Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.5232

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **5 (4):** 792-799 (2017)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Studies on Wood Chemical Parameters of *Pinus roxburghii* from Different Areas of Himachal Pradesh

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Received: 17.07.2017 | Revised: 26.07.2017 | Accepted: 29.07.2017

ABSTRACT

Pinus roxburghii is an important commercial species of the Himalayan region, it is also known for its timber, paper pulp and resin yield. The present study on chemical composition of Pinus roxburghii wood from 10 different locations of Himachal Pradesh was carried out. Five wood samples from different trees were taken from each site. These were further analysed for moisture content and chemical composition. The results revealed thatmaximum moisture content (18.32 %) and cold water soluble extractives (7.52 %) were found in Ghanahatti population. Maximum hot water soluble extractives (9.47 %) and Klason-lignin content (33.58 %) were observed in the wood samples from Nihari. Whereas, alcohol-benzene and holocellulose contents of 14.15 and 70.44 per cent were recorded in Ghanahatti and Sarahan locations, respectively.

Key words: *Pinus roxburghii, Hot water soluble extractive, Klason-lignin content, Alcohol-benzene, Holocellulose.*

INTRODUCTION

Pinus roxburghii Sargent, belonging to family Pinaceae and commonly known as chir pine which extends from northern Pakistan (North-West Frontier Province, Azad Kashmir), across northern India (Jammu and Kashmir, Punjab, Himachal Pradesh, Uttrakhand and Sikkim) and Nepal to Bhutan[27&2]. The total area under chirpine is estimated to be 8,900 km[21]. In Himachal Pradesh, it is distributed in Shimla, Kunihar, Solan, Rajgarh,Chopal, Nahan, Dalhousie, Bilaspur, Hamirpur, Palampur, Dharamshala and Nurpur divisions covering an area of 1.36 lac hectares[1].

Pinus roxburghii is an important commercial species of the Himalayan region and also known for its timber, paper pulp and resin yield[26&11]. It also has many traditional medicinal uses such as antiseptic, diuretic, diaphoretictonic, vermifuge and rubefacient as well as cultural uses[20].

Chirpine turpentine have 25-35 per cent alpha-pinene, 5-10 per cent beta-pinene, 50-60 per cent delta-3 carene, 2 per cent longifolene and 3-5 per cent other terpenes.

Cite this article: Kumar, V. and Sharma, K.R., Studies on Wood Chemical Parameters of *Pinus roxburghii* from Different Areas of Himachal Pradesh, *Int. J. Pure App. Biosci.* **5(4):** 792-799 (2017). doi: http://dx.doi.org/10.18782/2320-7051.5232

These terpenes are of considerable industrial importance, finding use in the manufacture of essential commodities, finding use in the manufacture of essential commodities of day to day life such as soaps and cosmetics; scents and incense; paints and varnishes; coatings and lacquers; rubber and adhesives; insecticides and pesticides; paper, textiles, leather and a wide range of other goods, which are very vital for economic and industrial development of India[22].

The chir pine populations growing in Himachal Pradesh show a good amount of variation. Hence, the chir pine populations under present work have been selected by scientist of HFRI Panthaghati, Shimla for DUS (Distinctness, Uniformity and Stability) characteristics.The present investigation was undertaken with the objective to study the variation in the chemical parameters of wood.

MATERIAL AND METHODS

The present investigation was carried out in the Department of Forest Products, College of Forestry, Dr. Yashwant Singh Parmar University of Horticulture and Forestry Nauni, Solan, 173230 (H.P) during 2014-2015. The details of materials used and methodologies followed are given bellow.

Experimental details

S.No.	Sites	District	Longitude	Latitude
i.	Platu	Hamirpur	76^0 30 E	31^0 36 N
ii.	Nihari	Bilaspur	76^0 31 E	30^0 53 N
iii.	Swarghat	Bilaspur	76^0 31 E	30^0 53 N
iv.	Nurpur	Kangra	75^0 53 E	32^0 17 N
v.	Malan	Kangra	76^0 25 E	32^0 06 N
vi.	Ghanahatti	Shimla	77^0 17 E	31^0 10 N
vii.	Banetthi	Sirmour	76^0 48 E	30^0 51 N
viii.	Chabbal	Solan	76^0 57 E	30^0 56 N
ix.	Rajgarh	Sirmour	77^0 18 E	30^0 51 N
x.	Sarahan	Sirmour	77^0 11 E	30^0 43 N
xi.	Control (Teak) from market			

Replications = 5

Design = Randomized Block Design (RBD)

Parameter to be observed in the present study:

i) Moisture content (%)

Fresh weight of the samples was recorded just after they were cut from the logs. After initial weighing, the samples were oven dried first at 60^oC for few hours and then at 102 ± 1^oC till constant weight. This weight of samples was recorded as oven dried weight (g).

The moisture per cent of the samples was calculated by using the formula given by Desch and Dinwoodie[4].

$$\text{Moisture content (\%)} = \frac{M_{ini} - M_{od}}{M_{od}} \times 100$$

Where,

M_{ini} = Initial weight of samples (g)

M_{od} = Oven dried weight of sample (g)

ii) Determination of water soluble extractives

The water soluble extractives were determined by employing the following methods.

a) Cold water solubility

Two grams of oven dried wood meal was weighed and transferred into a conical flask containing 300 ml double distilled water. The mixture was digested at room temperature with frequent stirrings for 48 hours. The material was then filtered through IG-1 crucible and washed thoroughly with cold distilled water and dried to a constant weight in an oven at 105±3°C. The cold water solubility was determined by calculating the loss in weight of the sample taken and was expressed as percentage on the basis of oven dry weight of wood.

b) Hot water solubility

Two grams of oven dried wood meal was taken in flask having 100 ml of double distilled water fitted with reflux condenser. It was digested on boiling water bath for 3 hours. The contents were then filtered through IG-1 crucible and the residue was dried in an oven at 105±3°C till constant weight. The solubility was determined by calculating the loss in weight of the sample taken and expressed in percentage.

iii) Alcohol-benzene extractives

Two grams oven dried powdered sample was placed in a porous thimble (oven dried and weighed). The thimble was placed in a soxhlet apparatus and extracted with 200 ml of alcohol-benzene (1:2 v/v) for six hours. The porous thimble was then taken out and allowed to dry in open air and finally in an oven at 105±3°C till constant weight. The alcohol-benzene soluble extractives were determined by calculating the loss in weight of the sample taken and expressed in percentage.

iv) Klason-Lignincontent

Two grams oven dried sample pre-extracted with alcohol-benzene (1:2 v/v) was treated with 15 ml of 72 per cent sulphuric acid for 2 hours at 18-20°C with constant stirrings. The material was brought down to 3 per cent by adding 345 ml. of double distilled water. The solution was refluxed for 4 hours and then allowed to settle. The contents were filtered, washed with hot distilled water and dried in an oven at 105±3°C till constant weight and expressed in percentage on oven dry weight basis.

v) Holocellulose

Five grams oven dried sample pre-extractcd with alcohol-benzene (1:2 v/v), was taken in a conical flask and 160 ml. of double distilled water was added to it. The contents were treated with 1.5 gram of sodium chlorite and 10 drops of acetic acid at 70-80^{o}Con a water bath for one hour. The process was repeated four times till the meal became white. The contents were then filtered through IG-2 crucible, washed with water and finally with acetone. The sample was dried in an oven at 105±3 °C to a constant weight. The extracted holocellulose content was calculated on the basis of the oven dry weight and expressed in percentage.

RESULTS AND DISCUSSION

The results of present study has been described under the following sub heads:

Moisture content

The data related to moisture content of wood samples of *Pinus roxburghii* populations are presented in Table-1. The maximum moisture content was observed in Ghanahatti (18.32%) which was statistically at par with Nihari (18.30%), Swarghat (16.88%), Rajgarh (16.05%), Malan (16.01%), Sarahan (16.00%) and Platu (15.84%).The minimum moisture content of 12.87 per cent was observed in control (Teak) and among chirpine populations, the minimum value was found in Banethi (13.82%) which was statistically at par with Nurpur (14.96%).

The wood is hygroscopic in nature and extent of hygroscopicity depends upon the cellular composition of wood. Increased moisture content percentage in *Pinus roxburghii* wood samples from different sites might be due to the variation in wood percentage, wood porosity andcellular composition. In the present findings there is significant variation in moisture content of

wood samples from different populations. The similar results are reported by El Baha *et al*.[5] in *Leucaena leucocephala*, Kumar[12] in *Eucalyptus teriticornis* and Nimkar[18].

Table: 1: Variation in moisture content,cold water soluble extractives (%), hot water soluble extractives (%) and alcohol-benzene extractives (%) in wood of *Pinus roxburghii*

Sites	Moisture Content (%)	Cold water soluble extractives (%)	Hot water soluble extractives (%)	Alcohol-benzene extractives (%)
Platu	15.84	6.72	8.71	11.17
Nihari	18.30	7.05	9.47	12.46
Swarghat	16.88	7.48	8.73	11.43
Nurpur	14.96	7.10	8.90	14.06
Malan	16.01	6.66	8.45	11.91
Ghanahatti	18.32	7.52	9.31	14.15
Banethi	13.82	6.87	8.60	12.06
Chabbal	15.66	7.44	9.24	12.66
Rajgarh	16.05	7.15	9.09	13.55
Sarahan	16.00	6.57	8.68	10.93
Control(Teak)	12.87	9.17	12.17	14.56
Mean	15.88	7.24	9.21	12.63
SE(d)	1.24	0.30	0.35	0.41
$CD_{0.05}$	2.52	0.62	0.72	0.84

Cold water solubleextractives of wood

The data on cold water soluble extractives of wood from different sites of *Pinus roxburghii* are presented in Table 1. A critical observation of data revealed significant variation. The highest value of 9.17 per cent was noticed in Teak. However, in chir pine populations the highest value of 7.52 per cent was recorded in Ghanahatti which was statistically at par with Swarghat (7.48%), Chabbal (7.44%), Rajgarh (7.15%), Nurpur (7.10%) and Nihari (7.05%). The lowest value of 6.57 per cent was obtained for Sarahan which was statistically at par with Malan (6.66 %), Platu (6.72 %), Banethi (6.87%), Nihari (7.05%), Nurpur (7.10%) and Rajgarh (7.15%).

The cold water soluble compounds in wood are generally sugars, salts, tannins and gums. However, in conifers tannins and gums may not be present. The species containing large amount of extractives have better durability, dimensional stability and plasticization. The variation in cold water soluble extractives of wood has been reported by Guler *et al.*[9] in *Pinus nigra*, Kumar *et al.*[13] in *Dalbergia sissoo*. The content, type and position of extractives affect the strength properties of wood[19], thus, making these studies imperative.

Hot water soluble extractives of wood

The data related tohot water soluble extractives of wood from different sites of *Pinus roxburghii* are presented in Table 1. The maximum value of 12.17 per cent was observed for Teak. Among chir pine populations, the highest value of 9.47 per cent was recorded in Nihari which was statistically at par with Ghanahatti (9.31 %), Chabbal (9.24 %), Rajgarh (9.09%) and Nurpur (8.90%). The minimum value of 8.45 per cent was recorded for Malan which was statistically at par with Banethi (8.60 %), Sarahan (8.68 %), Platu (8.71%), Swarghat (8.73%), Nurpur (8.90%), Rajgarh (9.09%), Chabbal (9.24%) and Ghanahatti (9.31%).

The significant differences are noticed among different sites of *Pinus roxburghii* studied for hot water soluble extractives of wood. Generally, the hot water contents of wood are gums, resins, tannins, sugars, salts and phenols. The variation in contents in the pine wood samples from different sites may be attributed to variable level of accumulation. The variation in wood extractives has also been reported by Guler *et al*.[9] in *Pinus nigra*, Kumar *et al*.[13] in *Dalbergia sissoo*, Silva *et*

al.[24] in *Eucalyptus grandis*, Esteeves *et al.*[6] in *Pinus pinaster*, Hernandez and Salazar[10] in *Quercus coccolobifolia*, Q. *durifolia, Q. rugosa* and *Q.oleoides* and Gierlinger *et al.*[8] in *Larix* species.

Alcohol-benzene soluble extractives of wood

The data on alcohol-benzene extractives of wood samples from different sites of *Pinus roxburghii* are presented in Table 1. The maximum alcohol-benzene solubility of 14.56 per cent was recorded in Teak wood samples. Among pine wood samples, the maximum value of 14.15 per cent was found in Ghanahatti, which showed parity with 14.06 per cent in Nurpur and 13.55 per cent in Rajgarh. The minimum value of 10.93 per cent was recorded in Sarahan, which was statistically at par with Platu (11.17 %) and Swarghat (11.43 %).

Alcohol-benzene solubility of wood is an important character representing extractives present in wood which affect the pulping quality. The components which are generally soluble in alcohol-benzene are oleoresins, fats and waxes. The present investigations are similar to the studies of Liang[15] in *Acacia mangium,* Mahdavi *et al.*[16] in *Eucalyptus camaldulensis*, Hernandez and Salazar[10] in *Quercus coccolobifolia, Q. rugosa* and *Q.oleoides* and Fakhrian *et al.*[7] in *Alnus glulmosa.* These species are found growing in varied habitats hence have variation in growth, so accumulation of extractives may be variable. The significant differences have been observed among different sites of *Pinus roxburghii* studied for alcohol-benzene soluble extractives of wood. The variation in alcohol-benzene soluble extractives of *Pinus roxburghii* have also been reported by Nimkar[18]. The similar variation is also reported by Morais *et al.*[17] in *Pinus oocarpa.*

Klason-lignin and Holocellulose content of wood

The data presented in Table 2 revealed significant variation in wood samples from different sites of *Pinus roxburghii*. The highest value of 33.58 per cent was noticed, in Nihari which was statistically at par with Nurpur (32.97%), Ghanahatti (32.06%) and Platu (31.52%). The minimum value of 29.04 per cent was found in Sarahan which are statistically at par with Chabbal (29.10%), Banethi (29.41%), Malan (29.80%), Rajgarh (30.11%) and Swarghat (31.03%).Teak wood sample was found to have the lignin content of 29.15 per cent, which was statistically at par with minimum value.

Perusal of Table 2 also revealed significant difference among all the sites of *Pinus roxburghii* for holocellulose content of wood. The maximum value of 70.44 per cent was recorded in Sarahan, which was statistically at par with Banethi (70.14%), Rajgarh (69.57%) and Chabbal (69.32%). The site Nihari (64.91%) recorded minimum holocellulose content followed by statistically at par with Malan (66.41 %). The holocellulose content in Teak was 70.68 per cent.

Beleam and Harkin[3] have reported that lignin content varies among species, individuals and within plant. The possible reason for variation in cell wall constituents can be assigned to the varied production of dry matter. The lignocellulosic materials having higher lignin have lower holocellulose content and vice-versa[22].

In present study, there is significant difference in both holocellulose and lignin contents of wood. Sczukowski *et al.*[25] have reported variation in lignin and holocellulose contents of *Salix viminalis* and its cross with *Salix purpurea.* Kumar[14] while working on *Dalbergia sissoo* and Beleam and Harkin[3] in *Eucalyptus* hybrid have also reported the similar findings. Guler *et al.*[9], while working on *Pinus nigra* and Nimkar[18] on *Pinus roxburghii* have observed the similar trends in both lignin and holocellulose contents.

Table 2: Variation in Lignin (%) and Holocellulose (%) in wood of *Pinus roxburghii*

Sites	Lignin (%)	Holocellulose (%)
Platu	31.52	67.06
Nihari	33.58	64.91
Swarghat	31.03	68.62
Nurpur	32.97	67.57
Malan	29.80	66.41
Ghanahatti	32.06	67.04
Banethi	29.41	70.14
Chabbal	29.10	69.32
Rajgarh	30.11	69.57
Sarahan	29.04	70.44
Control (Teak)	29.15	70.68
Mean	**30.70**	**68.34**
SE(d)	**1.06**	**0.67**
$CD_{0.05}$	**2.15**	**1.34**

CONCLUSION

In Himachal Pradesh, *Pinus roxburghii* Sargent, is distributed in Shimla, Kunihar, Solan, Rajgarh, Chopal, Nahan, Dalhousie, Bilaspur, Hamirpur, Palampur, Dharamshala and Nurpur divisions covering an area of 1.36 lac hectares. Out of these divisions, 10 sites were selected which shows the good amount of variations. From the present study, it was concluded that different chemical parameters viz. moisture content,cold water soluble extractives,hot water soluble extractive, alcohol-benzene, Klason-lignin content, and holocellulose were varied from 13.82 to 18.32 per cent, 6.57 to 7.52 per cent, 8.45 to 9.47 per cent, 10.93 to 14.15 per cent, 29.04 to 33.58 per cent, and 64.91 to 70.44 per cent, respectively among selected chir pine populations. It was recommended from the study that chir pine wood present in Nihari, Ghanahatti and Sarahan was very useful for manufacture of essential commodities of day to day life such as soaps and cosmetics; scents and incense; paints and varnishes; rubber and adhesives; and a wide range of other goods, which are very vital for economic and industrial development of the state and nation.

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