A review on Phytochemical and Pharmacological studies of Kundur (Boswellia serrata Roxb ex Colebr.) - A Unani drug

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ABSTRACT

Oleo-gum resin of Boswellia serrata Roxb ex Colebr. (Burseraceae) called Kundur in Unani system of Medicine is a prime ingredient in modern quality perfumes. The gum is popularly used in Indian Systems of Medicine (Unani, Ayurvedic & Sidha) for the last several centuries in curing various ailments especially rheumatism and skin diseases. Kundur is one of the popular drugs for various ailments such as dysentery, dyspepsia, lung diseases, haemorrhoids, rheumatism, urinary disorders and corneal ulcer in Unani system of medicine for the last several years. It is also an ingredient in certain compound formulations viz: Majoon Kundur, Majoon Murawwah-ul-Arwah, Dowa-ul-Kibrit and Habbe Suzak of Unani medicine used in renal disorders. The studies carried out on Kundur (Boswellia serrata Roxb) reveal that Oleo-gum resin exhibits potent Anti-fungal, Anti-complementary, Juvenomimetic and Anti-carcinogenic properties. Investigations on Kundur also revealed its beneficial effects in Immunomodulation, Bronchial asthma, Polyarthritsis, Hepatitis C-virus, Colitis and Crohn's disease.

Phytochemistry and pharmacology on Kundur (Oleo-gum resin) of Boswellia serrata Roxb has been reviewed in this paper with the view to justify its recorded uses in Unani System of Medicine on scientific lines.

Keywords: Kundur, Boswellia serrata, Unani drug, Phytochemistry.

INTRODUCTION

Boswellia serrata Roxb ex Colebr (Kundur) belonging to family Burseraceae, is commonly known as 'Salai' or 'Salia' in Orissa. The tree is commonly found in West Asia, Oman, Yemen, South Africa, Southern Arabia and many parts of India (Western Himalayas, Rajasthan, Gujarat, Maharashtra, Madhya Pradesh, Bihar, Orissa). A medium to large sized, deciduous tree; up to 18m in height and 2.4m in the girth (normally 1.5m); The bark of this plant is thin, greenish grey, yellow or reddish and finally turning to ash colour, peeling off in smooth, exfoliating papery flakes; blaze pinkish and exuding small drops of resin (Saxena & Brahmam, 1994). The leaves alternate, imparipinnate, 30-45 cm long, exstipulate and crowded at the end of the branches. The leaflets are 2.5-6.3 x 1.2-3.0cm, ovate or ovate-lanceolate, 8-15 in number, nearly sessile with short toothed, mostly pubescent. The flowers are bisexual, small, white in axillary racemes or panicles at the tip of the branches. The calyx is small cupular and 5-6 lobed. The petals are 0.5-0.8 cm oblong-ovate with basal disk. (Dymock et al., 1972; Anonymous, 1988). The fruits are cotyledous, trifed, 1.25 cm long, trigonous, splitting into three valves. Seeds are heart-shaped and attached to the inner angle of the fruit, compressed, pendulous.
OLEO-GUM-RESIN

It is an exudate, which comes out from cortex after an injury or natural crack in the bark. It is fragrant, transparent and golden yellow. After solidification it turns into brownish yellow tears or drops and crusts. Its size varies from pea size to walnut size. The smell is agreeable. The oleo-gum-resin is tapped by shaving off a thin band of bark about 20 cm wide and 30 cm long, at a height of 15 cm from the base of the tree. This initial blaze should be made to a depth of about half the thickness of the bark, viz. up to 0.75 cm. Tapping should start from November and stopped before the monsoon. The number of blazes required depends upon the girth of the tree. For a tree of 90 cm girth, one blaze may be made, and for every increase of 50 cm girth one more blaze may be added. Blazes may be made horizontally leaving approximately equal space between them. The length or height of the blaze is to be increased by about 1.6 cm in fortnightly and 0.8 cm in weekly freshening every time on the upper edge. The surface already blazed or freshened may not be scraped. For continuous tapping on a 3-year cycle, the bole may be divided into three zones, each one being tapped for one year. For making another horizontal row of blazes in the subsequent year 7.5 cm space may be left above the blazed portions. The horizontal blazes of the subsequent years should be alternating or staggering with the preceding ones. Again alternating the blazes within the same zone, the blazed portions may be given complete rest for six years during which period the wounds heal up and are ready for fresh tapping. The oleo-gum-resin is scrapped off and collected in a circular tray suitably placed around the trunk. It is collected in a semi-solid state and the vegetable impurities are manually removed. It is then kept in baskets up to 30 days on a cemented and sloping floor, whence the fluid portion containing the volatile oil is collected and used in paints and varnishes. The remaining semi-solid to solid part is mainly gum-resin which is thoroughly dried and sometimes treated with soapstone powder to make it brittle. It is then broken into small pieces, cleaned and graded for marketing.

Following kinds of oleo-gum-resin (Kundur) have been described in Unani literature:-

1. Kundur-unsa (Female), Deep pale tears 2. Kundur-zakar (Male) Yellow tea 3. Kundur Mudaharah Artificial tears 4. Kishar Kundur (Karfa) (It contains bark or scurf tears) and 5. Kundur Dukak. Dust of gum According to Unani philosophers ‘Kundur zakar’ mentioned at serial number 2 above, is red in colour, considered the best in quality and can be stored up to 20 years. It is also mentioned that the Kundur unsa is white and mostly found in India. Usually the gum is white or yellow in colour but when old, it become ruby or blackish-red or some time golden colour. The smell of ‘Kundur-Zakar’ is very similar to the smell of Mastagi (Pistacia terebinthus Linn.). The purity can be checked by the burning of the gum which gives the flames, while adulterated gum gives only smoke. (Afaq & Siddiqui, 1984; Ghani N, 1917; Ibne Senu, 1912; Azam Khan, 1895; Nadkarni, 1976; Anonymous, 1988) Kundur is being used for various ailments such as dysentery, dyspepsia, lung diseases, haemorrhoids, rheumatism, urinary disorders and corneal ulcer in Unani system of medicine for the last several years (Azam, 1885; Ghani, 1917; Ibne Sina, 1912). It is also an ingredient in certain compound formulations viz: Majoon Kundur, Majoon Murawwah-al-Arwaah, Dawa-al-Khibit and Habbe Suzak of Unani medicine used in renal disorders (Nigrami, 1995; Lubhayya, 1979). Oleo-gum resin of Boswellia serrata Roxb. (Kundur) possesses Anti-fungal (Garg, 1974), Anti-complementary (Kapil and Moza, 1992), Juvenonimetic (Dennis et al., 1999) and Anti-carcinogenic properties (Huang et al., 2000). Investigations on Kundur revealed its beneficial effects in Immunomodulation (Sharma et al., 1996), Bronchial asthma (Gupta et al., 1998), Polyarthritis (Sander et al., 1998), Hepatitis C-virus (Hussein et al., 2000), Colitis (Gupta et al., 2001) and Crohn’s disease (Gerhardt et al., 2001).

MIZAJ (TEMPERAMENT)

The temperament (mizaj) of Kundur (Boswellia serrata) is mentioned as Hot³ Dry² temperament.

Action (Afal)

Kundur (Oleo-gum resin of Boswellia serrata) is recorded as Dafe humma (Antipyretic), Dafe khafiganj (Palpitation), Dafe Tafjin (Antiseptic), Mudire haiz (Emmenagogue), Mulhalle auram (Anti-inflammatory), Mulhallile reyah (Carminative), Mulhallile khoon Manjamiid (Thrombolytic), Muharrake dam (Haemodynamic), Muhazil (Antiobesity), Muqavvie bah (Aphrodisiac), Muqavvie Qalb (Cardiotic), Qatle kirm (Antihelmenthic), and Tiryaq (Antidote) in classical Unani texts

Istemaal (Therapeutic uses)

Kundur (Oleo-gum resin of Boswellia serrata) is used for the treatment of Amraze jild (Skin diseases), Atshak (Syphilis), Nafe kasrate boul (Polyuria), Nafe suzak (Gonorhoea), Nafe Diabetes (Diabetes), Simane mufrat (Anti-obesity), and Wajaul mufasil (Arthritis), (Sheerazi, 1913; Ibne Rushd, 1980, Ibne Sina, 1912, Azam Khan, 1314; Singh D., 1949; Ghani N., 1917 Kiritk & Basu, 1995; Varier’s, 1994; Nadkarni, 1976; Asolkar, L.V., 1992; Chopra, R. N., 1986; Dymock, 1976; Anonymous, 1988.)

PHYTOCHEMICAL STUDIES

The chemistry of Kundur (oleo gum resin) of Boswellia serrata is now thoroughly worked out. Sample of oleo gum resin analysed by Imperial Institute London showed following composition:-Moisture – 10 – 11%, volatile oil 8 – 9% resin 55 – 57%, Gum 20 – 23%, Insoluble matter 4 – 5%. (Try and find some recent reference for analysis of Kundur. The constituents can be grouped under: A: Oil, B: Terpenoids and Gum

A. Oil

The fixed oil is usually pale yellow in colour and has an agreeable odour. Essential oil is obtained in yield of up to 16% oleo-gum-resin by steam distillation. The specific gravity of essential oil is 0.8470; [a]D20 +24.0; nD20 1.4574; acid value, 0.76; ester value, 8.5; ester value after acetylation, 42.8; and iodine
value, 182 (Anonymous, 1984). α and β–pinenes were reported as the main constituents of oil (Pearson and Singh, 1918). Simonson (1922) studied the low boiling fractions of the oil and found α-thujene and major constituent α-pinenes and β-phellandrene in small quantities. High boiling fractions worked out in detail by the presence of terpenol, methyl chavicol and sesquiterpenes as the major components. On the basis of spectral data and interconversion isolation of acetyl-β-boswellic acid has also been reported. The methods for separation of essential oil, resin & gum, characteristics and uses of essential oil. (Winterstein et al., 1932). The physico-chemical characteristics of oil are quite variable because of the diversified sources. The constituents of the oil are α-pinene dipentene, phellandrene, cadinene, camphene, p-cymene, d-bornol, verbena and verbenol. Girgune et al., (1979) have reported the presence of α-thujene (50%), α-pinene 6.2%, d-limonene (4.5%), p-cymene (14%), cadinene (4%), geraniol (0.8%) and elemol (1.3%) as the major constituents of the essential oil. The α and β-pinenes, and d-epsilonene as the major constituents. In the presence of terpinyl acetate 3.5%, methyl chavical 2%, linalool 1.5% and terpinol 1% is reported (Anonymous, 1988). Composition of essential oil prepared by steam distillation (Abdel Wahab S. M. et al., 1987).

B. Terpenoids

Three triterpene acids, α, β and γ–boswellic acids by the use of barium hydroxide as precipitant. The constitution of α & β Boswellic acids have been described (Simpson et al., 1938, 1941). Ruzicka et al., 1940 converted α-boswellic acid into β-amyrin. They prepared surfactants from these acids. Bilhma et al., 1942 have assigned the position of –COOH group in β-boswellic acid. Ruzicka et al., 1944 carried out various reactions in the ring A & B of the Boswellic acid and its derivatives. Beton et al., 1956 have described the chemistry of triterpenoid and related compounds with special reference to isolation of β-boswellic acid. A review with emphasis on Boswellic acid and abietic acids have been written by (Sharma et al., 1962; Budzikiewicz et al., 1963) which describes the NMR and Mass spectrometry of triterpenes. β-sitosterol from the bark of B. serrata has been isolated (Beri et al., 1963, 1964). Critical examination of the non volatile fraction of the resin has been done by (Pardy et al., 1978) and 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. 3α-acetoxyturcaril-8, 24-dien-21-oxic acid (C22H30O4, m.p.220°), 3-ketoturcaril-8, 24-dien-21-oxic acid (C20H26O4, m.p.212°), 3α-hydroxyturcaril-8, 24-dien-21-oxic acid, 3β-hydroxyturcaril-8, 24-dien-21-oxic acid (C20H26O4, m.p.198°), β-boswellic acid, acetylboswellic acid (C22H32O4, m.p.253°), acetyl-11-keto-β-boswellic acid (C24H30O4, m.p.271°) and 11-keto-β-boswellic acid (C24H30O4, m.p.195°). Two new triterpenoids, 2α,3α-dihydroxy-urs-12-ene-24-oxic acid and urs-12-ene-3α, 24-diol, have been isolated from the gum resin of boswellia serrata (Babita Mahajan, 1995). Non aqueous titrimetric method was developed by (Gupta et al., 1984) for the estimation of total triterpenic acids present in different forms of B. serrata on the basis of β-boswellic acid which constitutes more than 30% of the total triterpene acids. Total triterpenoids include β-boswellic, 11-ketoboswellic and acetyl 11-keto β-boswellic acids. Estimation of triterpene acids alone or in combination of two was done using functional groups analysis. The functional groups analyzed were acetyl and hydroxyl groups at 3 position and keto group at the 11-position.

C. Gum

Analysis of Oleo-gum resin yielded: Moisture 10-11%, volatile oil 8-9% resin 55-57%, Gum 20-23%, insoluble matter 4-5%, (Fowler et al., 1921, 1925) have given methods of separation of the oleo gum resin into its various constituents and have also examined gum enzymes as diastase and oxidase. The gum contains 0.16% of nitrogen. Malandkar, 1925 has hydrolyzed the gum by heating it with 3% H2SO4 for 8 hours and identified sugars as arabinose, xylose and galactose. Sharma et al., 1980 revealed that the emulsion prepared from B. serrata was slightly better than those prepared with acacia gum. Emulsifying properties of Na–□-Boswellialata, which was found suitable for the preparation of emulsions for internal administration has been reported. Tablets prepared with 9% B. serrata mucilage were comparable to those prepared with 5% Acacia mucilage. Ashis et al., 1992 isolated 4-O-methyl-glucuronoarabinogalactan from the water soluble protein of gum resin.

PHARMACOLOGICAL STUDIES

Analgesic and Psychopharmacological effects

The Boswellia serrata (Kundur) exhibited marked analgesic activity in experimental animals in addition to its sedative effect. Boswellia serrata (Kundur) have found that it produces reduction in the spontaneous motor activity and causes ptosis in rats (Menon & Kar 1969).

Anti-complementary activity of boswellic acids (BA) –an inhibitor of C3-convertase

Boswellia serrata (Kundur) is found to possess anti-complementary activity. It inhibited in vitro immunohaemolysis of antibody-coated sheep erythrocytes by pooled guinea-pig serum. The reduced immunohaemolysis was found to be due to inhibition of C3-convertase of the classical complement pathway. The threshold concentration for inhibiting C3-convertase was found to be 100 micrograms. However, higher concentrations of BA showed constant inhibitory effects on immunohaemolysis. BA also exhibited weak inhibitory effects on individual components of the complement system. In vivo administration of BA also showed the inhibitory effect on guinea-pig serum. (Kapil A. & Moza N., 1992)

Antifungal activity of B. serrata

Boswellia serrata yield 0.6 percent of essential oil upon hydrodistillation. The oil has weak antifungal activity against human pathogens, and highly effective against plant pathogens, where it inhibited the tested organisms viz. Pythophthora parasifica. (Garg S.C. et al., 1974).
Anti-hyperlipidmic Activity

Serum cholesterol and triglycerides levels, deposits of fat, in different organs and area of body of the rabbit, fed on high cholesterol and saturated fat diet, was noted and found the deposits in various organs including iris was significantly less marked in the Salai gum treated group. The protective effect was established, whereas, several effects was also confirmed in the other experiments. The effect was probably at the biosynthesis level. This mechanism of action was studied by incorporating the U-C14 acetate in cholesterol biosynthesis. They also suggested that Salai gum is mainly effective in checking the rats of biosynthesis and partly effective in enhancing the excretion of cholesterol (Zutshi et al., 1980). The alcoholic extract, tested at different dose level in 25-50 mg/kg. p.o. doses, shows anti-hyperlipidemic activity on hypercholesteroninic animals decrease the 30-50% in cholesterol level and 20-60% triglycerides level.

Anti-arthrosclerotic agent

The anti-arthrosclerotic activity was taken up in rabbits fed on the diet containing cholesterol and saturated fat. Four groups of rabbits (five in each group) were employed and kept on high liquid diet for three months. 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. Serum cholesterol and triglycerides levels, deposits of fat in different organs and areas of the body including that in iris was significantly less marked in DAESG treated group as compared to control. Anti-arthrosclerotic studies made on rabbits fed on high lipid diet for three months 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 artherosclerotic process as was evident from the start of high lipid diet (Atal et al., 1980, 1981).

Anti-inflammatory and Anti-arthritic activities

Anti-inflammatory and anti-arthritic activities have been tested against carrageen in-induced paw oedema adjuvant arthritis in rats. DAESG treatment caused inhibition of the carrageen in induced rat hind paw oedema by 39.75% and 65-73%, administered orally (p.o) in dose ranges of 50-200 mg per kg and interaperitoneal (i.p.) in dose range of 50-100 mg per kg respectively compared to 47% inhibition seen with phenylbutazone (50 mg/kg p.o.). The anti-inflammatory effect was equally well marked in adrenalectomized rats. In the anti-arthritic study on the mycobacterial adjuvant-induced poly-arthritis in rats, salai guggal showed 34% and 49% inhibition of paw swelling with 50 and 100 mg per kg (p.o) doses respectively as compared to controls. Phenyl butazone in doses of 50 and 100 mg per kg (p.o.) showed 26% and 60% inhibition respectively. (Atal, et al., 1980-1981)

The in vivo effect of a herbal based, non-steroidal anti-inflammatory product salai guggal, prepared from the gum resin exudates of Boswellia serrata active principle “boswellic acids” on glycosaminoglycan metabolism has been studied in male albino rats. The biosynthesis of sulfated glycosaminoglycan evaluated by the uptake of [35S] sulfate, and the content of glycosaminoglycan were measured in specimens of skin, liver, kidney and spleen. Statistical analysis of the data obtained with respect to the boswellic acids and salai guggal were compared with those of ketoprofen. A significant reduction in glycosaminoglycan biosynthesis was observed in rats treated with all of the drugs. Glycosaminoglycan content was found to be decreased in the ketoprofen-treated group, where as that of the boswellic acids or salai guggal treated groups remained unaltered. The catabolism of glycosaminoglycan was followed by estimating the activities of lysosomal glycohydrolases, namely be glucuronidase, beta-N-acetylglucosaminidase, cathepsin B1, cathepsin B2 at cathepsin D, in tissues and by estimating the urinary excretion and hexosamini and uronic acid. The degradation of glycosaminoglycan was found to be reduced markedly in all drug-treated animals as compared to controls. The potential significance of boswellic acids and salai guggal was discussed in the light of changes in the metabolism of glycosaminoglycan. (Reddy, G.K. et al., 1989).

Curcumin from Curcuma longa and the gum resin of Boswellia serrata, which was demonstrated to act as anti-inflammatory in in-vivo animal models, was studied in a set of in vitro experiments in order to elucidate the mechanism of their beneficial effects. Curcumin inhibited the 5-lipoxygenase activity in rat peritoneal neutrophils as well as the 12-lipoxygenase and the cyclooxygenase activities in human platelets. In a cell free peroxidation system curcumin exerted strong antioxidative activity. Thus, its effects on the dioxygenases is probably due to its reducing capacity. Boswellic acids was isolated from the gum resin of Boswellia serrata and identified as the active principles. Boswellic acids inhibited the leukotriene synthesis via 5-lipoxygenase, but did not affect the 12-lipoxygenase and the cyclooxygenase activities. Additionally, boswellic acids did not impair the peroxidation of arachidonic acid by iron and ascorbate. The data suggest that boswellic acids are specific, non-redox inhibitors of leukotriene synthesis either interacting directly with 5-lipoxygenase or blocking its translocation. (Ammon, H.P. et al., 1993; Singh, G. B., 1992)

Anti-microbial and anti-oxidant effect

The essential oil of Boswellia serrata was analysed by GC and GC-MS, and their antimicrobial and anti-oxidant activity tested. 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). (Baratta M. T. et al., 1998) Extracts of gum resins was found to be active against six test organisms- Staphylococcus aureus, Escherichia coli, Klebsiella species, Pseudomonas aeruginosa, Proteus mirabilis and Bacillus subtilis. (Mishra et al., 1980)

Anti-tumor and anti-carcinogenic activities

Boswellin (BE), a methanol extract of the gum resin exudates of Boswellia serrata, contains naturally occurring
triterpenoids, beta-boswellic acid and its structural related derivatives. Topical application of BE to the backs of mice markedly inhibited 12-O-tetradecanoylphorbol-13-acetate (TPA) - induced increase in skin inflammation, epidermal proliferation, the number of epidermal cell layers and tumor promotion in 7, 12-dimethylbenz(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%. Addition of pure beta boswellic acid, 3-O-acetyl-beta-boswellic acid, 11-keto-beta-boswellic acid or 3-O-acetyl-11-keto-beta-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. These results indicate that beta-boswellic acid and its derivatives (the major constituents of Boswellia) have anti-carcinogenic, anti-tumor and anti-hyperlipidemic activities. (Huang, M.T. et al, 2000).

Effects of Boswellia serrata in Chronic colitis

Patients studied were suffered from chronic colitis characterized by vague lower abdominal pain, bleeding per rectum with diarrhoea and palpable tender descending and sigmoid colon. The inflammatory process in colitis is associated with increased formation of leukotrienes causing chemotaxis, chemokinesis, synthesis of superoxide radicals and release of lysosomal enzymes by phagocytes. The key enzyme for leukotriene biosynthesis is 5-lipoxygenase. Boswellic acids were found to be non-redox, non-competitive specific inhibitors of the enzyme 5-lipoxygenase. The gum resin of Boswellia serrata was studied for the treatment of this disease. Thirty patients, 17 males and 13 females in the age range of 18 to 48 years with chronic colitis were included in this study. Twenty patients were given a preparation of the gum resin of Boswellia serrata (900 mg daily divided in three doses for 6 weeks) and ten patients were given sulfasalazine (3gm daily divided in three doses for 6 weeks) and served as controls. Out of 20 patients treated with Boswellia gum resin 18 patients showed an improvement in one or more of the parameters; including stool properties, histopathology as well as scanning electron microscopy, besides haemoglobin, serum iron, calcium, phosphorus, proteins, total leukocytes and eosinophils. In the control group 6 out of 10 patients showed similar results with the same parameters. Out of 20 patients treated with Boswellia gum resin 14 went into remission while in case of sulfasalazine remission rate was 4 out of 10. In conclusion, this study shows that a gum resin preparation from Boswellia serrata could be effective in the treatment of chronic colitis with minimal side effects. (Gupta I. et al., Jul. 2001)

Effects of Boswellia serrata gum resin in bronchial asthma

The gum resin of Boswellia serrata, known in Ayurvedic system of medicine as Salai guggal, contains boswellic acids, which have been shown to inhibit leukotriene biosynthesis. In a double-blind, placebo-controlled study forty patients, 23 males and 17 females in the age range of 18-75 years having mean duration of illness, bronchial asthma, of 9.58 +/- 6.07 years were treated with a preparation of gum resin of 300 mg thrice daily for a period of 6 weeks. 70% of patients showed improvement of disease as evident by disappearance of physical symptoms and signs such as dyspnea, rhonchi, number of attacks, increase in FEV subset 1, FVC and PEFR as well as decrease in eosinophilic count and ESR. In the control group of 40 patients 16 males and 24 females in the age range of 14-58 years with mean of 32.95 +/- 12.68 were treated with lactose 300 mg thrice daily for 6 weeks. Only 27% of patients in the control group showed improvement. The data show a definite role of gum resin of Boswella serrata in the treatment of bronchial asthma. (Gupta et al., 1998; Miller et al., 2001).

Effects of Boswellic acids extracted on autoimmune encephalomyelitis

Mixed acetyl boswellic acids, pentacyclic triterpenes extracted from the gum resin of Boswellia serrata Roxb., significantly inhibited the ionophore-stimulated release of the leukotrienes (LT) B4 and C4 from intact human polymorphonuclear neutrophil leukocytes (PMNLs), with IC50 values of 8.48 micrograms/ml and 8.43 micrograms/ml, respectively. Purified acetyl-11-keto-beta-boswellic acid was about three times more potent as inhibitor of the formation of both LTB4 (IC50 = 2.53 micrograms/ml) and LTC4 (IC50=2.26 micrograms/ml) from human PMNLs in the same assay. The comparative agent MK 886 (3-[1-(4-chlorobenzyl)-3-t-butyl-thio-5-isopropylindol-2-yl]-2, 2-dimethylpropanoic acid, L-663, 536, CAS 118, 414-82-7) was about 10 to 100-fold more active than the boswellic acids in inhibiting. The formation of 5-lipoxygenase products in human PMNLs, with IC50 values of 0.0068 microgram/ml (LTB4) and 0.49 microgram/ml (LTC4). After daily intraperitoneal dosage the extract of mixed acetyl boswellic acids (20 mg/kg) significantly reduced the clinical symptoms in guinea pigs with experimental autoimmune encephalomyelitis (EAE) between days 11 and 21. However, the inflammatory infiltrates in the brain and the spinal cord were not significantly less extensive in the treated animals than in the respective control group. The multiple intraperitoneal application of boswellic acids did not inhibit the ionophore-challenged ex vivo release of leukotrienes B4 and C4 from PMNLs separated from the blood of guinea pigs with EAE. The boswellic acids have been characterized as selective, non-redox and potent inhibitors of the biosynthesis of leukotrienes in vitro. (Wildfeuer A. et al., 1998)

Effects of Boswellia serrata gum resin in ulcerative colitis

Ulcerative colitis is a chronic inflammatory disease of the colon where leukotrienes are suggested to play an important role for keeping inflammation active. Boswellic acids, the biologically active ingredients of the gum resin of Boswellia serrata (Sallai guggal), have been shown to be specific, nonredox and noncompetitive inhibitors of 5-lipoxygenase, the key enzyme of leukotriene biosynthesis. In patients suffering from ulcerative colitis grade II and III the effect of Boswellia serrata gum resin preparation (350 mg thrice daily for 6 weeks) on stool properties,
histopathology and scan microscopy of rectal biopsies, blood parameters including Hb, serum iron, calcium, phosphorus, proteins, total leukocytes and eosinophils was studied. Patients receiving sulfasalazine (1gm thrice daily) served as controls. All parameters tested improved after treatment with Boswellia serrata gum resin, the results being similar compared to controls: 82% out of treated patients went into remissions in case of sulfasalazine remission rate was 75%. (Gupta et al., Jan. 1997).

**Effects of Boswellia serrata in Polymyartitis**

*Boswellia serrata* are used in India for the treatment of chronic polymyartitis. Employing the main constituents of both plants i.e. curcumine and boselic acids, their effects on the pathways of arachidonic acid cascade in stimulated polymorphonuclear neutrophiles (PMNL) and platelets have been studied. Extracts from the resin of *Boswellia serrata* in a dose related manner inhibited formation of 5-lipoxygenase products in PMNL. A similar effect was observed employing boswellic acids EC50 being 2-7 micro M. Curcuma exhibited an antioxidative effect in Fe/ascorbate-induced peroxidation of arachidonic acid. Moreover, curcumin inhibited the formation of cyclooxygenase and 5-lipoxygenase as well as 12-lipoxygenase products. (Ammon H.P.T. et al., 1992)

**Effect of Boswellia serrata in hepatitis C-virus (HCV)**

The methanolic and water extract of *Boswellia* species used in traditional medicine were screened for their inhibitory effects on hepatitis C-virus (HCV) protease (PR) using in vitro assay methods. The methanolic extract showed significant inhibitory activities. (Hussein G. et al., 2000).

**Effect of Boswellia serrata on liver and cardiac function**

Efficacy of six different gums Acacia ((A), Tragacanth (B), Butea monosperma (C), Boswellia glabra (D), Balsamoderon mukul (E), and Melia azadirachta (F),were investigated for various biochemical parameters :ALAT, ASAT, LDH, CK, bilirubin ,and albumin in serum of rabbits. The serum level of transaminases showed a significant increase with all gums A, C, D, E and F while the effect of gum B was not significant. The serum level of LDH was reduced with gums A, B, C, D and F. The serum level of CK was decrease with gums A, B, C, and E. The serum albumin level was not affected significantly by the gums investigated. The bilirubin level was elevated with gums A, E and F while it was decreased with gums B and C. (Rasheed et al., 1993)

**Effect on the gonads of male Dy sedercus of Boswellia serrata oil**

Topical application of the essential oil from *B. serrata* on the freshly moulted fifth insets nymphs resulted in production of super nympha adult nymphs. In the resultant from both spermatogenesis were seriously affected. Thus the essential oil can act as a effective insect growth regulation (Rao et al., 1989).

**Immunomodulatory effect of Boswellia serrata**

Boswellic acid, a mixture of pentacyclic triterpene acids (BA) from *Boswellia serrata*, was investigated for their effect on cell mediated and humoral components of the immune system and the immunotoxicological potential. A single oral administration of BA (50-200 mg/kg) inhibited the expression of the 24hr delayed type hypersensitivity (DTH) reaction and primary humoral response to SRBC in mice. The secondary response was appreciably enhanced at lower doses. In a multiple oral dose schedule Ba (25, 50 and 100 mg/kg) reduced the development of the 24h DTH reaction and complement fixing antibody titres and slightly enhanced the humoral antibody synthesis. In concentrations greater than 3.9 micro g/mL BA produced almost similar and dose related inhibition of proliferative responsiveness of splenocytes to mitogens and alloantigen. Preincubation of macrophages with different concentrations of BA enhanced the phagocytic function of adherent macrophages. Prolonged oral administration of BA (25-100 mg/kg/dx 21 days) increased the body weight, total leukocyte counts and humoral antibody titers in rats. It is not found to be cytotoxic or to cause immunosupression (Sharma M.L. et al., 1996; Dandeker et al., 1993).

**Inhibitory activity of human leukemia HL-60 cells in culture**

Four major triterpene acids including beta-boswellic acid, 3-O-acetyl-beta-boswellic acid, 11-keto-beta-boswellic acid, and 3-O-acetyl-11-keto-boswellic acid were isolated from the gum resin of *Boswellia serrata* and examined for their in vitro antitumor activity. They inhibited the synthesis of DNA, RNA and protein in human leukemia HL-60 cells in a dose dependent manner with IC50-values ranging from 0.6 to 7.1 microM. Among them, 3-O-acetyl-11-keto-beta boswellic acid induced the most pronounced inhibitory effects on DNA, RNA and protein synthesis with IC50 values of 0.6, 0.5 and 4.1 microM, respectively. Its effect on DNA synthesis was found to be irreversible. This compound significantly inhibited the cellular growth of HL-60 cells, but did not affect cell viability. (Shao et al., 1998) Acetyl-11-keto-beta-boswellic acid (AKBA) is a pentacyclic triterpene isolated from *Boswellia serrata*, AKBA treated cells showed morphological changes like membrane blebbing and subsequent flow cytometric analysis of propidium-iodide stained cells indicated that the cells underwent apoptosis. This was confirmed by flow cytometric detection of sub-G1-peaks in AKBA treated cells. As inhibitors of topoisomerasers are known to be potent inducers of apoptosis. The effect of AKBA on topoisomerase 1 from calf thymus in vitro was examined. In a DNA-relaxation assay with OX174RF DNA, AKBA inhibited topoisomerase 1 and IC50 being 20 micro M. This suggests that induction of apoptosis in HL60 and CCRF-CEM by AKBA might be topoisomerase 1. (Hoernlein et al., 1996/97)

**Inhibition of 5-LO by boswellic acids**

Boswellic acids represent the active principle of *Boswellia serrata* gum resin with antiphlogistic and antirheumatic properties. Among the Bas, 11-keto-beta-BA was the most potent. The presence of a carboxylic function and an 11-keto function has been reported to be crucial for the 5-lipoxygenase inhibiting property of this unique pentacyclic triterpene derivative. (Satyahi, et al., 1994/2000) Pentacyclic triterpenes from the 11-keto-boswellic acid
series were identified as the active principal ingredients of Boswellia resin, inhibiting the key enzyme of leukotriene biosynthesis, 5-lipoxygenase (5-LO). Of the genuine boswellic acids hitherto characterized, 3-O-acetyl-11-keto-beta-boswellic acid, AKBA proved to be the most potent inhibitor of 5-LO. In the course of purification of further boswellic acid derivatives from Boswellia resin, degradation of the natural compound 3-O-acetyl-11-hydroxy-beta-boswellic acid to the thermodynamically more stable product 3-O-acetyl-9, 11-dehydro-beta-boswellic acid was observed. The metastable intermediate of this conversion, under moderate conditions of workup in methanolic solutions, was identified as 3-O-acetyl-11-methoxy-beta-boswellic acid (Schweizer, 2000).

**Juvenomimetic activity of Boswellia serrata**

The essential oil from the gumoleoresin of Boswellia serrata showed juvenomimetic activity when tested at 1:10-4:50 acetone dilution on Dysdercus similes V instar nymphs. Its terpene constituents were characterized by GLC and GC-MS analysis (Dennis et al., 1999).

### Table 1: evidence based scientific validation of (boswellia serrata) kundur.

<table>
<thead>
<tr>
<th>Therapeutic Uses and Actions</th>
<th>Unani &amp; other alternative medicine References</th>
<th>Scientific References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antiseptic</td>
<td>Ibne Sina, 1912; Azam Khan, 1314; Anonymous, 1888; Varier’s, 1994; Kirtikar &amp; Basu, 1995;</td>
<td>Mishra et al., 1980; Baratta M. T. et al., 1998; Garg et al., 1974</td>
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<tr>
<td>Anti fungal, anti microbial</td>
<td>Ibne Sina, 1912; Azam Khan, 1314; Anonymous, 1888; Varier’s, 1994; Kirtikar &amp; Basu, 1995;</td>
<td>Mishra et al., 1980; Baratta et al., 1998; Garg et al., 1974</td>
</tr>
<tr>
<td>Anti-inflammatory</td>
<td>Ibne Sina, 1912; Azam Khan, 1314; Ghanu, N.; Varier’s, 1994; Nadkarni, 1976; Asolkar, L.V.; 1992; Anonymous, 1988</td>
<td>Menon &amp; Kar 1969</td>
</tr>
<tr>
<td>Arthritis</td>
<td>Azam Khan, 1314; Ghanu, N., 1917; Asolkar, L. V., 1992; Varier’s, 1994;</td>
<td>Ammon et al., 1992; Atal, et al., 1980-1981; Reddy et al., 1989; Ammon et al., 1993; Singh 1992; Zutshi et al., 1980</td>
</tr>
<tr>
<td>Anti-obesity</td>
<td>Ghanu, N., 1917; Nadkarni, 1970</td>
<td>Gupta et al., 1998; Miller et al, 2001</td>
</tr>
<tr>
<td>Asthma</td>
<td>Kirtikar &amp; Basu, 1995; Varier’s, 1994</td>
<td>Rasheed et al, 1993</td>
</tr>
<tr>
<td>Cardiotonic</td>
<td>Ibne Sina, 1912; Azam Khan, 1314; Ghanu, N., 1917; Ibne Rushd, 1980; Asolkar, L.V., 1992</td>
<td>Wildfleur et al, 1998</td>
</tr>
<tr>
<td>(Gastropathy)</td>
<td>Ibne Sina, 1912; Azam Khan, 1314; Ghanu, N., 1917; Ibne Rushd, 1980</td>
<td>Rao et al, 1989</td>
</tr>
<tr>
<td>Aphrodisiac</td>
<td>Azam Khan, 1314; Ghanu, N., 1917</td>
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</table>

**CONCLUSION**

This review literature provides evidence based scientific validation (Table -1) to some of the therapeutic uses and actions described for Kundur in classical texts of Unani medicine. It clearly reveals that phyto-chemicals particularly secondary metabolites reported so far from Oleo-gum resin (Kundur) of Boswellia serrata and related pharmacological activities justify its recorded therapeutic actions in Unani literature. For example: antifungal (Garg 1974) and antimicrobial (Mishra et al., 1980) activities reported from essential oil provides clear cut evidence for its recorded use as Dafe Tafun (Antiseptic) in Unani system of medicine. Similarly there are clear evidences that Kundur is one of the potential antiinflammator and anti arthritic drug popularly used for the treatment of arthritis in Unani system of medicine since long (Table -1). It is further suggested that phytochemical and pharmacological studies on some of the less known or controversial Unani drugs may be taken up on priority basis not only to scientifically validate therapeutic actions/uses recorded, but revive the faith and confidence of Unani practitioners in its actions to serve the large strata of the rural society.

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