International Standard Serial Number (ISSN): 2249-6807

International Journal of Institutional Pharmacy and Life Sciences 6(6): November-December 2016

INTERNATIONAL JOURNAL OF INSTITUTIONAL PHARMACY AND LIFE SCIENCES

Pharmaceutical Sciences

Review Article……!!!

Received: 17-10-2016; Revised: 31-10-2016; Accepted: 01-11-2016

KUNDUR (*BOSWELLIA SERRATA)* – A REVIEW

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Keywords:

Frankincense, Shallaki, oleoresin, Boswellic acids, hyperlipidemia

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ABSTRACT

Kundur, in unani literature has been described as a oleo resin gum of *Boswellia serrarta Roxb*. The genus *Boswellia* of family *Burseraceae*. is represented by many species of which *Boswellia serrata Roxb* is well known for its medicinal properties The oleoresin gum is known as Indian Olibanum or Indian Frankincense or *Salai-guggul*. Frankincense was one of the four components in the medicinal "Balsam of Jerusalem" from the Franciscan Monastery and, as noted in the Papyrus Ebers, circa 1500 BC, had applications in Egypt for mummification, cremation, and the treatment of skin wounds. It is referred to as *Shallaki* in Sanskrit. *Shallaki* or *Sallai guggulu*, has been used for thousands of years in Indian system of medicine as a wonder drug for treatment of various ailments like arthritis, obesity, hypertension, dysentery, dyspepsia, bronchitis, asthma, skin disorder, palpitation and rheumatism. *Boswellia serrata* contains a number of photochemical constituents, essential oils, Boswellic acids like ABA, KBA, and AKBA and other pentacyclic triterpene acids. Out of these β-boswellic acid is the major constituent which has different biological activities like anti inflammatory, anti obesity, anti hyperlipidemic, anti atherosclerotic and anti hypertensive etc. In this review an effort is made to update the information regarding its medicinal uses and pharmacological activities in traditional or Indian system of medicine and justify its use on modern scientific parameters.

INTRODUCTION

Herbal drugs are used now-a-days to provide safe alternatives to allopathic medicine. Because of severe adverse reactions of the allopathic medicine, these can be used as an alternative to minimize the adverse effects to a great extent and have lasting results without any adverse side effects. At present, throughout the world health care management is the most concerning issue that we are facing. Medicinal plants have been used since ages to cure many disorders and are still being researched to resolve the health care problems in the world. The biological and pharmacological properties of many plants are still unknown. The scientists worldwide are exploring the possibilities of utilizing or finding out pharmacologically active compounds from medicinal plants. Among these widely researched plants, *Kundur* or *boswellia serrata* is of high medicinal value as it has been used to cure various diseases since ages and even more now-a-days. [1,2,3,4,5, 6, 7, 8.]

Description of Boswellia serrata Plant; *Boswellia serrata* is a medium sized , moderate to large branching deciduous tree reaching up to the height of 4-5m and having 1.0-1.5m girth with a spreading flat crown. The height of this plant does not exceed 10m and girth does not go above 1.5-2m.

Stem and bark;

The bark of this plant is nearly 1.25cm thick, greenish ashy color which peels in thin and smooth flakes .Bark is juicy(when fresh) with brown inner surface. According to others, the color of the bark is greenish-grey or reddish- yellow, exfoliating in thin flakes as papery bark.

Leaves;The leaves are imperpinnate 20-35cm long, exstipulate, crowded at the end of the branches. The leaflets are 2.5-6.3cm long, sessile, ovate serrate, alternate, optuse mostly pubescent with simple hairs.

Flowers; *B.Serrata* bears white flowers at the tip of the branches, in axillary racemes shorter than leaves. Calyx is smaller, pubescent outside, 5-6 lobed broadly triangular- ovate. Petals are 5mm long oblong-ovate, pubescent outside, tips inflexed. Stamens are 10-12, inserted at the base of red fleshy disk, anthers, introse. Ovary with twocollateral ovules in each cell.

Fruits; Are cotyledons, trifid, drupe, 1.25cm long trigonous, splitting in three valves, sustended by woody disk.

Seeds; Are heart shaped, attached to the inner angle of the fruit, Lanciniate radical, compressed and multified cotyledons.

Morphology of gum and its varieties; It is an exudates which oozes out from the wounds and cracks of the bark. This exudates – an oleo resin gum is an known as Indian Olibanum or Indian Frankincense or *Salai- guggul*. The gum is transparent with a peculiar and agreeable fragrance. The Indian writers describe this oleo-gum resin as moist, viscid, fragrant and of golden color when freshly exudated and solidifies to brownish yellow tears or drops and crusts, varying for pea-size to walnut size. The Greeko-Arabs considered it to be hot and dry. They describe several kinds of it as follows;

1; Deep and pale tears called *Kundur- Usna* or female

2; Yellow tears called *Kundur-Zakar* or male.

3; Artificial tears called *Kundur Mudahraj*.

4;The bark or scurf of the tree coated with the exudation called *Kishar-Kundur or Kasfa*.

5; Dust of the gum called *Dukak-Kundur*.

It is mentioned in that the male or *Kundur –Zakar* is red in color and female or *Kundur Unsa* is white in color. Usually the gum is white or yellow in color but when old it becomes ruby or blackish red or sometimes golden in color. *Kundur –Zakar* is considered the best and can be used up to 20years. The smell of this gum is similar to the smell of *mastagi* (Pistacia-trebinthus Linn). The purity can be checked by burning the gum which gives the flame, while adulterated gum gives only smoke. [6,,7,8, 9,10,11,12,13]

Distribution; It is distributed in west Asia, Omen, Yemen, North East Africa mountains of Southern Arabia and commonly on dry hills throughout the greater parts of India except Assam and Burma.

Alternate or Vernacular names; English: Incense tree, Frankincense tree.

Arabic: *Baslaj, Kundur, Laban.*

Hindi*: Kundur*

Sanskrit*; Ashvamutri*

Roman: *Safiroos.*

Bombay: *Salai, Salayadhup*.

Tamil: *Attam, Kunduru, Kungali*

Cutch; *Saliyaguggu l*[2, 8, 9]

Toxonomical classification:

Kingdom: Planate.

Order: Sapindales

Family: *Burseraceae.*

Genus: Boswellia.

Species: serrata. [10]

Chemical constituents; Oleo- resin gum of *Boswellia serrata* has various active chemical constituents and pharmacologically active constituents like terpenoids and oils. Terpenoids are volatile in nature and give fragrance to the plant. oleo resin gum is a mixture of terpenoids and sugars.

TERPENOIDS; Terpenoids are hydrocarbons of plant origin and are classified as

1 :Essential oils or lower Terpenoids: The gum yields upto 10-16% of volatile oil by steam distillation and is yellow in color with an agreeable smell. α- thujene, α- pinene, β- pinene, δ-limonene, ρ-cymene, cadinine, geraniol, elemol, terpenol, methyl chavicol and phellandrene are the essential mono terpenes in the oils. [11,12, 13, 14,]

2; Higher Terpenoids; These constitute 20-30% of oleoresin gum. Three triterpene acids α, β, δ -boswellic acids by the use of barium hydroxide as precipitant and their constitution has been described. The examination of non volatile fraction of the resin has led to the isolation of terpene acids and several neutral products including methyl chavicol, α - and 3-amyrins and a new diterpene alcohol serratol, four tetracyclic triterpene acids and four pentacyclic triterpene acids viz. 3 α --acetoxytirucall-8, 24-dien-2l-oic acid (C32H50O4, m.p.2200), 3 α -ketotirucall-8, 24-dien-21-oic acid (C30H46O3, m.p.2120), 3- α hydroxytirucall-8, 24-dien-21-oic acid, 3-hydroxytirucall-8, 24-dien-21-oic acid (C30H48O3, m.p.1980), , β- boswellic acid, acetyl--, β boswellic acid (C32H48O4, m.p.2530), acetyl-11-keto-β -boswellic acid (C32H48O5, m.p.2710) and 11-keto-boswellic acid (C30H46O4, m.p.1950). Two new triterpenoids, 2 α ,3 α -dihydroxy-urs-12-ene-24-oic acid and urs-12-ene-3 α, 24-diol, have been isolated from the gum resin of *boswellia serrata*. [15,16,17,] [18.]

GUM: Oleo gum resin of *Boswellia serrata* yields; Moisture 10-11%, volatile oil 8-9% resin 55-57%, Gum 20-23%, insoluble matter 45%, 0.16% of nitrogen also various constituents like gum enzymes as diastase and oxidase. Oleo resin gum contains 45 – 60% carbohydrates. Hydrolysis of the gum by heating with 3% sulphuric acid for 8 hours revealed presence of sugars like arabinose, galactose, xylose and mannose. 4-O-methyl-glucuronoarabinogalactan has also been isolated from the water soluble protein of gum resin. [19, 20, 21]

Temparament (Mizaj); [5]

Hot[1], Dry[1]

Actions of Boswellia Serrata; *Boswellia serrata or Kundur* has been described in detail in ethno medical and Unani literature. It is reported to have many pharmacological actions like anti-obesity**,** anti-hyperlipidemia, diuretic, emmenogogue, anti-inflammatory, anti-atherosclerotic, thrombolytic, concoctive, desiccant, anti-arthritic, carminative, resolvent, astringent, nervine, cardiac tonic, expectorant, alternative, anti-diabetic, anti-toxin, expectorant, anti-pyretic and anti-septic. [5, 6, 7, 8,]

Therapeutic uses;

It is therapeutically used in obesity, hyperlipidemia, arthritis, coronary thrombosis, cardiac disorders, Diabetes, Paralysis, asthma, dyspnea, hypertension, palpitation, bronchitis, gout, arthritis, hemorrhoids, Tumors, ulcers, septic conditions, laryngitis, lymphadenopathy, neurological disorders, pleurisy, sciatica, renal calculus and many uterine disorders. [22, 23, 24,]

Toxicology; Its excessive oral intake with wine may be fatal. [25]

Pharmacological Activity; The presence of large variety of essential compounds in *Boswellia serrata* like mixtures of Pentacyclic triterpenes (Resins), mixture of polysaccharides Pentose and Hexose (Gums) and Monoterpenes, diterpenes, and sesquiterpenes (essential oil) along with four principal boswellic acids, like β- boswellic acid (BA), acetyl- β- boswellic acid (ABA), 11- keto- β- boswellic acid (KBA), and 3- O- acetyl- 11- keto- β- boswellic acid (AKBA) has made it an important drug in *Unani* as well as in modern system of medicine. The boswellic acids are responsible for inhibition of pro- inflammatory enzymes. 5- lipoxygenase, which is an enzyme responsible for inflammation is inhibited by 3- O- acetyl- 11- keto- β- boswellic acid (AKBA). (AKBA) binds to this enzyme in a reversible and calcium dependent manner and acts as a non-redox type, non-competitive inhibitor. It also reduces the activity of Human Lymphocyte Elastase (HLE) released by Polymorphnuclear neutrophils (PMNs). HLE is thought to be responsible for causing a lot of diseases like asthma, cystic fibrosis, chronic bronchitis, acute respiratory distress syndrome, rheumatism, arthritis, colitis and inflammatory bowel disease. AKBA also inhibits the formation of free radicals that lead to tissue damage causing various ailments like rheumatoid arthritis. *Kundur* has been proven to have leukotriene inhibitor activity which being responsible for various reactions, are known to be the best potent promoters

of inflammation. *Kundur* blocks the synthesis of of leukotrienes. Thus many inflammatory disease like inflammatory bowel disease, asthma, colitis, rheumatism, arthritis and psoriasis are treated by *Kundur*. [26, 27, 28]

Pharmacological studies;

Anti-inflammatory and anti-arthrtic effects; ·Anti-inflammatory and anti-arthritic activities have been tested against carrageen in-induced paw edema adjuvant arthritis in rats. DAESG treatment caused inhibition of the carrageen in induced rat hind paw edema by 39.75% and 65-73%, administered orally (p.o) in dose ranges of 50-200 mg per kg^{-1} and interaperitoneal (i.p.) in dose range of 50-100 mg per kg^{-1} respectively compared to 47% inhibition seen with phenylbutazone (50 mg/kg^{-1} p.o.). The anti-inflammatory effect was equally well marked in adrenalectomized rats. Another study observed that the mixture of boswellic acids inhibited 25-46% paw edema in rats, proving its anti-inflammatory property. [29, 30]

Anti Tumor and anti carcinogenic effect; The compounds like triterpenoids and boswellic acids present in *Kundur* have been reported to have anti cancer activities like cancers of blood, skin, prostate and in brain tumors. Boswellin (BE), a methanol extract of the gum resin exudates of *Boswellia serrata*, when applied topically to the backs of mice markedly inhibited 12-O-tetradecanoylphorbol-13-acetate (TPA) and induced increase in skin inflammation, epidermal proliferation, the number of epidermal cell layers and tumor promotion in 7, 12dimethylbenz[a] anthracene (DMBA)-initiated mice. Feeding 0.2% of BE in the diet to CF-1 mice for 10-24 weeks reduced the accumulation of parametrial fat pad weight under the abdomen, and inhibited azoxymethane (AOM)-induced formation of aberrant crypt foci (ACF) by 46%. Also it was seen that addition of pure beta boswellic acid, 3-Oacetyl-beta-boswellic acid, 11-keto-beta-boswellic acid or 3-Oacetyl-11-keto-boswellic acid to human leukemia HL-60 cell culture inhibited DNA synthesis in HL-60 cells in a dose dependent manner with IC50 values ranging from 0.6 to 7.1 microM, indicating that β-boswellic acid and its derivatives (the major constituents of Boswellin) have anti-carcinogenic, anti-tumor and anti-hyperlipidemic activities. [31, 32]

Analgesic and sedative Effects; The oleoresin gum of *Boswellia serrata (Kundur)* exhibited marked analgesic activity and sedative effects in experimental animals. It was found that it produces reduction in the spontaneous motor activity and causes ptosis in rats. [33.]

Anti-fungal Effects: The essential oil (0.6%) yielded upon hydro distillation from the plant *Boswellia serrata* showed weak antifungal activity against human pathogens but was highly

effective against plants pathogens where it inhibited the tested organisms- *Pytophothora parasifica.* [34, 35,]

Anti-ulcer Effects; The petroleum ether and aqueous extracts of bark of *Boswellia Serrata* revealed significant antiulcer activity in aspirin induced albino rat model at the dose of 250 mg/kg body wt. [36]

Anti-diabetic Effects.A herbal formulation having oleoresin gum of *kundur* as an active constituent has been reported to show significant anti-diabetic activity in non insulin dependent diabetes mellitus in streptozocin induced diabetic rats where reduction in blood-glucose level was comparable to that of phenformin. The results were also found significant when *B, serrata* gum resin in amount of 900 mg daily for 6 weeks was orally administered (as three 300 mg doses) to diabetic subjects. [37, 38]

Immunomodulator Effects; *Kundur* extracts have been reported to exhibit anti anaphylactic and mast cell stabilizing or inhibiting mast cell degranulation activity in- vitro and in vivo method.. In another study done to investigate the effect of Boswellic acids obtained from *Boswellia serrata Roxb*. on cell mediated and humoral components of the immune system and the immunotoxicological potential, it was found that a single oral administration of BA (50–200 mg/kg) inhibited the expression of the 24 hr delayed type hypersensitivity (DTH) reaction and primary humoral response to SRBC in mice. The secondary response also improved significantly at lower doses. In a multiple oral dose schedule BA (25, 50 and 100 mg/kg) reduced the development of the 24 hr DTH reaction and complement fixing antibody titers and slightly enhanced the humoral antibody synthesis. It was also reported that in concentrations greater than 3.9 μg/mL and with prolonged oral administration of BA (25–100 mg/kg/d×21 days) increase in the body weight, total leukocyte counts and humoral antibody titers was found in rats. It is not cytotoxic nor does it cause immune-suppression. [39, ,40.]

Anti-hyperlipidmic Effects; In rats fed on atherogenic diet, it was reported that the water soluble fraction of *B.serrata* extract has hypolipidemic effects. It decreased total cholesterol by (38-48%) and increased HDL by 39%. [41]

Hepatoprotective Effects; The evaluation of hepatoprotective effect of hexane extract of oleo-gum-resin of *Boswellia serrata* (BSHE) on liver injury induced by carbon tetrachloride, paracetamol or thioacetamide was done, The BSHE was given in two different doses (87.5mg/kg p.o. and 175mg/kg p.o.) and Silymarin (hepatoprotective agent) was used as standard. In this

study it was reported that the lower dose of BSHE (87.5mg/kg p.o.) reduced the elevated levels of serum marker enzymes significantly and prevented the increase in liver weight in all three models of liver injury, while the higher dose showed mild hepatoprotective activity. It was thus concluded that hexane extract of oleo-gum-resin of *Boswellia serrata* in lower doses possess hepato protective activity, which was supported by changes in histopathology. [42]

Anti-Dementic Effects; when aqueous extract of B serrata was given orally in rat models during gestation period, a significant increase in the power of learning at post-learning stage, short-term memory, and long-term memory in their births was reported. In another study of Alzheimer's disease induced rats, treatment with aqueous infusions of B. Serrata at the dose of 45 and 90 mg/kg /day for 12 successive weeks significantly reduced the neurodegenerative characteristics in rats. [43, 44]

Anti-artherosclerotic Effects; ·Antiartherosclerotic studies were made on four group of rabbits (five in each group), fed on high lipid diet for three month. DAESG treatment was started on day 50 in one group, day 90 in second and continued up to day 150. The other two served as controls. It was showed that treatment with DAESG decreased serum cholesterol and triglyceride levels by 32-46% and 53-62% respectively, monitored at weekly intervals. DAESG treatment showed both prevention and reversal of atherosclerotic process as was evident from the start of high lipid diet. [30]

Anti-diarrheal Effects: The *Boswellia serrata* extract inhibited gastrointestinal transit in croton and castor oil induced diarrhea in mice. However, it was also reported that the intestinal motility remained unaffected in control mice by this extract. [45]

Anti-microbial and anti-oxidant effect: ·The essential oils of *Boswellia serrata* were analyzed for their antimicrobial and anti-oxidant activity. The volatile oil exhibited considerable inhibitory effect against all tested organisms. The oil also demonstrated anti-oxidant activity comparable with alpha-tocopherol and butylated hydroxytoluene (BHT). In another study it was also found that the extracts of gum resin was active against six test organisms- *Staphylococcus aureus, Escherichia coli, Klebsiella species, Pseudomonas aeruginosa, Proteus mirabilis and Bacillus subtilis.* [46, 47]

Conclusion: *Boswellia serrata* is used in traditional medicine since long time and reference goes to *Sushruta, Charaka* and Ibn-Sena.. It has been widely acceptable due to pharmacological actions, therapeutic uses and anti-bacterial, anti-diabetic, anti-carcinogenic and mutagenic, anti-

oxidant, anti-fungal, anti-inflammatory, anti-obesity, anti-hyperlipidemic, anti-arthritic, hepato-protective, immune-modulatory and analgesic activities. It has been regarded as a plant of high medicinal value because of presence of a number of bioactive compounds like terpenoids, boswellic acids, volatile oils etc. In present scenario when people are distressed by diseases like obesity, arthritis, diabetes, hyperlipidemia and even deadly diseases like cancer and tumors are on rise the studies and research done on *Boswellia serrata* has proven to be a guiding source for treating and curing these diseases in a natural way. Advanced research and clinical trials need to be done to explore its medicinal properties further.

ACKNOWLEDGEMENT

Source of data was central library Jamia Hamdard, HIMSAR, Library Faculty of Medicine (Unani) and Library Faculty of Pharmacy, Jamia Hamdard.

Authors' Statements

Competing Interests

The authors declare no conflict of interest.

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