastric pain, gastroesophageal reflux symptoms, diarrhea, and nausea were reported by 6 of 34 patients (18%) receiving 350 mg, three times a day of *Boswellia* for 6 weeks. It is not clear to what extent these symptoms were related to the patient’s underlying colitis. Two of 80 patients (3%) complained of hyperacidity and nausea (Gupta, et al., 1997, Gupta, et al., 2001).

It is recommended that *Boswellia spp.* be used cautiously in people with pre-existing gastritis or GERD and people taking lipid-soluble medications, as the gum resin of *Boswellia* has been reported to lower cholesterol and triglyceride levels and may bind to and impair absorption of these medications (Basch, et al., 2004, ).

### **Pregnancy and Lactation**

Due to Indian literature suggesting that *Boswellia spp.* is an emmenagogue and may induce abortion it is not recommended that it be used during pregnancy. At the present time it has not been established as being safe (Kamboj, 1988 and Basch, et al., 2004).

### **Drug Interactions**

Based on rat studies, frequent use of NSAIDs, COX-2 inhibitors may disrupt the benefits of *Boswellia* (Reddy, et al., 1989). It has been shown to lower cholesterol and triglyceride levels *in vivo* and *in vitro* (Pandey, et al., 2005), therefore it may bind to and impair the absorption of lipid-soluble agents and potentiate lipid lowering agents. Continued use of *Boswellia* with other anti-proliferative agents may potentiate effects or toxicity due to its inhibition of protein synthesis via effects on nucleic acids and inhibition of proliferation of human leukemic HL-60 cells (Shao, et al., 1992, Basche, et al., 2004 and Jing, et al., 1999). *Boswellia’s* ability to reduce production of leukotrienes by inhibiting 5-lipoxygenase in animal and *in vitro*, points to its potential to increase the actions of pharmaceutical leukotriene inhibitors used in the treatment of asthma such as Accolate and Singulair (Safayhi, et al., 1996, Ammon, et al., 1991, and Safayhi, et al., 1992).

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## **Illustrations**

### **Front cover**

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