

Pinus roxburghii- Incredible Gift in the Lap of Himalayas

*¹Dhirender Kaushik, ¹Ajay Aggarwal, ¹Pawan Kaushik, ¹Ravinder Mehra, ²A.C Rana

¹Institute of pharmaceutical sciences, Kurukshetra University, Kurukshetra-136119

²Rayat Institute of Pharmacy, V.P.O. - Railmajra, Distt. Nawanshahr, Punjab – 144533

ABSTRACT

Pines clearly form the most ecologically and economically significant tree group in the world. The genus *Pinus* contains 110 species, comprising more than half the species in the pinaceae and almost 20% of all gymnosperm species. *Pinus roxburghii* sarg is one of the species belonging to family pinaceae found in East Asia-Himalayas from Afghanistan to Bhutan, forms extensive forests to 2700 meters and does best on north slopes on good soils. The chief constituents of *Pinus roxburghii* sarg are α -pinene, β -pinene, car-3-ene and longifolene. A yield of turpentine from resin averaged was almost 26.7%. The needles being rich in resin content is a highly inflammable fuel for igniting forest fires. The turpene obtained from resin of tree is antiseptic, diaphoretic, diuretic, rubefacient, stimulant and vermifuge. The oil is also an ingredient in many ointments, liniments and lotions for treating minor aches and pains as well as colds, when applied externally. It is used internally as well as externally for many diseases. Extracts of the roxburghii were tested for growth inhibitory against bacterial plant pathogens, mosquito. The species suggests phytomedicine for anti-inflammatory, antimicrobial, antibacterial activities with industrial applications which are based on the antioxidant potential of the species. Tress is extensively tapped for their resin in India and is the main source of resin in that region. The distribution region plays an important determinant of pine distribution and abundance in the landscape.

Key words:

INTRODUCTION

Pinus roxburghii Sarg. is the only tree with an ornamental specimen and having different medicinal values found in Himalayan region of Bhutan, Nepal, Kashmir, Sikkim, Tibet and other parts of north India(1). It generally occurs at lower altitudes than other pines in the Himalaya, from 500-2000 m, occasionally up to 2300 m. The Chir Pine (*Pinus roxburghii* Sarg.) named after William Roxburgh, is a pine native to the Himalaya. The range extends from northern Pakistan (North-West Frontier Province, Azad Kashmir), across northern India (Jammu and Kashmir, Punjab, Himachal Pradesh, Utrakhand, Sikkim) and Nepal to Bhutan (2). Pines are among the oldest terrestrial plants in world, appearing more than 60,000,000 years ago during the Mesozoic era and emerging as a highly successful competitors amongst the world's flora(3). Plant is belonging to family Pinaceae commonly known as Chir pine (4). It comprises of the world's largest coniferous genera. It consists 110-120 species distributed throughout temperate regions of the northern hemisphere and more than 40 taxonomic treatments have recognized several major divisions within the genus (5). Economically, pines play a major role as sources of timber, pulp, resin, nuts, and other products. Pines have also been cultivated in many parts of the world, both within and well outside their natural range, and they form the foundation of exotic forestry enterprises in many southern hemisphere countries. Moreover, pines have featured in ancient myths and rituals throughout human

history, and have been celebrated in visual art, prose, poetry, and music (6).

India has a rich flora i.e. widely distributed throughout country. Herbal medicines have been the basis of treatment and cure for various diseases and physiological conditions in traditional methods practiced such as Ayurveda, Unani and Siddha. Several plant species are used by many ethnic groups for the treatment of various ailments ranging from minor infections to dysentery, skin diseases, asthma, malaria, etc(7). In Uttaranchal, there are three major communities of Chir pine such as sal-pine, (*Shorea robusta*-*Pinus roxburghii* Sarg.) pine pure stand and oak-pine (*Quercus leucho-trichophora*-*Pinus roxburghii* Sarg.) communities. The sal- pine community occurs at the foothills areas and the oak-pine community on the upper reaches of Chir pine habitats. In the middle elevation range the Chir pine forms the pure stands (8).

Pinus roxburghii Sarg has many medicinal uses, the wood is Aromatic, Deodorant, Haemostatic, Stimulant, Anthelmintic, Digestive, Liver tonic, Diaphoretic and Diuretic. It is useful in eye, ear and pharynx diseases, foul ulcers, haemorrhages, haemoptysis, worn infections, flatulence, liver diseases, bronchitis, inflammations, skin diseases, pruritus and giddiness(1). The medicinal value of plant extracts of *Pinus roxburghii* Sarg on various human as well as plant pathogenic bacteria is undergoing extensive research. It has been found that nearly all the plant part extracts have shown both inhibitory effects against *Agrobacterium tumefaciens* (9). *Pinus roxburghii*

Sarg embryogenic cultures were successfully established and adventitious buds were successfully induced on the surface

wing 7.5-13.0 mm. × 5.0-6.5 mm. wings long, membranous (22). The cones are small and herbaceous. They produced large

Kingdom	Division	Class	Order	Family	Genus	Subgenera	Binomial name
Plantae	Pinophyta	Pinopsida	Pinales	Pinaceae	Pinus	<i>Strobos</i> , <i>Ducampopinus</i> , <i>Pinus</i>	<i>Pinus roxburghii</i> Sarg. Sarg. Pinaceae (14,55)
Common name:	Chir pine (8,14,15,18,27,28,36,51)						
Botanical name:	<i>Pinus roxburghii</i> Sarg. (1,18,36,51)						
Synonyms:	<i>Pinus longifolia</i> (14,30)						
Range:	East Asia- Himalayas from Afghanistan to Bhutan (14)						
Habitat:	Form extensive forests to 2700 meters. Found in Himalayan region at 450-2,200 m elevation (14), from Kashmir to Bhutan (1). A characteristic tree of subtropical pine forest (16)						
Known hazards:	The wood, sawdust and resins from various species of pine can cause dermatitis in sensitive people (14).						
Part used:	Wood, oleoresin, oil (1), bark, needles and female cones (3)						
Product offered	Leaves, Oil, Gum Resins (1)						
Flowering period	March-June (32)						

of cotyledons on cytokinin media (10). *Pinus roxburghii*'s scientific classification is listed in table [1]. (11)

The chief chemical constituents extracted from resin of plants are α -pinene (18.1%), longifolene (13.8%) and carene (51.8%) (12). In order to develop successful herbal therapy, it is necessary to carry out basic systematical investigations of growing certain physiological and pharmacological activity, and therefore could be used in preparations of certain phyto pharmaceuticals (13).

General characteristics of *Pinus roxburghii* Sarg.: The genus *Pinus*, of the pine family, characterized by evergreen leaves (8). A tall (18,36) trees to 55 m tall and over 100 cm dbh (1,8) and a trunk diameter of up to 2 m, exceptionally 3 m. (34) Branches more or less whorled (22), Bark dark grey (18) dark red-brown (1,22), thick, deeply and longitudinally fissured and rough (1,18,36), exfoliating in longitudinally elongated plates, (22) scaly; winter buds brown, small, ovoid, not resinous. (1) Species of *Pinus* can often be identified by the leaf arrangement, one needle or clusters of from two to five (in all cases enclosed in a sheath at the base) (8) leaves 3 per bundle, slender, flabellate-triangular in cross section, 20-30 cm × 1.5 mm long (1,22), finely toothed, light green, persisting on an average for a year and a half (22). Chir pine is distinguished from other pine species on the basis of its 3 needle shaped leaves per bundle (8). The flowers are monoecious (individual flowers are either male or female, but both sexes can be found on the same plant) and are pollinated by Wind (14). Male flowers about 1.5 cm. Long, arranged in the form of cones, female cones, solitary or 2-5 together, ovoid, 10-20 cm. × 7.5-13.0 cm. When ripe, brown, woody (22, 34) seeds winged, without

amount of pollen, carried away by wind.

Seed cones shortly pedunculate, ovoid, 10-20 × 6-9 cm (1, 8). Seed scales oblong, thick, stiff, apophyses strongly swollen(1), broad at base when closed, green at first, ripening glossy chestnut- brown when 24 months old, (34) conspicuously transversely ridged; umbo triangular, protruding. The seeds of Chir pine are 8-12 mm long, wing 2.5 cm long. Seed maturity Oct-Nov(1, 8).

Fire is selectively shaping most of the traits of plants growing in fire- prone environment and research suggest the relevance of fire as a selective force for the pines which is outperformed by the relevance of dispersal and emergence time as adaptive traits in the post- fire scenario, hence studies of Pine species, heated seeds needed more time to emerge, with seed attributes being relatively unimportant, when this covariate (treatment) is deleted, significant Cox model were built with some seed size parameters (weight or length) as significant variable. So,

in the absence of fire the Pines seemed to follow the general trend between seed size and speed of emergence (31). The plant prefers light (sandy) and medium (loamy) soils, requires well-drained soil and can grow in nutritionally poor soil. The plant prefers acid, neutral and basic (alkaline) soils and can grow in very alkaline soil. It cannot grow in the shade. It requires dry or moist soil and can tolerate drought. They open slowly over the next year or so, or after being heated by a forest fire, to release the seeds (34) The seeds ripen in April (14)

Traditional System: Traditional medicine (also known as indigenous or folk medicine) comprises medical knowledge systems that developed over generations

within various societies before the era of modern medicine (39). Folk medicine representing traditional medical wisdom usually unwritten but orally transmitted will encompass

whole world has become increasingly interested in Indian Ayurveda and other traditional health systems. The demand for medicinal plants is increasing in both developing and more-developed countries as a result of

Traditional uses of *pinus roxburghii* sarg.

Parts used	Traditional use
Leaves	Leaves(needles) are used to increase the flow of urine (diuretic) ⁽²⁾ , prevent soil erosion ⁽³⁵⁾ , used for sheltering and for keeping fruits in crates ⁽¹⁶⁾ decoction of leaves is applied locally to treat sprains ⁽⁵⁷⁾
Wood	Wood is used to cool the burning sensation of the body ⁽³²⁾ , emollient, aromatic, antiseptic, deodorant, haemostatic and diuretic. Stimulant, anthelmintic, digestive, liver tonic, diaphoretic and useful in eye, ear and pharynx disease, foul ulcers, haemoptysis, worm infection, flatulence, liver diseases, bronchitis inflammation, use for skin disease ^(1,42) , pruritus and giddiness ⁽¹⁾ , fuel wood ⁽⁸⁾ , wood oil is used as a nerve tonic, expectorant, burns and cracks ⁽⁴²⁾ , resinous wood is applied inside the lower eyelids to keep the eye clean and attractive ⁽²⁷⁾
Bark	Fuel wood ⁽⁸⁾ , bark paste is used in burns and cracks, used for skin diseases and ulcers ⁽⁴²⁾
Oil/turpentine oil	The turpentine oil is rubefacient, in the form of Linimentum Terebinthinae and Linimentum Terebinthinae Aceticum, in chronic rheumatism ⁽²¹⁾ . Used as diuretic ⁽²⁾ .
Resin	Plant resin is applied locally on the pimples for about 2-3 hours daily ⁽³⁴⁾ , resin is employed as a stimulating application for ulcer and abscesses and as basis for plaster, used in snake bite and scorpion sting, used for painful chest ⁽³²⁾ , skin disease and blood purifier ⁽¹⁶⁾ , oleoresin is thermogenic, expectorant, anodyne, anti-inflammatory, purgative ⁽⁵⁴⁾ , rubefacient, vermifuge ^(2,54) and demulcent, 2 g of resin with an equal amount of common salt is boiled in 250-300 ml of water and drunk warm before bedtime for 2-4 days ⁽⁵⁴⁾ to cure cough ^(1,8,42) , cold, asthma, chronic bronchitis, liver and spleen disease ^(1,42) , kidney and bladder ^(1,2) , gonorrhoea, scurvy, epilepsy, haemorrhoids and tuberculosis ⁽¹⁾ , it is used in steam bath for the treatment of rheumatic infections ⁽²⁾ , Resin is applied on boils, pimples and blisters, pus formation. ^(27, 33, 42) , heel cracks, above the eye to remove swelling ^(8,27) used in broken ceramic pottery ⁽⁸⁾ , used in cuts and wound ⁽³³⁾
Seed	Roasted seeds are eaten as a galactagogue ⁽⁵⁴⁾ edible and source of oil ⁽⁸⁾ .

ethno medicine, community medicine, household medicine and any other forms of local medicines (33).

Practices known as traditional medicines include herbal, Ayurveda, Siddha medicine, Unani, ancient Iranian medicine, Islamic medicine, traditional Chinese medicine, acupuncture, Muti, Ifá, traditional African medicine, and other medical knowledge and practices all over the globe(39). Traditional medicine systems are part of India's culture (40) dating back to the ancient times. The word Ayurveda is a combination of two words – F meaning "life" or "life principle" and Veda meaning a system of "knowledge". Hence it explains Ayurveda as the "knowledge of life" (63).

Over the past decade, there has been a dramatic increase in the demand for medicinal plants for use in traditional medicine (TM) and Complementary and Alternative Medicine (CAM) in both developing and developed countries. The world market for herbal remedies in 1999 was calculated to be worth US\$ 19.4 billion and for the herbal medicines based on traditional knowledge the estimate was US\$ 60 billion in 2000 (50). Today the

recognition of the non-narcotic nature, lack of side effects and easy availability of many herbal drugs (40).

Medicinal uses: *Pinus roxburghii* Sarg. is used as diuretic (2). In Nepal, the resin of *Pinus roxburghii* Sarg. known locally as ahule sallo, which is used to relieve the symptoms of cough. In Uttranchal, the resin of Chirpine was applied to boils, heel cracks and on either side of eye to reduce swelling (8). The essential oil is decongestant and antiseptic. It is used in rubefacients for rheumatism and muscle stiffness (43). Pine bark is used as a supplement (pynogenol), powerful antioxidant and free-radical-scavenger, pine bark extract is used in cardiovascular and heart formulas. It has also shown to have benefits for those with chronic venous insufficiency (61). *Pinus roxburghii* Sarg. have potent anti-inflammatory activities and potent anti-oxidants activity. *Pinus roxburghii* Sarg. adds synergism to anti-inflammatory property (49). It is also medicinally used as diaphoretic, stimulant, vermifuge. It is valuable remedy internally in the treatment of kidney and bladder complaints (14) *pinus* is used as plaster to boboes and

abscesses for suppuration. Its burnt wood (ash) and oleo-oil is applied to wash and snake sting for rapid relief used in wounds to heal promptly (20). The woods of Pinus roxburghii Sarg. is acrid,

Reported pharmacological activity of *pinus roxburghii sarg.*

Author	Activity	Parts used	Year
		Bark, Leaves(Needles), Female	
Bissa et al	Antibacterial Inhibitory activity against microbes	Cones	2008
Selvakumar et al		Leaves(Needles)	2007
Sharma et al	Heterozygosity/fitness	Embryos, using isozyme	2007
Parihar et al	Antibacterial	Oil	2005
Kolhapure et al	Anti-inflammatory/Antioxidant	----	2005

thermogenic, emollient, deodorant, haemostatic, anthelmintic, digestive, liver tonic. It is useful in eye, ear, pharynx diseases, foul, ulcers, haemorrhages, haemoptysis, flatulence, liver diseases, pruritus and giddiness (1) the turpentine oil obtain from the Chir pine is valued in medicine as a rubefacient, also in many ointments, liniments, and lotions for treating minor ache and pains as well as colds when applied externally (36).

Chemical Constituents: In India, at present Pinus roxburghii Sarg., (Chir) is the extensive source of turpentine oil. This is one of the most important and typical oils obtained from the oleoresin exuded from the tree. Essential oils and balsams are the main constituents of pharmaceutical interest of the family of pines (34). The chief constituents of turpentine oil from Pinus roxburghii Sarg. are α -pinene, β -pinene, car-3-ene, and longifolene (23,28,51), hydrocarbons (d- and l-pinene), resin acids, camphene, fenchene, dipentene and polymeric terpenes (21,49). The principal source of Indian turpentine oil at present is Pinus roxburghii Sarg. (24). Main phytochemicals present in Pinus roxburghii Sarg. sergeant ISL 350 is turpentine pinene, limonene, calophony, and oleum rebinthinae(60) the active constituents of Pinus roxburghii Sarg. (turpentine) are hydrocarbons(d-and α . Pine), resin acids, camphene, fenchene, dipentene and polymeric terpene(49). Extensive studies on the C₆H₆ extract of Pinus roxburghii Sarg. sargent which is used as a liniment in rheumatic pains has resulted in the isolation of phenolic constituent hexacosylferulate was confirmed by its unambiguous synthesis from ferulic acid and hexacosanol in presence of dicyclohexylcarbodiimide(DCC),(Yield 75%) (30).

It was identified the presence of the condensed tannins in bark of Pinus roxburghii Sarg. (26). Mean values of the acid number, saponification and unsaponifiable matter of Pinus roxburghii Sarg. is 174.7, 184.1 and 4.8% respectively (25).

Antibacterial activity of different parts of the Pinus roxburghii Sarg. extracts were found to effective against

most of the tested bacteria example leaves were found most effective against K. pneumonia (zone of inhibition ,10mm for aqueous extract), female cone effective against S. typhi and K. Pneumonia, whereas bark extract was

effective on A. Tumefaciens (Bissa et al) (55). Crude extracts from pine needles revealed by thin layer

chromatography the presence of four distinct phenolic compounds. Both the extracts were found to be inhibitory to several microbes of agricultural importance. Amongst the bacterial strains studied, Azotobacter sp (VL-A2) was able to tolerate upto 1000 ppm of crude tannin concentration without any growth inhibition. While growth of Rhizobium (VL-R1) and Bacillus halodurans (MTCC7181) was inhibited by crude tannin concentrations of 50 and 100 ppm. (Selvakumar et al) (59). Sharma et al examined the association between heterozygosity and survival in Pinus roxburghii Sarg. which could be helpful in the successful establishment of plantations (56). Bioactivity of the plants/parts has been evaluated either as repellent or as larvicide. Some of the studies pertain to the evaluation of adult mortality activity is generally tested using laboratory bioassay. Evaluation of bioactivity of oil from Pinus roxburghii Sarg. was experimented on adult mosquito species, Culex quinquefasciatus and Aedes aegypti (Naik et al) (53). Kolhapure et al reported some clinical studies that prove the benefits of topical analgesic in the management of certain acute and chronic painful inflammatory musculoskeletal conditions and hence summarized that the beneficial effects of Rupalaya gel are due to anti-inflammatory activities and antioxidant activities are due to the Pinus roxburghii Sarg. (49). IFRA (1976) has published a guideline recommending the essential oils and isolates derived from the Pinacea family, including Pinus and Abies genera, should only be used when the level of peroxides is kept to the lowest practicable level, example by adding antioxidants at the time of production. Such products should have a peroxide value of less than 10mm/lit, determined according to the EOA method (52). Miscellenious Activities: Decomposition of three root litter classes of Pinus roxburghii Sarg. was studied during 18 months to examine the temporal change in nutrient concentration and mass loss and its spatial pattern and to develop a vegetational model of litter mass loss based on the controls of climate and substrate quality (57). Thorpe

et al studied plantlet regeneration in Chir pine includes morphogenesis and histology. *Pinus roxburghii* Sarg. Sargs or Chir pine has not been regenerated in vitro and a protocol was developed for the regeneration of the species and to examine some histological aspects of the process. Some of the structural pattern of shoot histogenesis were studied in which the cotyledonary cells of the Chir pine were relatively quiescent as mitotic figures were absent. Finally observation was accounted for the deep-sited origin of the meristemoids, which leads to the shoot formation (58).

Production of Resin by Tapping: Although the existence of a worldwide industry based on the production of turpentine and rosin has given commercial impetus to the analysis of resin from pinus species (29). The family pinaceae have 110-120 species in the world and divided in to 3 sub genera. Most pines species yield resin of some sort upon tapping. Various method tapping has been adopted by different countries in accordance with development of new technology, availability of labour and tapping trees. Resin tapping system was started in fifteen century as naval stores industries in America. American used resin for sealing the crack or hole in the boat. Tapping work in India was started in 1896 (38). The oleoresin tapping also called "turpentine", implies in general to several operations, such as—selection of trees, making of blaze or face on the tree, fixing of lips and pots to collect the resin exuding from the cut-face, freshening of the blaze, collection of oleoresin and scrape (solidified oleoresin) (62). Crude resin obtained by tapping living pine trees is a thick, sticky, but usually, still fluid material. It is opaque (due to the presence of occluded moisture), milky-gray in colour, and inevitably contains a certain amount of forest debris (pine needles, insects etc.) when it is collected from the trees (44).

Chir pine is widely tapped for resin in India. Resin tapping begins at the age of 60 years in (in natural forests) when the average crop diameter is about 30 cms. Light continuous tapping is done from 60th year to 85th year. Heavy tapping is carried out for 5 years before felling. Two methods of resin tapping are employed in the country. In the old method known as cup and lip method, a blaze of 15x10 cm is cut near the base of tree and is freshened weekly throughout the tapping season. The resin is collected in a cup fixed as the base of the blaze. This method is being replaced by a new method, known as Rill method (standardized at FRI Dehradun) (45). All the Pines yield resin in greater or smaller quantities, which is obtained by tapping the trees. The crude resin is almost entirely used for the distillation of Oil of Turpentine and Rosin, only small quantities being employed medicinally - for ointments, plasters, etc. When the Oil of Turpentine is entirely distilled off, the residuum is Rosin or Colophony, but when only part of the oil is extracted, the viscous mass remaining is known commercially as common Crude Turpentine (46).

Resin tapping of *Pinus roxburghii* Sarg. has been going on for several decades. It has great economic significance, providing raw materials for domestic use and for the rosin and turpentine industry. One large resin

processing plant is being operated by Nepal Rosin and Turpentine Industry, a parastatal. Six small scale private industries are also operating. Bulk of the resin is tapped in the western and far western regions of the country (47). In Nepal, Only Chir pine can be tapped economically, as a Chir pine tree yields about 3 to 6 kilograms annually. Turpentine oil and Rosin, which are the products of resin, fetch high price in national and international markets. Rosin and its derivatives are used in paper making, sizing, boot polish, adhesives, paints, printing inks, surface coatings, varnishes, textiles, rubber making, soap making, the entire industry, the sporting goods industry, and many others. Rill method is considered the best method of sustainable resin collection, which was introduced in 1976 from Forest Research Institute, Dehradun, India. Cup and lip method was used in the past before introduction of this technique (48).

CONCLUSION

India, with its great biodiversity, has a tremendous potential and advantage in the emerging field of herbal medicine. Plants provide a variety of resources that contribute to the fundamental need of food, clothing and shelter. Plants are utilized as therapeutics agents since time immemorial in both organized (Ayurveda, Unani) and unorganized (folk, tribal, native). From the many years the traditional and ethno-botanical use of natural compounds, specially of plant origin play a important role in treating many of diseases and other area, where natural product is use, as they well tested for their efficacy and generally believed to safe for human use. In the recent year the medicinal importance of the natural product comes in to demand because they obviously deserve scrutiny on modern scientific lines such as phytochemical investigation, biological evaluation on experimental animal models, toxicity studies, investigation of molecular mechanism of action of isolated photo-principles and their clinical trials. The use of herbal drug as a medicinal purpose solve the many of compliance regarding to drug toxicity as compare to synthetic drug, but we cannot refuse to use the synthetic drug due to its specificity. Herbal drug is the best classical approach in the search of new lead molecules for management of various diseases.

With the medicinal use of the herbal plant it also uses for the many other general requirements. Medicinal plants help in alleviating human suffering and are widely used for home remedies and trade. Thorough screening of literature available on *Pinus roxburghii* Sarg. depicted the fact it is a popular remedies among the various ethnic groups, vaidyas, hakims for cure of many ailments. Following is the tribute to Himalayas, very little efforts have been made by researchers to explore the therapeutic potential of this plant and there is need to explore this plant very thoroughly.

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