Ethnobotanical Leaflets 13: 766-74, 2009.

Pharmacological Activities of *Boswellia serrata* Roxb. - Mini Review

Aman Upaganlawar[1]* and Balu Ghule[2]

[1]Department of Pharmacy, The M.S.University of Baroda, Gujarat, India
[2]Institute of Pharmaceutical Education and Research, Wardha, India
*Corresponding author: amanrx@yahoo.com

Issued 01 June 2009

Abstract

Boswellia serrata (Salai Guggal) is one of the most ancient and respected herbs in Ayurveda. "Gajabhakshya" a Sanskrit name sometimes used for *Boswellia* suggests that elephants enjoy this herb as a part of their diet. Historically *Boswellia serrata* is recommended for osteoarthritis, juvenile rheumatoid arthritis, soft tissue fibrosis and spondilytis without any side effect. Present review focuses on pharmacological activities of *Boswellia serrata* Roxb.

Keywords : Pharmacological activities, *Boswellia serrata,* Oleogum resin.

Introduction

Boswellia serrata (Family: Burseraceae) is a deciduous middle sized tree, which is mostly concentrated in tropical; parts of Asia and Africa. In India it occurs in dry hilly forests of Rajasthan, Madhya Pradesh, Gujarat, Bihar, Assam, Orrisa as well as central penisular regions of Andhra Pradesh, Assam etc. The gum is tapped from the incision made on the trunk of the tree which is then stored in specially made bamboo basket and converted into different grades of material according to flavor, color, shape and size. The fresh gum obtained from the tree is hot dry with a pleasant flavor and slightly bitter in taste. It is the 'frankincense' of ancient Egyptians, Greeks and Romans who used it as prized incense, fumigant as well as a multipurpose aromatic. It is generally used in making incense powder and sticks.

The oleo gum resin of *Boswellia serrata* is used in various Unani and Ayurvedic preparation. It is reported to be useful in the treatment of bronchitis, asthma, cough, bad throat and various intestinal problems. It is a diaphoretic and astringent prescribe in various syphilitic

and pulmonary diseases. It acts as both internal and external stimulant, expectorant, diuretic and stomachic. The gum is also prescribed in cases of jaundice, diahhroea, dysentery, dyspepsia and hemorrhoids. It is also recommended in weak and unhealthy kind of ulceration (1, 2, 3, 4).

Chemistry

The essential oil of *B. serrata* predominantly comprised monoterpenoids, of which α-pinene (73.3%) was the major constituent. Other monoterpenoids identified included β-pinene (2.05%), *cis*-verbenol (1.97%), *trans*-pinocarveol (1.80%), borneol (1.78%), myrcene (1.71%), verbenone (1.71%), limonene (1.42%), thuja-2,4(10)-diene (1.18%) and *p*-cymene (1.0%), while α-copaene (0.13%) was the only sesquiterpene identified in the oil.(8). Higher terpenoids constitute the major fraction (25-35 %) of the oleo-gum-resin. The first terpenoids isolated is boswellic acid in1898 by Tschirh *et al* (5). Since then a number of chemists have worked on the structural elucidation of boswellic acid. Structure of methyl ester of acetyl- β -boswellic acid has also been confirmed by single crystal X-ray studies recently (6).

Besides boswellic acid several other triterpenoids have also been isolated from the gum resin, these, compounds include α -amyrins, 11-keto-a-boswellic acid, 3’ hydroxyl urs-9, 11 – dien-24-oic acid, 3’-acetoxy urs-9, 11-dien-24-oic- acid (Fig. I). Tetracyclic triterpenoic acids have, also been reported by Pardhy et. al., these compounds are 3’- hydroxyl-tirucall-8, 24-dien-21-oic acid 3’- hydroxyl-tirucall-8, 24-dien-21-oic acid, 3-keto-tirucall-8, 24-dien-21-oic acid 3’-hydroxy-tirucall-8, 24-dien-21-oic acid 3-keto-tirucall-8, 24-dien-21-oic acid, and 3’-acetoxy tirucall-8, 24-dien-21-oic acid (Fig.2) Besides, these authors have also reported the isolation of a new diterpene alcohol serratol (7).

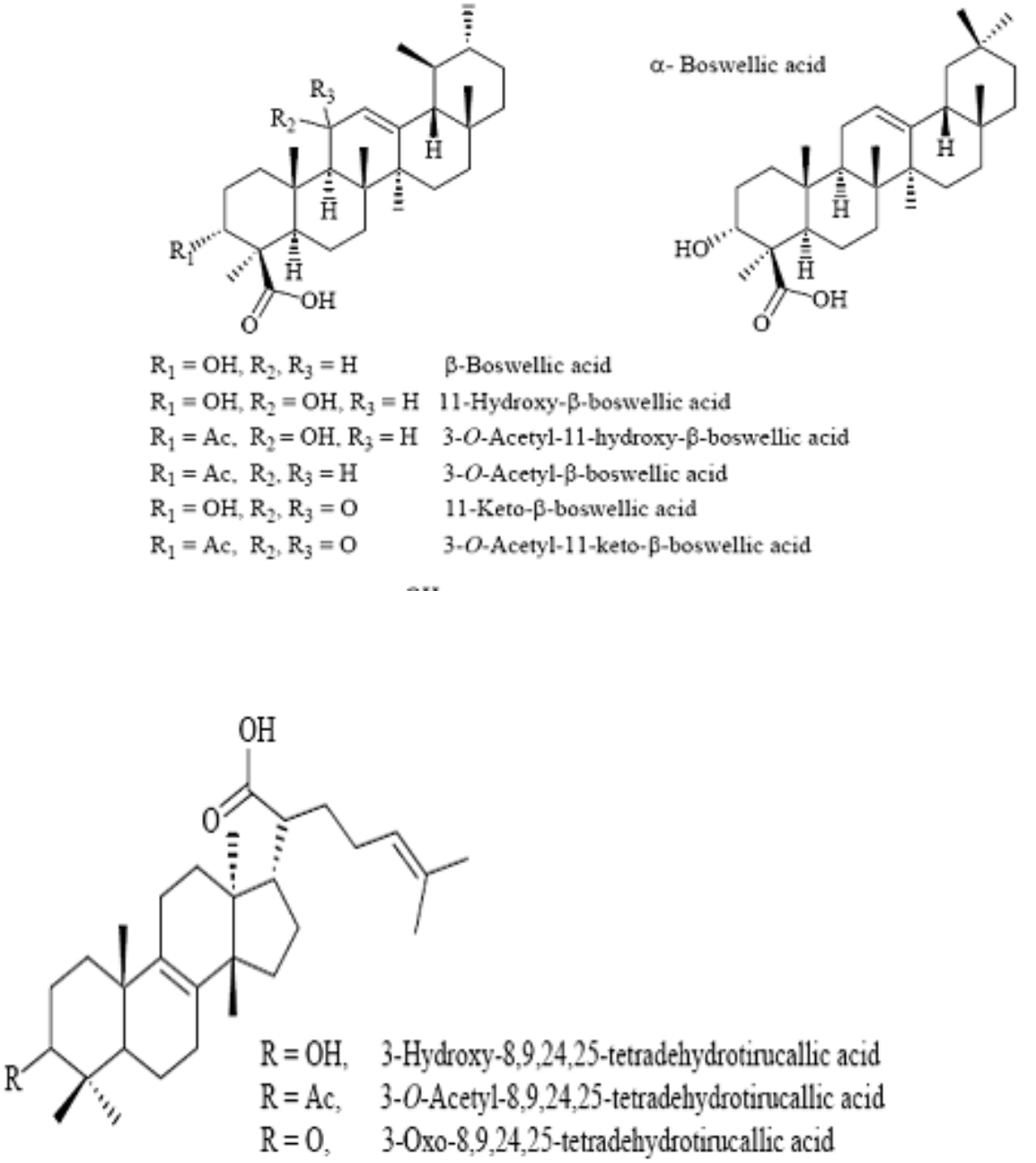

Fig. 1. Structures of different boswellic acids.

Pharmacological Activities

Anti-inflammatory Activity on New Papaya Latex Model

The Boswellic acid from ***B. serrata*** when tested on new model i.e Papaya Latex Model, showed significant activity of mean 35% inhibition of inflammation. Since the new model is reported to be sensitive to slowly acting, remission inducing drugs. Its effectiveness on boswellic acid throws some light on its mechanism of action which seems to be unlike aspirin

and steroidal drugs (9).

Leukotriene Inhibition

Ethanol extract of the gum resin inhibits the formation of Leukotriene B_4 in rat peritoneal neurophils. Leukotriene such as LTB_4 is recognized as one of the important mediators of inflammatory reactions. Leukotrienes are synthesized by stimulated phagocytes cells, particularly the neutrophills. The production of chemostatic factors by these cells attracts more phagocytes to sites of inflammation. Most other non-steroidal anti-inflammatory drugs act through the inhibition of prostaglandins produced by stimulated phagocytes. Boswellic acid, therefore, is different from other known non-steroidal anti-inflammatory drugs in its mode of action and relatively free from side effects (10).

Analgesic and Psychopharmacological effects

Menon *et a*l, revealed that the gum resin of *B. serrata* possess marked analgesic activity in experimental animals in addition to its sedative effect. They have found that it produces reduction in the spontaneous motor activity and caused plosis in rats (11).

Anti inflammatory and Anti-arthritic activity's **(12)**

Extract of salai guggal caused inhibition of the Carrageenan induced rat hind paw oedema 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 does rang of 50-100 mg per kg-1 respectively compared to 47% inhibition seen with phenylbutazone (50mg/kg $^{-1}$ p.o.). In the anti-arthritic study on the mycobacterium adjuvant-induced poly-arthritic in rats, salai guggal showed 34% and 49% inhibition of paw swelling with 50 and 100 mg per kg -1 (p.o.) doses respectively as compared to controls.

Singh *et al* (13) studied the anti-inflammatory activity of mixture of Boswellic acid (Composed of 5 acids with a-Boswellic acid as the major component). This showed 25-46% inhibition of paw oedema in rats and mice. In chronic test of formaldehyde arthritis it exhibited 45-67% antiarthritic activity in a similar dose range. The fraction was effective in both adjuvant arthritis (35-59%) as well as established arthritis (54-84%) It also showed antipyretic effect, with no ulcerogenic effect and well tolerated in as high a dose as 2 gm/kg p.o, mice.

Effects on leucocytes migration

Ammon, *et al*, (14) carried out studies on leukocytes migration into the inflammatory exudates caused by Carrageenan. It was found to exert marked inhibitory effect on both the volume and leucocytes population of pleural exudates. In acute test model of Carrageenan induced pleurisy in rats. Extract of salai guggal in a dose of 100 mg per kg orally showed significant reduction of pleural exudates volume (47.93%): $P<0.001$) and leucocytes population

(26.42% P <0.001). The effects on these parameters were more pronounced when animals were treated with Extract of salai guggal in a dose of 100 mg per kg p.o. for 10 days before the test performance.

Immunomodulatory activity

Extract of gum resin of B. serrata containing 60% acetyl 11-keto beta boswellic acid (AKBA) along with other constituents such as 11-keto beta-boswellic acid (KBA), acetyl beta-boswellic acid and beta-boswellic acid has been evaluated for antianaphylactic and mast cell stabilizing activity using passive paw anaphylaxis and compound 48/80 induced degranulation of mast cell methods. The extract inhibited the passive paw anaphylaxis reaction in rats in dose-dependant manner. However, the standard dexamethasone (0.27 mg/kg, p.o) revealed maximum inhibition of edema as compared to the extract. A significant inhibition in the compound 48/80 induced degranulation of mast cells in dose-dependant manner was observed thus showing mast cell stabilizing activity. The standard disodium cromoglycate (50 mg/kg, ip) was found to demonstrate maximum per cent protection against degranulation as compared to the extract containing 60% AKBA (15).

Anticancer Activity

Alcoholic extract of salai guggal (AESG) for anti-carcinogenicity in mice with ehrlic ascites carcinoma and S-180 tumor, found inhibition of tumor growth by inhibiting cell proliferation and cell growth due to the interference with biosynthesis of DNA, RNA and proteins (16). Topical application of Boswellin with 5 nmol TPA twice daily for 16 weeks to mice previously treated with dimethylbenz-anthracene caused 87- 99% inhibition in the number of tumor (17). Boswellic acids induce concentration dependent inhibition of glioma cell proliferation and show anti-edema effect in glioblastoma patients (18). It was also revealed that Boswellic acids induced apoptosis is protein synthesis dependent and not associated with free radical scavenging activity.

Hypolipidemic and Hepatoprotective activity

Water soluble fraction of B. serrata extract decreased total cholesterol (38-48%) and increased HDL in rats fed on atherogenic diet, thus proving its hypolipidemic potential (19). alcoholic extract of salai guggal (AESG) causes hepatoprotection in galactosamine/endotoxin induced liver damage in mice which was reflected by reduced titre of SGOT, SGPT, aminotransferase and serum enzymes (20).

Hypoglycemic Activity

Herbal formulation containing B. serrata oleo-gum-resin as one of the ingredients has been reported to produce significant anti-diabetic activity on non-insulin dependent diabetes mellitus

in streptozocin induced diabetic rat model where reduction in blood-glucose level was comparable to that of phenformin (21).

Antidiarrhoeal

Boswellia serrata extract (BSE) was found effective in treating diarrhoea in patient with inflammatory bowel syndrome without causing constipation. It was also found effective against acetylcholine and barium chloride induced diarrhoea by inhibiting contraction of intestinal smooth muscles. The extract also inhibited gastrointestinal transit in croton and castor oil induced diarrhoea in mice. However, intestinal motility remained unaffected in control mice by BSE (22).

Antimicrobial activity

Essential oil from the bark of B.serrata was tested against Gram positive and Gram negative bacteria. The essential oil exhibited significant inhibitory activity against *S.aureus* OGSUTH 108, *E.coli* LASUTH 54 and *Proteus mirabilis* UCH 28 (24).

Boswellic acids: novel, specific, nonredox inhibitors of 5-lipoxygenase

BA and derivatives concentration dependently decreased the formation of leukotriene B4 from endogenous arachidonic acid in rat peritoneal neutrophils. Among the BAs, acetyl-11-keto-beta-BA induced the most pronounced inhibition of 5-lipoxygenase (5-LO). It did not impair the cyclooxygenase and 12-lipoxygenase in isolated human platelets and the peroxidation of arachidonic acid by Fe-ascorbate (25).

Clinical Evaluation

Kimmatkar, N., et al**,** A randomized double blind placebo controlled crossover study was conducted to assess the efficacy, safety and tolerability of Boswellia serrata Extract (BSE) in 30 patients of osteoarthritis of knee, 15 each receiving active drug or placebo for eight weeks. After the first intervention, washout was given and then the groups were crossed over to receive the opposite intervention for eight weeks. All patients receiving drug treatment reported decrease in knee pain, increased knee flexion and increased walking distance (26).

Anti-asthmatic activity

In a double blind placebo control clinical study with 300mg thrice daily dose for 6 weeks, Gupta et al (1998) established anti-asthmatic potential of alcohol extract of salai guggal (AESG) where 70% of the patients with prolong history of asthma showed improvement in physical symptom and sign of dyspnoea, bronchi, number of attacks, increase in stimulation of mitogen activated protein kinase MAPK and mobilization of intracellular Ca2+ (23)

Chronic Toxicity Studies

Atal, *et al.* (1982), conducted chronic toxicity studies in 16 normal healthy monkeys

divided in four groups. Each group comprised of two, weight was recorded before and at monthly intervals after drug administration. Haematological and biochemical estimations were done prior to drug administration and monthly intervals after drug administration. Haematological and biochemical estimations were done prior to drug administration and at monthly intervals after drug treatment. DAESG was administered orally in three dose levels to three groups i.e., low dose of 2 X ED50, medium does of 5 X ED50, for six moths and one group served as a control. All the animals were maintained under uniform husbandry condition throughout the experiment. Biochemical hematological, histopathological, and other observations revealed no toxicity.

References

1. Mathe, C. Culioli, G and Archier P, 2004. Characterization of archeological frankincense by gas chromatography-mass spectrometry. *Journal of Chromatography*.1023:277-285.
2. Lemenih, M and Teketay, D, 2003. Frankincense and myrrh resources of Ethiopia: II. Medicinal and industrial uses. *Ethiop J Sci.* 26(2):161-172.
3. Sharma, S Thawani, V and Hingorani L, 2004. Pharmacokinetic study of 11-keto beta-boswellic acid. *Phytomedicine.* 11:255-260.
4. Hostanska, K. Daum, G, and Saller R. 2002. Cytostatic and apoptosis-inducing activity of boswellic acids toward malignant cell lines *in vitro*. *Anticancer Research.* 2853-2862.
5. Choudhary, A. C and Dikshit, S. K., 1999. Ayurvedic Pharmacopoeia, *The Eastern Pharmacist*, 10, 52.
6. Sane, R. T, 2002, Standardization, quality control, and GMP for herbal drug, *Indian Drugs*, 39(3), 184-189.
7. Handa, S. S., 1995, Herbal raw material and traditional remedies, *The Eastern Pharmacist*, 3, 24.
8. Adeleke A. Kasali , Adewale M. Adio , Adebola O. Oyedeji , Adeolu O. Eshilokun and Morufa Adefenwa. Volatile constituents of *Boswellia serrata* Roxb. (Burseraceae) bark. 17 (6),462 – 464.
9. Gupta, O. P., Sharma, N and Chand, D,1992. A sensitive and relevant model for evaluating anti-inflammatory activity – papaya latex induced rat paw edema, *J. Pharmacol Toxicol Methods*, 28(1), 15-9.
10. www.naturalremedies.com

11. M.K. Menon and A. Kar.1970. Analgesic and psychopharmacological activity of gum resin of *Boswellia serrata*. *Planta Med.* 19: 51-4 .

12. Vernon, R., 1969, Lymphocyte to macrophages transformations in the peritoneal cavity proceeding the mobilization of peritoneal macrophages to inflamed areas, *Nature*, 222, 1268-1288.

13. Singh, G. B and Atal, C. K.,1984, Pharmacology of an extract of salai guggul ex-Boswellia serrata, *Indian Journal of Pharmacology*, 16, 51.

14. Ammon, H. T. P., Mark, T., Singh, G. B and Safayhi, H.,1991, Inhibition of leukotriene B4 formation in rat peritoneal neutrophils by an ethanolic extract of gum resin exudates of *Boswellia serrata*, *Plant Medica,* 57(3), 203-7.

15. Pungle P, Banavalikar M, Suthar A, Biyani M and Mengi S.2003. *Indian J Exp Biol.* 41 (12):1460-2.

16. T. Tsukada, K. Nakashima and S. Shirakewa.1986. Archidonate 5-lipoxygenase inhibitors show potent antiproliferative effects on human leukemia cells. *Biochemical Biophysical Research Communication.* 140: 812-6.

17. M.T. Huang, V. Badmaev, J-G. Xie, Y-R Lou, Y. P. Lu and C. T. Ho. 1997.Inhibitory effect of an extract of the gum resin exudate Of *Boswellia serrata* on 12-Otetradecanoylphorbol-13-acetate (TPA)-induced skin tumor promotion in mice.
Proceedings in American Association of Cancer Research 38: 368.

18. D.K. Boker and M. Winking. 1997.Die Rolle von *Boswellia sauren* in der therapie maligner glione. *Deutsches Arzteblatt*. 94: B958-60.

19. U. Zutsi, P.G. Rao and S. Kaur. 1986. Mechanism of cholesterol lowering effect of Salai guggal ex-*Boswellia serrata* Roxb. *Indian J Pharmacol* 18: 182-3.

20. U. Gerlach, Sorbitol dehydrogenase In: *Methods of enzymatic analysis*. 112-7 (1983).

21. F. al-Awadi, H. Fatania and U. Shamte. 1991.The effect of a plants mixture extract on liver gluconeogenesis in streptozocin induced diabetic rats. *Diabetes Res.* 18(4): 163-8 .

22. F. Borrelli, F. Capasso, R. Capasso, V. Ascione, G. Aviello, R. Longo and A.A. Izzo. 2006. Effect of *Boswellia serrata* on intestinal motility in rodents: inhibition of diarrhea without constipation. *Br J Pharmacol.* 148: 553-60.

23. Gupta, V. Gupta, A. Parihar, S. Gupta, R. Ludtke, H. Safayhi and H.P. Ammon. Effect of *Boswellia serrata* gum resin in patient with bronchial asthma: Results of a double blind, placebo controlled 6 week clinical study. *Eur J Med Res.* 3(11): 511-4, (1998).

24. Kasali, A. A., Adio, A. M., Kundayo, O. E., Oyedeji, A. O., Adefenwa, A. O. E. M., Adeniyi, B. A. Antimicrobial activity of the essential oil of *Boswellia serrata* Roxb. (Fam. Burseraceae) bark Journal of Essential Oil-Bearing Plants.

25. Safayhi, H., Mack, T, Aanazodo, M, 1992, Boswellic acid novel specific nonredox inhibitor of 5-lipioxygenase, *J. Pharmacol. Exp. Ther*., 261(3), 1143-6.

26. Kimmatkar, Tawani, V., Hingorahi, L and Khiyani, R., 2003, Efficacy and tolerability of *Boswellia serrata* extract in treatment of knee- a randomized double blind placebo controlled, *Phytomedicine,* 10 (1), 3-7.