



Characteristics and Quality Assessment of Oleoresin Production through Bore-hole Method in Chir-pine Under Narendranagar Forest Division, Uttarakhand, India

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ABSTRACT

The present study aimed to evaluate the Oleoresin quality in Chir-pine. It was observed that the main compounds of Chir-pine's Oleoresin were Rosin, α and β -pinene with the highest percentage and are considered products with high commercial value. There was significant variation recorded while testing the quality of Oleoresin in Chir-pine. Oleoresin obtained from the Bore-hole method was found to be pure as compared to the traditional Rill method. The content of Rosin, α - Pinene, β - Pinene, Carene, and Turpentine oil was in good quality in Bore-hole method. It was further observed that in 1 Kg of Oleoresin, about 70.00 -72.20 % of Rosin was obtained in Rill method whereas in Bore-hole method, approximately 74.10 % of Rosin. On the other hand, α - Pinene, β - Pinene was significantly recorded with 20.80 and 03.40 in Bore-hole method as compared to the three year data of Rill method which showed the purity of the Oleoresin in Bore-hole method. So, the present study recorded that best quality of Oleoresin in Bore-hole method as compared to the Rill method.

INTRODUCTION

Pinus is one of the most important species used commercially for the production of resin as well as in the paper and pulp industry. About 600 species of *Pinus* are known till date which is being commercially tapped. Oleoresin is an important Non-wood forest product obtained from *Pinus* by various tapping methods such as Rill, Bark streak, Bore-hole in which chemical stimulants to avoid cicatrization. About 90% of the resin is produced from five to six pine species namely *Pinus roxburghii*, *P. elliptic*, *P. yunnanensis*, *P. caribaea* and *P. merkussii*, *P. massoniana* around the world. China, Brazil, and Indonesia together produce more than 90% of the pine resin in the world. The other producers includes India, Argentina, Mexico, Nepal, Russian Federation, Portugal, Spain, Cuba, Vietnam, Madagascar, Fiji, Honduras, South Africa, Colombia, Malaysia, and Uruguay. As per recent

records, China is the leading producer of Oleoresin in the world preceding Brazil, US, and India. Brazil produced the highest Oleoresin in 2012-2013 with 96 million tons (ARESB, 2013).

The production of resin in countries like Spain was approximately, 55,000 Tones per year (Justes and Solino, 2018), but due to the lower cost and other factors also has abandonment of resin activities Ortuno ~ Perez et al., 2013). Oleoresin generally consists of terpine and diterpenes which is a fraction of rosin, is highly valuable Non-wood forest product having different industrial use (Neis et al., 2019b; Rodrigues-Correa et al., 2012). In *Pinus*, the resin is produced and a complex network of radial and axial resin ducts is responsible for its storage and through which it flows (Vazquez-Gonzalez et al., 2020). Resin is collected from mechanical wounding an chemical stimulation (Rodrigues-Correa et al., 2013).

Pinus roxburghii Sargent (Pinaceae) commonly known as “Chir Pine” is one of the most important species of the Western Himalaya which covers an area of 8900 km² in India (Sharma, 2002). Chir-pine grows between altitudes of 450-2300 amsl. It widely occurs in Himachal Pradesh, Jammu and Kashmir, Uttarakhand, Arunachal Pradesh and West Bengal. In India, Chir-pine occupies an area of 412,000 ha in Uttarakhand, 158,813 ha in Jammu and Kashmir, and 1,36000 ha in Himachal Pradesh (Anonymous, 1990). Pine trees naturally grow in Uttarakhand and the local inhabitants use different parts of the plant for various purposes. The houses are mostly constructed with the help of the timber extracted from the plant.

The whole belt of the Himalaya has been diversified for medicinal and aromatic wealth which has been although explored but more information needs to come yet on the status of medicinal and ethnomedicinal plants (Akash et al., 2020a). Every year diversity, structure, pattern of species and regeneration potential changes have to be explored (Akash et al., 2019, 2020b). Oleoresin mainly consists of terpenoids, gum, rosin, and turpentine oil (Bohlmann-Keeling, 2008). Turpentine can be separated into α - and β -pinene. α -pinene is used as an insecticide and for the preparation of synthetic oils, flavor, and as a fragrance ingredient whereas β -pinene is used mainly in the Pharma industry in the manufacturing of various products (Stubbs et al., 1984). On the other hand, the rosin is used for coating and in preparation of rubber and adhesives (Rodrigues-corrêa et al., 2012, Stubbs et al., 1984). Therefore, the present study aims to characterize the quality and characteristics of Oleoresin obtained from Chir-pine in Narendranagar forest division under Garhwal Himalaya.

MATERIALS AND METHODS

The present study was carried out during 2020 with in three different Compartment of Narendranagar Range lies at 30° 29' to 30° 3' N latitude and 78° 10' to 78° 53'E longitude from July to September. Narendranagar Forest Division comes between the Alaknanda River in the east with the forest ranges of Rudraprayag Forest Division and by Mussoorie-Dehradun Forest Division in the West. The present study area is highly occupied with *Pinus roxburghii* (Chir-Pine) with an area of

22977 ha along with *Quercus-Rhododendron* community, *Shorea-mallotus* community, and mixed dense forest community. Most of the residents of the area were Garhwali and small villages of Muslim. They live in the vicinity of the forest and depend on the forest for sustainability and livelihood. In the first phase, Bore-hole was implemented as a trial base in the Narendranagar forest division. *Pinus* forest was divided into different diameter ranges 20-30, 30-40, 40-50, 50-60, 60-70, and 70-80 cm. Hand-driven drill bits of 1.00 inch, 1.25 inch were made for drilling bore-hole. The chemical stimulant was sprayed and small pipes were fixed tightly in the holes which are attached to the plastic bags on which the Oleoresin collected. Analysis of variance (ANOVA) and Pearson correlation was done for statistical analysis by using the SPSS (Statistical Package for Social Science) Version 20.

RESULTS AND DISCUSSION

Quality and Characteristics Assessment of Oleoresin

Oleoresin is an important Non-wood forestry product because the different conventional and potential uses of its terpenes. Oleoresin is an essential source of terpenes which forms a volatile fraction called turpentine and a solid fraction called rosin. Oleoresin is used in different industries like cosmetics, food, pharmaceuticals, chemicals, and in the preparation of various products like varnishes, insecticides, adhesives, and disinfectants (Mercier et al., 2009; Kelkar et al., 2006). In spite of the fact that all the pines are capable of producing good quantity and quality of resin. The superiority of resin without impurities is one of the most important advantages of Bore-hole technique as the Oleoresin is collected in almost in a tight bag attached to the spout.

In the present study, we have analyzed the quality and characteristics of Oleoresin in Bore-hole method. Further, we also have recorded the comparative analysis of the Oleoresin obtained from both Bore-hole and Rill method. It was observed that there were the significant variation in the Rosin %, α - Pinene, β - Pinene, Carene and Turpentine Oil % in all the year both in Rill and Bore-hole method. The quality of the rosin and turpentine and other products are much better than the Oleoresin

obtained from rill method hence sold with high price.

The present study recorded best quality of Oleoresin in Bore-hole method as compared to the Rill method. In 1 Kg of Oleoresin, about 70.00 - 72.20 % of Rosin was obtained in Rill method whereas in Bore-hole method, approximately 74.10 % of Rosin was obtained which was best among all the three years of Rill method. On the other hand, α - Pinene and β - Pinene was simultaneously recorded with 18.55 -19.89 and 3.20 -3.25 in all three years but in Bore-hole the α - Pinene and β - Pinene was 20.80 and 03.40 which was best as compared to the three year data of Rill method. It was further observed from the present study that the quality of Turpentine Oil and Carenein in Rill method varied from 14.00 -16.20% and 50.62 - 54.62 in all the studied three years which was less compared to the study of Bore-hole method where the quality of Turpentine Oil was 18.50% and Carene was 55.02. So there were huge differences recorded in both method while observing the quality and characteristics of Oleoresin. Bore-hole method was found to be very effective in terms of quality parameters Viz. Rosin%, α - Pinene, β - Pinene, Carene and Turpentine Oil. Various species are being tapped all over the world (Langenhein, 2003 and Coppen and Hone, 1995) such as *P. elliottii*, which also showed good and reasonable composition of turpentine.

On the other hand, *P. pinaster*-Maritime pine, *P. halepensis* Mill. - Aleppo pine, *P. caribaea* Morelet - Caribbean being tapped over the world which produces good quality of Oleoresin. Our

results presented in Table 1 show the essential quality products obtained from the Oleoresin in *Pinus*. According to Silvestre e Gandini (2008), dehydroabietic acid a diterpenoid, is also an essential compound in Oleoresin obtained from *Pinus*. Dehydroabietic acid constitutes about 15.38% of the total of Oleoresin.

α and β -pinene determine the quality of the Oleoresin as per their different concentration. α and β -pinene are the main component of turpentine oil (Graikou et al., 2012; Rodrigues-Corrêa et al., 2012). In the present study, it was observed that there were significant variations in the Rosin %, α - Pinene, β - Pinene, Carene, and Turpentine Oil % in all the year both in Rill and Bore-hole method. The quality of the rosin, turpentine, and other products are much better than the Oleoresin obtained from Rill method hence sold with high price. The two essential compounds (α and β -pinene) is highly appreciated by the industry which deals with NWFP (Non-wood forest products). Industry deals with pharmaceuticals, insecticides, repellents, solvents, flavor, and fragrances industries mainly depend on the α and β -pinene for the preparation of various products (Zulaicavillagomez et al., 2005; Mercier et al., 2009; Silva et al., 2012). α and β -pinene, are found in huge quantities in various species of Pine such as *P. sylvestris*, *P. pinea*, *P. halepensis*, *P. brutia*, and *P. halepensis* (Ustun et al., 2012). Pinenes is also act as a natural antifungal agent for treating various fungal diseases (Chang et al., 2008; Matan et al., 2012).

Table 1. Comparative Analysis of Oleoresin Quality

Parameters	Rill Method (01 Kg Raw Resin)			Bore-hole Method (01 Kg Raw Resin)
	2018	2019	2020	2020
Rosin %	70.00	71.1	72.20	74.10
Turpentine Oil %	14.00	15.00	16.20	18.50
α - Pinene	18.55	19.20	19.89	20.80
β - Pinene	03.20	03.05	03.25	03.40
Carene	50.62	52.50	54.62	55.02

* Bore-hole was applied firstly in Narendranagar forest division under the supervision of DFO

Comparative Analysis of Oleoresin Production in Bore-hole and Rill Method

It has been observed from various studies that the resin yield varied across the season (Hood and Sala, 2015; Lombardero et al., 2000; Neis et al.,

2018 and Rodrigues et al., 2009, Zas et al., 2020) as there is variation in the air tem, availability of water and other factors (Blanche et al., 1992; Gaylord et al., 2007; Rodriguez-Garcia et al., 2015, 2018). As per the study of Hood and Sala, 2015; Rodriguez-

Garcia et al., 2016, groove-to-groove variation in resin yield is also affected by accumulation of induced response and wounds on the bark. Pinenes are the most important compounds of turpentine purchased by various industries for obtaining pine oil and food additives (Limberger et al., 2012; Hagedorn and Kaphammer, 1994; Swift, 2004). It was observed that Alpha-pinene is often the highly obtained compound of pine turpentine, whereas β – Pinene is the isomer with the highest value for the chemical industry. A comparative analysis was also done from our results with the traditional rill method to determine the production and cost of the total Oleoresin obtained in the three compartments. In Advani, 3.03 ltr/per tree of Oleoresin was recorded followed by 3.01ltr/per tree in Udkhanda, and 2.32 ltr/per tree of Oleoresin in Fakot. It was observed that the rate of Oleoresin has varied significantly in the past few years. The rate of Oleoresin varied from 3241 – 8250 per quintal from 2015-2020 in Rill method but 9000/ quintal for the Oleoresin obtained through Bore- hole method. Rate of Oleoresin also varied with the purity of the Oleoresin. Our earlier studies revealed that the cost of Oleoresin in Bore-hole was `752.40 (cost of 8.26 ltr. Oleoresin) whereas in Rill method it was `194.70 (cost of 2.36 ltr. Oleoresin). The tapping of Oleoresin can be extended by using the lower diameter of Chir-pine depending upon their production potential without any severe damages. It will not only supplement the production but also tackle the problem of reduction of blazes.

Table 2. An Overview of Yield in Rill Bore-hole Method

No.	Compartment	Bore-hole/tree (Ltr)	Rill Method/tree (Ltr)
1	Udkhanda	3.01	1.17
2	Advani	3.03	1.19
3	Fakot	2.32	NA
	Total	8.36	2.36

NA = Not applicable as the method was not applied

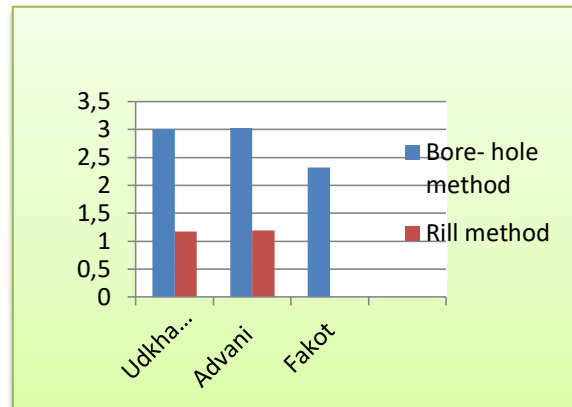


Figure 1. Oleoresin production potential in three compartments of Narendranagar forest division

Oleoresin Production Potential in Bore-hole Method

As per the report of Lekha (2005), the Oleoresin obtained from Bore-hole method was much superior and without impurities in comparison to Oleoresin obtained from Rill method. Although he used the chemical stimulant with 10% ethephon and 20% H_2SO_4 at the depth of 3.125 cm diameter with 17.5 cm depth holes. The quantity also seems to be obtained highest. The study also recorded that Oleoresin yield increased with greater diameter and depth of boreholes. The production of Oleoresin increasing greatly especially in the Himalayan state. Production was very high from 1975-76 but it decreased significantly in 25000 tonnes in 1990-91 and 25000-30000 tons were recorded in 1994-95 (Coppen and Hone, 1995). The main reason for the decline of production was less number of tapping, unavailability of good equipment, damaged by the use of inefficient and incorrectly applied method of tapping.

Further due to the great importance of Oleoresin in resin industry the demands increases highly in recent years. This forest product also has got increasing importance in the national economy. In present study, the data of the three compartments has been presented which showed that In Udkhanda, the overall production of Oleoresin was maximum recorded with 117.23Ltr in the month of August followed by in September with 31.57Ltr and 13.80Ltr in July whereas in Fakot, maximum production was recorded in the month of August with 45.22Ltr. Followed by 11.26Ltr in September but no production was recorded in the month of July. In Advani, maximum production was recorded

in August with 216.05Ltr whereas 25.90Ltr in September.

There was high production of Oleoresin was recorded in these three studied compartments. So traditional methods like cup and lip was replaced by Rill method and Bore-hole in state like Himachal and then other states. It was also observed that the rate of Oleoresin was varied significantly due to the quality of the resin obtained in recent years. All the species of *Pinus* produce different concentrations of pinene. In *Pinus radiata*, produces turpentine with the best quality of α – Pinene and β – Pinene but at the same time, it also produces less quantity. It was due to the presence of an extra undesirable compound monoterpene 3-carene (Coppen and Hone, 1995). Further, the as per the requirement of trade, choosing of pine species is also crucial step for tapped. In the present study, the content of Rosin, α - Pinene, β - Pinene, Carene, and Turpentine oil was in good quality in Bore-hole method. It was further observed that in 1 Kg of Oleoresin, about 70.00 -72.20 % of Rosin was obtained in Rill method whereas in Bore-hole method, approximately 74.10 % of Rosin.

On the other hand, α – Pinene and β – Pinene was significantly recorded with 20.80 and 03.40 in Bore-hole method as compared to the three year data of Rill method which showed the purity of the Oleoresin in Bore-hole method. The overall production also varied in all the three months in all

three studied compartments of the study area. In Udkhanda, the overall production of Oleoresin was maximum recorded with 117.23 Ltr in the month of August followed by in September with 31.57Ltr and 13.80 Ltr in July. In Fakot, Maximum production was recorded in the month of August with 45.22Ltr. followed by 11.26Ltr in September whereas no production was recorded in the month of July. In Advani, maximum production was recorded in August with 216.05Ltr whereas 25.90Ltr in September. No production was recorded in the month of July in Advani compartment.

In the present study, it was observed that the quality of Oleoresin was good in Bore-hole as compared to rill method. So, the rate of Oleoresin varied with the purity. The rate of oleoresin varied from 3241 – 8250 per quintal from 2015-2020 in Rill method but 9000/quintal for the Oleoresin obtained through Bore-hole method. The comparative analysis of data reveals that the cost of Oleoresin in Bore-hole was `752.40 (cost of 8.26 ltr. oleoresin) whereas in Rill method it was `194.70 (cost of 2.36 ltr. oleoresin) in 2021. So, Bore-hole method has proved to be a less injurious method so far as the health of trees and the production of wood is concerned. However, the lesser yield is a big hurdle in its implementation but the successful attempts made to increase the yield are bearing fruits.

Table 3. Overall Oleoresin Production in Three Compartments

Months	Udkhanda (Ltr)	Fakot(Ltr)	Advani(Ltr)
July	13.80	0.00	0.00
August	117.23	45.22	216.05
September	31.57	11.26	25.90

* Data of best 240,137 and 683 trees of Chir-pine in three compartments of Narendranagar range

CONCLUSION

The Oleoresin production of pine is not only important to resin industries but it has also got immense potential to generate employment to rural people. Various methods of Oleoresin tapping have been used in the past but a new method known as Bore-hole method has been developed which is superior to other methods in improved quality and no impurities. The turpentine, rosin, and other products manufactured from it will be better and fetch higher prices. Therefore, the present study was

carried out to study the quality of Oleoresin yield. It was concluded from our results that the quality and characteristics of Oleoresin production depend on the techniques used in tapping. Bore-hole can play a significant role as the method can provide high production, cost, and purity of the resin. Further study also suggests that different concentrations of chemical stimulants can be used when the environmental conditions are unfavorable. The results also indicated that higher yield and good cost of resin tapping can be achieved by using the Bore-

hole as an alternate method along with managing the subset of *Pinus* trees based on different diameter classes.

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