

Original Research Article

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Standardization of Sustainable Oleo Gum Resin Tapping Technique in Salai (*Boswellia serrata* Roxb.) from Tropical Dry Deciduous Forest of Chhattisgarh

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ABSTRACT

Boswellia serrata (Salai guggul), is a moderate to large sized branching tree of family Burseraceae, grows in dry mountainous regions of India, Northern Africa and Middle East. Oleo-gum resin of *Boswellia serrata* 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) since last several centuries it cures various ailment especially rheumatism, Cancer and skin diseases. A field experiment was carried out on sustainable tapping methods conducted for one year to standardize the tapping methods, tapping seasons, chemical concentration. Trees of 80-150 cm girth (GBH) are selected in natural forest stands of Deopur Forest Range, Balodabazar Forest Division of Chhattisgarh. To obtaining the maximum oleo gum resin from this lesser known species, different tapping techniques have been applied to enhance the gum production without harm to standing trees. The trees of *B. serrata* by use of Mechanical + Chemical treatment tapping technique total quantity of gum produced in two season was highest in summer (2019) by using H₄30% conc. of ethephon the yield was 52.94 g/tree and in winter (2018) maximum gum was obtained by using V₃ 20% conc. ethephon the yield was 26.18 g/tree in winter season. Whereas, in Mechanical tapping techniques maximum gum was obtained by square shape cut method and the yield was 10.82 g/tree the other two method i.e., V shape and Hole shape not much effective for sustainable production of gum. The physiochemical properties of exudates oleo gum resin were investigated in the laboratory and was found to be mild acidic in nature with high moisture content of 17.32% and low ash content of 1%. This technique was found simple, safe and ensure sustainable gum yield, regeneration and survival of the tapped trees, having no deep incision on bole of trees which resulted no mortality with higher gum yield.

Keywords

Gum tapping,
Exudation, Oleo
gum resin,
Ethephon,
Sustainable yield

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Introduction

Salai gum is obtained from tree called *Boswellia serrata* which is also known as

Salai guggal, gum olibanum or frankincense tree. It is one of the most important forest products of our country. The genus *Boswellia* belongs to the family of Bruseraceae and

extent widely in the dry regions of tropical Africa, Arabia and India. The two most important trees *Commiphora* and *Boswellia*, produces gum resins that are of considerable high commercial value as raw materials for various products. The leaves of this tree is imparipinnate, alternate 30-45cm long, crowded at the ends of branches, leaflets 17-31, opposite, variable in shape and size. Flowers are small, white in short racemes, and crowded at the ends of branches. Fruits are trigonous, 12mm long, drupe, containing three 1-seeded Pyrenes, winged along the margins. Seed are compressed, hard and winged.

Worldwide there are about 18 species of *Boswellia* which are either shrubs or trees with outer bark often flaking. Out of these, only two species i.e. *B. serrata* and *B. ovalifoliolata* are distributed in India (Arabia, 2005). Two new species (*B. bullata* and *B. dioscoridis*) were recently identified in Yemen as reported by (Thulin 2001). Out of these, only two species i.e. *B. serrata* and *B. ovalifoliolata* are distributed in India (Arabia, 2005). In India it has a well marked distribution in central India between 16⁰ to 31⁰ N Latitude and 73⁰ to 86⁰ E Longitudes. It is a moderate to large branching tree, found in dry deciduous forests, being common in dry hills throughout India. The tree occurs mainly in Madhya Pradesh, Andhra Pradesh, Odisha, Rajasthan and Gujarat and to a lesser extent in Maharashtra, Uttar Pradesh and in other dry and tropical regions of the country but it is almost absent in the moist regions of North-east India and Western Ghat region. It is a characteristic species of dry teak forest, Southern dry mixed deciduous forests, dry peninsular Sal forest, northern dry mixed deciduous forest, and the edaphic climax type of the dry deciduous forests (Champion and Seth, 1968). It is present either singly or in pure belts or patches. Naturally the tree is found on the slopes and ridges of hills, as well as on flat terrain.

The tree is resistant to frost and serves as a nurse tree for other species grown in forest. It is a strong light demander and does not tolerate shade. It is extremely resistant to drought and resists fire better than any other species in its zone of occurrence. It typically grows well on neutral soils above schist, quartzite, and limestone and sandstone gneiss. It produces root suckers, coppices and pollards well. The species has the ability to resist in the poorest and the shallow soils where most of its associates remain stunted. The tree can be found up to 1150 m in elevation. The gum obtained from this tree commonly known as Salai guggal, gum olibanum or frankincense having constituents: gum: 20-36%, acid resin: 56-65% and volatile oils: 4-8%. Besides, the acid resin of *Boswellia serrata* usually contains 43% boswellic acids. Additionally the gum has been reported to contain arabinose, galactose, xylose, galacturonic acid and digitoxose (Holmes, 1999).

The extract obtained from this plant known as Shalaki extract. These extracts made into a very fine powder and transformed into a liquid like substances. Its gum is used for multiple health and medicinal benefits as per Ayurvedic system of medicine this extract is also known for its anti-inflammatory properties and ability to manage inflammatory disorders, reduce arthritis pain and also speed up healing from infections. These extract from this tree has proved to be beneficial in the prevention of loss of cartilage and also found as an effective painkiller. The tree extract are used in many industries such as beverage, cosmetics, spa treatment food and aromatherapy. Commercial tapping of gum and resin is done by blazing, peeling or making deep incision on the bole of tree (Nair, 2000). In case of gum extraction, it is generally observed that excessive injury caused due to unscientific methods of tapping and overexploitation lead to death of trees this is very serious issue. In this experiment we

are developing sustainable gum tapping techniques without giving any harm to tree.

Materials and Methods

Study area

The study was carried out in natural forest stands where *Boswellia serrata* is available in mixed stand at Compartment no 281 of Deopur Forest Range in Balodabazar Forest Division (Chhattisgarh), the study area reclined between 21^o 23' N Latitude and 82^o 33' E Longitude with an altitude of 319 above Mean seal level. The study was carried out from October 2018 to May 2019. The average rainfall of the district is 974 mm, temperature varies from 16^o C in winters to 42^o C in summer. Soil found in this region such as heavy clays to shallow loamy, reddish, brown upland graded. The soil comes under a rang series which further subdivided in to Kanhar-Dosra and Dosra and soil shows slight acidic or neutral in reaction

Vegetation structure

This mixed forest has a rich diversity of tree species which are dominated *Lagerstroemia lanceolata*, *Ixora pavetta*, *Diospyros melanoxyton*, *Chloroxylon swietenia*, *Gardenia resinifera* and so many other medicinal and aromatic plants and rich in wildlife (Table 1).

Materials and Methods

The potential gum yielding trees of *Boswellia serrata* having 80-150cm circumference were marked for tapping purpose. The two tapping techniques were tried for extracting of gum: Mechanical tapping techniques and Mechanical + Chemical tapping techniques by using Square shape, V shape and hole shape cut methods and data were collected in two seasons i.e. winter and summer.

Tapping techniques

Mechanical tapping technique

Three mechanical cut as Square shape, V shape and Hole shape incision were made on bole at breast height of trees of *Boswellia serrata* during Winter 2018 and Summer 2019 Seasons details of these incision is given below.

In Square shape cut was made both in length and breadth of 8cm with the help of carpenter wood Chisel having depth of 1-2 cm on trees of 80-150 cm girth class of trees.

In V shape cut of length 9 cm and width 3 cm having depth of 1cm depth was made on 80-150 cm girth class of trees and confined nearer to breast height with the help of chisel.

In hole shape cut method a cut of 2.5 * 2.5 cm deep hole was made on trees of same girth class with the help of battery operated drill machine at DBH of tree.

Mechanical + Chemical Tapping

Nine chemical treatments were used for *Boswellia serrata* in both the season. The chemical gum tapping of selected trees was initiated using different doses of gum enhancer Ethephon (2-chloro-ethyl-phosphonic acid) (trade name Ethereal) having 39% a.i in 10%, 20%, 30% concentration were injected by syringe of 60 ml volume in the tree trunk to induce gummosis process.

The 4 ml of gum enhancer Ethephon was injected on the tree trunk to tap the gum in selected all the tree by making Square shape, V shape and Hole shape cut made on trees.

The treatments are as follows:

Tapping technique

Mechanical tapping technique

Mechanical + Chemical tapping technique

Tapping season

Winter (October-November), 2018

Summer (March-May), 2019

Chemical concentration

Ethephon	a. 10% Concentration
Ethephon	b. 20% Concentration
Ethephon	c. 30% Concentration

In total 24 treatments (6 Mechanical treatment and 18 Mechanical+ Chemical treatment total in both the season) were applied on trees. Chemicals were sprayed through syringe with dose of 4 ml per incision. Gum ooze out was collected an interval of 15 days during experimental period and weight of gum samples was taken with help of digital field weighing balance.

Results and Discussion

Season wise and Treatment wise gum exudation in *Boswellia serrata* during winter 2018 and summer 2019 by various Methods used for this experiment (g/tree/season)

Mechanical tapping technique

In present investigation the highest rate of gum exudation and production was observed in mechanical method during summer season (March- May) *i.e.* 10.82g in case of square shape cut and 6.53 g during winter season (October –December). Whereas, other two mechanical tapping method *i.e.* Hole shape and V shaped cut only in V shape method gum yield was 4.56 g recorded during summer season and Hole shape method did

not showed much effective in sustainable production of gum. Square shape tapping method was found better during both the season in sustainable gum production. Bhatt *et al.*, (1989) also reported in *Commiphora wightii* that April and May are the peak months for gum tapping.

The debarked area was scraped to freshen with iron Chisel at regular interval of 3-4 days. The maximum quantity of gum produced in square shape cut however, not a single drop of gum obtained in other shape of cuts in winter and summer season of 2018 and 2019. Ballal *et al.*, (2005) also reported in his experiment that the Gum yield was positively correlated with tapping intensity, rainfall, and minimum and maximum temperature. The results obtained in the present experiment confirmed with the result of above worker that when the temperature is maximum and low relative humidity the rate of gum ooze out was more quantity. Similar finding also observed in this study confirms that the temperature and humidity playing a significant role in gum extraction method.

Mechanical + chemical tapping technique

In *Boswellia serrata* highest winter and summer season total production of gum was obtained by using H₄ 30% *i.e.* 52.94 gm in summer season and lowest amount of gum obtained by using V₄ 30% and the yield was 4.56 g. Similarly in winter season highest quantity of gum obtained was 26.18 g by using V₃ 20% and lowest quantity was obtained by using S₂10% *i.e.* 2.08 g. Sinha *et al.*, (2016) also reported that maximum gum yield obtained by V shaped cut method of 2 cm width for sustainable and high yield of gum in *Boswellia serrata* plantation.

Improved gum tapping method by using ethephon chemical treatment in tree trunk by injecting through a syringe into holes with the help of increment borer was developed and

recommended by Bhatt (1987). The similar results were obtained in the present study that the gum exudation increases with the application of higher concentration of Ethephon i.e. 30% injected in tree trunk gave maximum yield as compared with the 10% confirms the results with the above worker. Babu and Menon (1989) also reported that Ethephon induces gummosis in *Sterculia urens* without adversely affecting health of the tree. The similar results obtained in the present study that use of ethephon does not affect the tree health and after the gum exudation incision portion was covered with wet mud to prevent from further infection. Due to this technique the bark growth easily covers the incision made on the tree trunk. The recovery of tissues and bark was recorded fast and filled the incision. Mishra *et al.*, (2012) reported that there was no gum yield in trees of *Boswellia serrata* having 35 cm girth size. The small girth size of tree did not respond for good yield of gum.

The result on Season and Treatment wise gum exudation in *Boswellia serrata* during winter 2018 and summer 2019 by using various shape Methods (g/tree/season) presented in table 2 and figure 1, 2, 3, 4 and 5.

Month wise gum exudation rate in *Boswellia serrata* during the year 2018 -19 in winters and summer season (g/tree/month)

Mechanical tapping technique

In the present investigation maximum gum production rate was observed in mechanical method in May during summer i.e. 6.41 g and 2.39 g in October month winter season recorded in square shape incision. This result was found due to gum production is positively correlated with low relative humidity and high temperature. The average temperature during May and October was comparatively higher than other months so the gum yield was more in these two month. The debarked

area was freshened with manual Chisel at regular interval of 3-4 days. The maximum quantity of gum produced in square shape however, not a single drop of gum produced in other shape of cuts in winter season.

The result on effect of mechanical tapping rate of gum exudation for the month of October to May both the seasons presented in (Table 3).

Mechanical + chemical gum tapping technique

The variation in gum exudation rate was recorded during October 2018 to May 2019 both season's winter and summer. The highest rate of gum exudation was obtained in October month of winter season i.e. Maximum 14.32 g/tree/month in treatment V320% conc. and in the month of May i.e. Maximum yield i.e. 30.15 g/tree/month was obtained treatment H430% conc.. However, in mechanical and chemical method ethephon was used as gum enhancer. Bhatt *et al.*, (1989) also reported that application of ethephon in gum yielding trees increases the amount of gum exudation and total yield of gum/tree. The Maximum average temperature goes high in May 2019 (35.2⁰C) and RH was (32.5 %). During summer season month of May observed the best month showed significantly higher gum exudation followed by April and March. Ballal *et al.*, (2005) also reported that the gum yield was positively correlated with tapping intensity, rainfall, and minimum and maximum temperatures at tapping time, and negatively correlated with tapping time, and minimum and maximum temperatures at gum collection. Sinha *et al.*, (2016) also observed that 3 ml ethephon (2-chloroethylphosphonic acid) of 39% solution; (1) 1.5 cm diameter hole treated with 3 ml ethephon of 39% solution and patched up with clay and the yield was 5.86 ± 0.545 in the month of May in *Boswellia serrata* (5.86 ± 0.545 g/incision/plant)). The results reported

by the above workers are similar as in the month of May the gum exudation rate is high with the use of ethephon, however in present study the quantity of gum is more than 6 times high as reported by Sinha *et al.*, (2016) observed in case of *Boswellia serata* it may be the GBH of the tree was 32-35 cm compared with the *Boswellia serata* the GBH was in the range of 80-150 cm this variation in quantity was recorded in our experiment the soil type and microclimate also responsible for the exudation rate of gum. The difference in tree species also responsible for the yield this hypothesis confirms the results obtained in the present study. The development of gum duct known as traumatic duct is responsible for the gummosis (Setia, 1984) and develops within the xylem tissue of the mature plants reported by various workers (Shah and Setia, 1976).

The result on effect of Mechanical + Chemical tapping technique and rate of gum exudation for the month of October to May both the seasons presented in Table 4.

Quality parameter

Colour

The gum colour in case of *Boswellia serata* was cream yellow in color. The similar colour also determined by visual observation of *Boswellia serata* was brown as reported by (Shirwaikar *et al.* 2005). The results obtained in the experiment were almost same confirms the finding is correct and there is no difference or variation was recorded.

Odour

Odour of *Boswellia serrata* was noted as Sweet balsamic aromatic smell same observation was also reported by Gupta (2011) as well as (Shirwaikar *et al.*, 2005) also confirm the result of aroma (Table 5).

pH

The pH value of Salai gum in the present experiment was 4.6. Chandola *et al.* (2011) also analyzes the phyto-chemical evaluation of *Boswellia serrata* and found that the pH was 6.09. The value of pH variation in case of *Boswellia serrata* was low value as compared by above author may be due to availability of salts in the soils, rainfall pattern and microclimate of Chhattisgarh. These factors are affecting the acidity of the gum obtained from tree.

Moisture content

The moisture content of *Boswellia serrata* was 17.32 % recorded in our experiment as Gupta (2011) observed 20.74% there is 3.4 % variation in moisture content may be because of soil moisture, acidity of soil and age of tree may be the reason of collected gum from the tree. The variation in moisture content is based on location specific character.

Ash content

The ash content of gum in *Boswellia serrata* was observed 1% as Shirwaikar *et al.*, (2005) reported the ash content 1.75 % this variation may be because of polysaccharide available in the gum sample differ in relation to the site and age of the tree. The results having significant variations in ash content of gum as per above worker since this is biological science such variation occurs because of many factors like site quality soil and microclimate.

Statistical analysis

The yield of gum showed statistically significant value ($P < 0.05$) used with the chemical ethephon as compared to Mechanical Treatment because the ethephon act as a catalyst which activate the gummosis processes fast in the trees. Season was results

also showed statistically significant value ($P < 0.05$) the difference was due to high temperature and low relative RH and the maximum amount of obtained from the trees summer month of May, 2019.

In conclusions, the Salai gum obtained from the trees of *Boswellia serrata* is very important Indian gum yielding tree and having high economic value. Its demand is increasing day by day in western countries due to its industrial applications. However, its traditional extraction methods are unscientific and crude ones and cause severe injury to trees and ultimately population of trees are decreasing in alarming rate day by day. To overcome with this problem, proper gum tapping method known as V shape cut of length 9 cm and width 3 cm having depth of 1cm depth given maximum yield from trees of 80-150 cm girth class and confined nearer to breast height with the help of chisel and gum inducer is injected with the help of syringe in lower portion incision. This technique is simple and safe ensure sustainable yield, regeneration and survival of

the tapped trees without any kind of damage to the tree. The trees of *Boswellia serrata* by use of Mechanical + Chemical treatment Tapping technique total quantity of gum produced in two season in a year was highest in summer season by using H₄ 30% conc. the yield was 52.94 gram/tree and in winter maximum gum was obtained by using V320% conc. the yield was 26.18 gram/tree in winter season. Whereas, in Mechanical tapping techniques maximum gum was obtained by square shape cut method and the yield was 10.82gram/tree, the other two methods *i.e.* V shape and Hole shape not much effective for sustainable production of gum. The important conclusion of the study is that the Sustainable yield of gum, hole shape cut method along with Chemical ethephon *i.e.* (Mechanical + Chemical tapping technique) will be selected so that the gum tapping practices shall not affect the survival status of the species in the natural forest stands. Temperature and RH play a significant role in flow of gum through gum canals available in sap wood.

Table.1 Description of *Boswellia serrata*

Botanical Classification	Vernacular names
Division: Spermatophyta	English: Indian Olibanum or Indian frankincense or incense tree
Sub-division: Angiospermae	Hindi: Kundur, Salai,
Over-class: Rutanae	Chhattisgarhi- Salaiyya, Saale
Class: Anacardiales	Odia-Salai
Family: Burseraceae	Kannada: Chitta, Guguladhuph
Genus: Boswellia	Gujarati: Dhup, Gugali
Species: serrata	Telugu: Phirangi, Saambraani

Table.2 Season and Treatment wise gum exudation in *Boswellia serrata* during winter 2018 and summer 2019 by using various shape Methods (gram/tree/season)

SHAPE	MECHANICAL	<i>B. serrata</i> g/tree (Winter)	<i>B. serrata</i> g/tree (Summer)	TOTAL YIELD IN (g)
SQUARE SHAPE	S1-0%	6.53 g	10.82gm	17.35
	MECHANICAL+CHEMICAL			
	S2-10%	2.08 g	35.18g	37.26
	S3-20%	17.21 g	37.58g	54.79
	S4-30%	7.57 g	42.25g	49.82
V SHAPE	MECHANICAL			
	V1-0%	0 gm	4.56g	4.56
	MECHANICAL+CHEMICAL			
	V2-10%	16.05g	23.57g	39.62
	V3-20%	26.18g	37.42g	63.6
	V4-30%	3.02g	6.48g	9.5
HOLE SHAPE	MECHANICAL			
	H1-0%	0g	0g	0
	MECHANICAL+CHEMICAL			
	H2-10%	13.93g	34.54g	48.47
	H3-20%	6.89g	41.15g	48.04
	H4-30%	5.34g	52.94g	58.28

Table.3 Effect of temperature and relative humidity on rate of gum exudation in *Boswellia serata* by mechanical method (gram/month)

Treatment	2018(Winter)			Total	2019(Summer)			Total
	Oct	Nov	Dec		Mar	Apr	May	
Temp (°C)	27.10	23.65	19.15		27	32.4	35.2	
Rh (%)	66.50	60.00	65.00		50.5	25.5	32.5	
T1	2.39	1.86	2.28	6.53	1.9	2.56	6.41	10.82
T2	0	0	0	0	0	2.22	2.34	4.56
T3	0	0	0	0	0	0	0	0
Total	2.39	1.86	2.28	6.53	1.9	4.78	8.75	15.38

T1-Square shape cut, T2-V Shape cut, T3-Hole shape cut

* S = Square cut, V= V shape cut, H= hole shape cut

Table.4 Effect of temperature and relative humidity on rate of gum exudation in *Boswellia serata* during summer and winter seasons 2018-2019 by using Various Mechanical+ Chemical Treatments (g/tree/month)

Treatment	2018(Winter)			Total yield	2019(Summer)			Total yield
	Oct	Nov	Dec		Mar	Apr	May	
Temp(°C)	27.10	23.65	19.15		27	32.4	35.2	
Rh(%)	66.5	60	65		50.5	35.5	32.5	
T4	2.08	0	0	2.08	9.83	11.10	14.25	35.18
T5	10.12	3.54	2.39	16.05	3.20	8.72	11.65	23.57
T6	7.48	3.20	3.28	13.93	20.52	6.95	7.07	34.54
T7	9.52	4.26	3.43	17.21	7.30	9.83	20.45	37.58
T8	14.32	6.61	5.25	26.18	4.41	14.36	18.65	37.42
T9	4.39	2.48	0	6.89	6.41	14.28	20.46	41.15
T10	5.12	2.45	0	7.57	1.30	14.85	26.10	42.25
T11	3.02	0	0	3.02	0	3.16	3.42	6.48
T12	5.34	0	0	5.34	9.93	12.86	30.15	52.94
Total	61.39	22.54	14.35	98.27	62.9	96.11	152.2	311.11

T4-S210% T7-S320% T10-S430%
 T5-V210% T8-V320% T11-V430%
 T6-H210% T9-H320% T12-H430%

S = Square shape cut, V= V shape cut,
 H= Hole shape cut.

Table.5 Quality parameter tests of *Boswellia serrate* GUM

Parameters	<i>Boswellia Serrata</i>
1. pH	4.6
2. Odour	Sweet balsamic aromatic
3. Colour	Cream yellow/white yellow
4. Moisture content	17.32%
5. Ash Content	1%

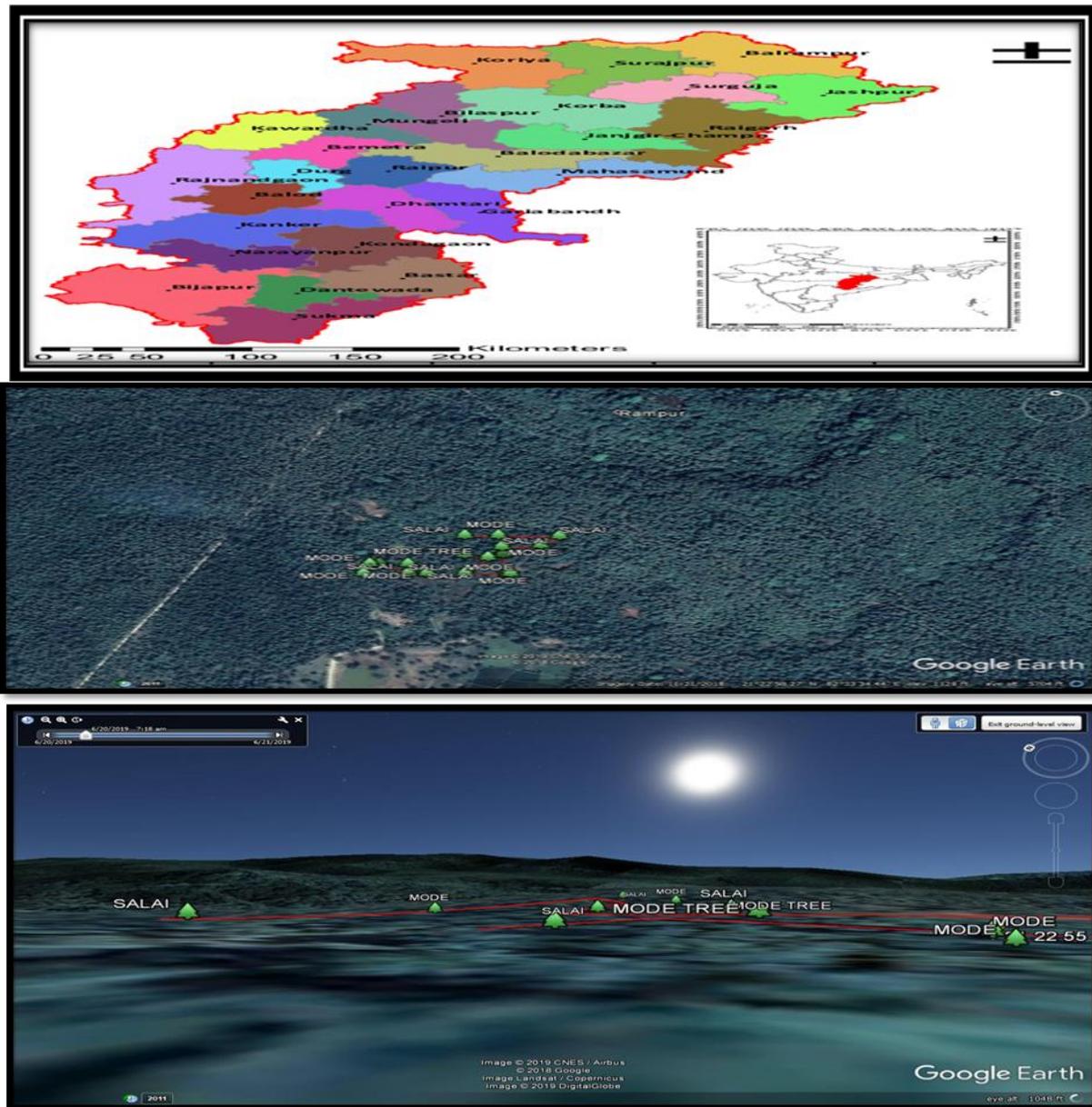


Plate.1 a) Map showing geographic location of Chhattisgarh state in India. b and c. Map showing geographic location of compartment no 281 of Deopur Forest Range in Balodabazar Forest Division, Chhattisgarh

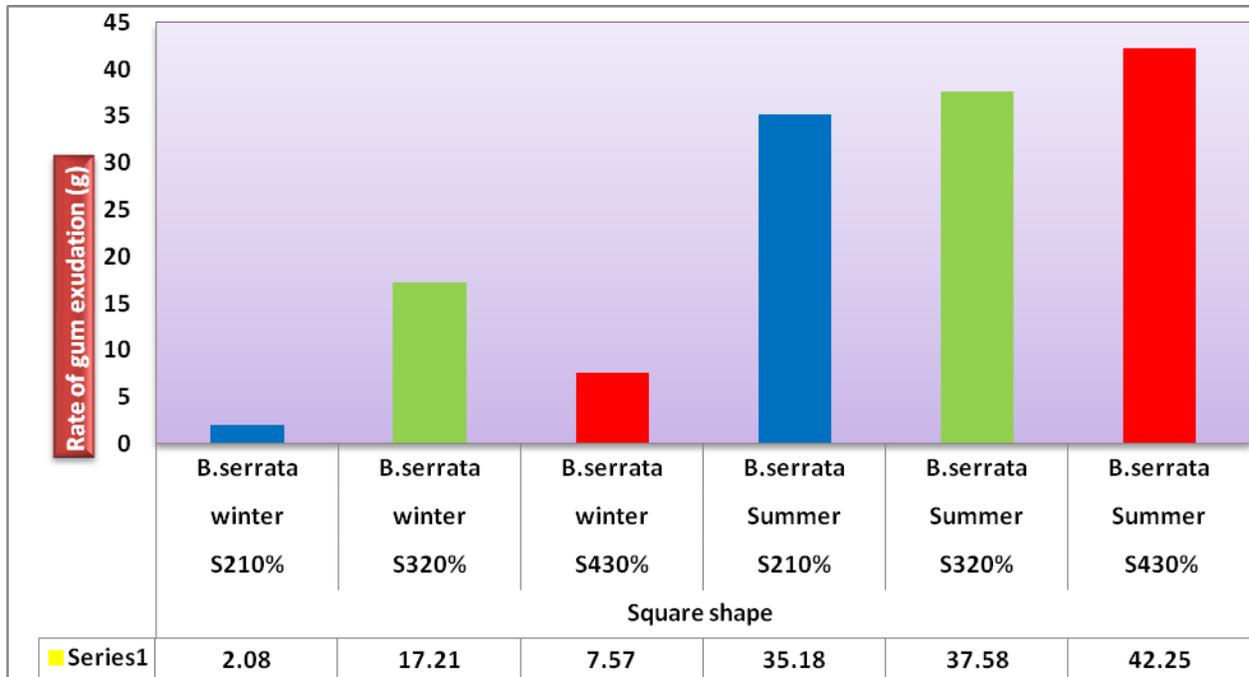


Figure.1 Gum exudation rate of *Boswellia serrata* by Mechanical +Chemical tapping technique during winter 2018 and summer 2019 by Square shape cut Method (g/tree/season)

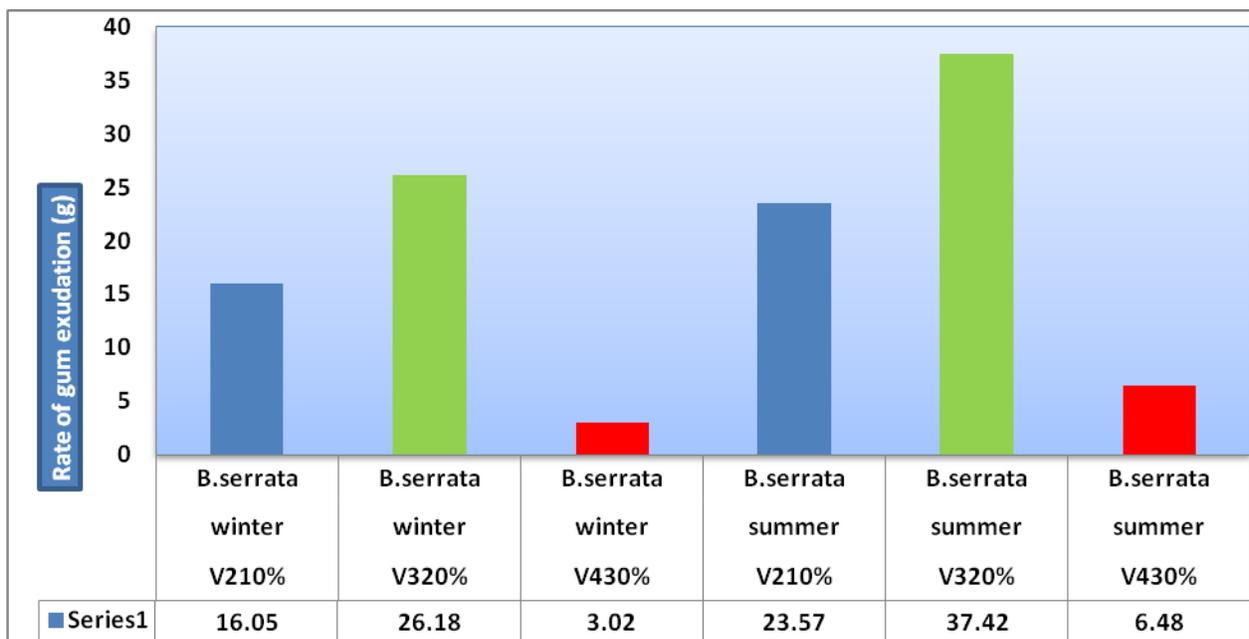


Figure.2 Gum exudation rate of *Boswellia serrata* by Mechanical +Chemical tapping technique during winter 2018 and summer 2019 by V shape cut Method (g/tree/season).

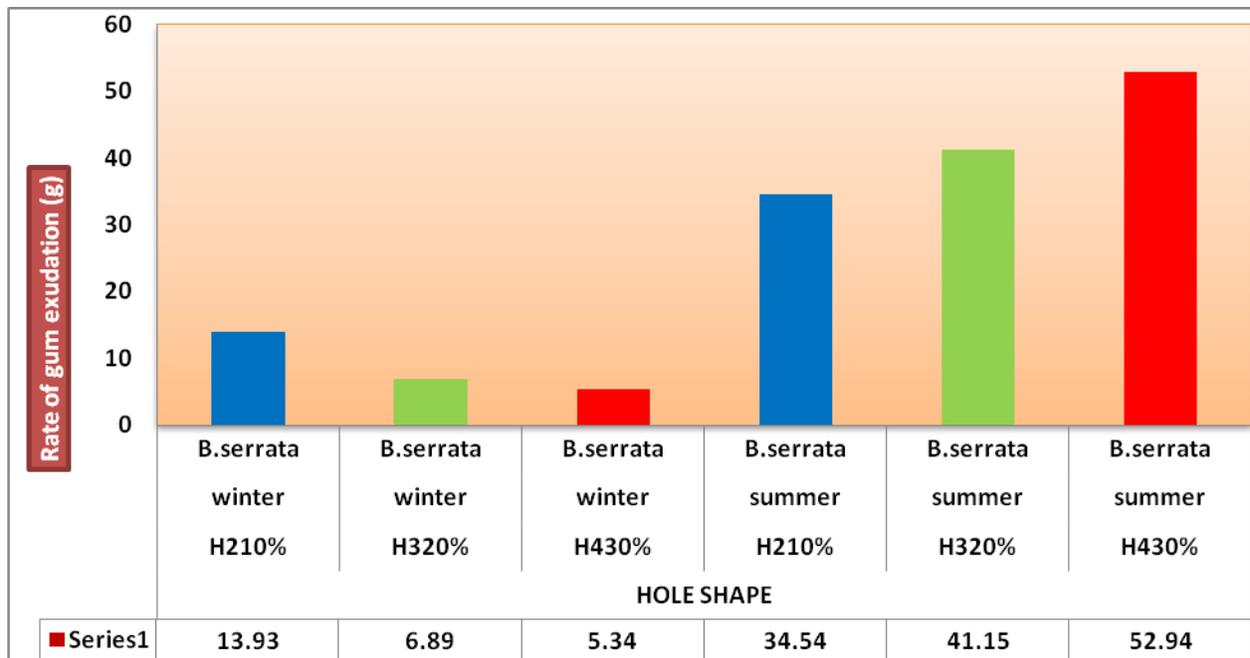


Figure.3 Gum exudation rate of *Boswellia serrata* by Mechanical +Chemical tapping technique during winter 2018 and summer 2019 by Hole shape cut Method (g/tree/season)

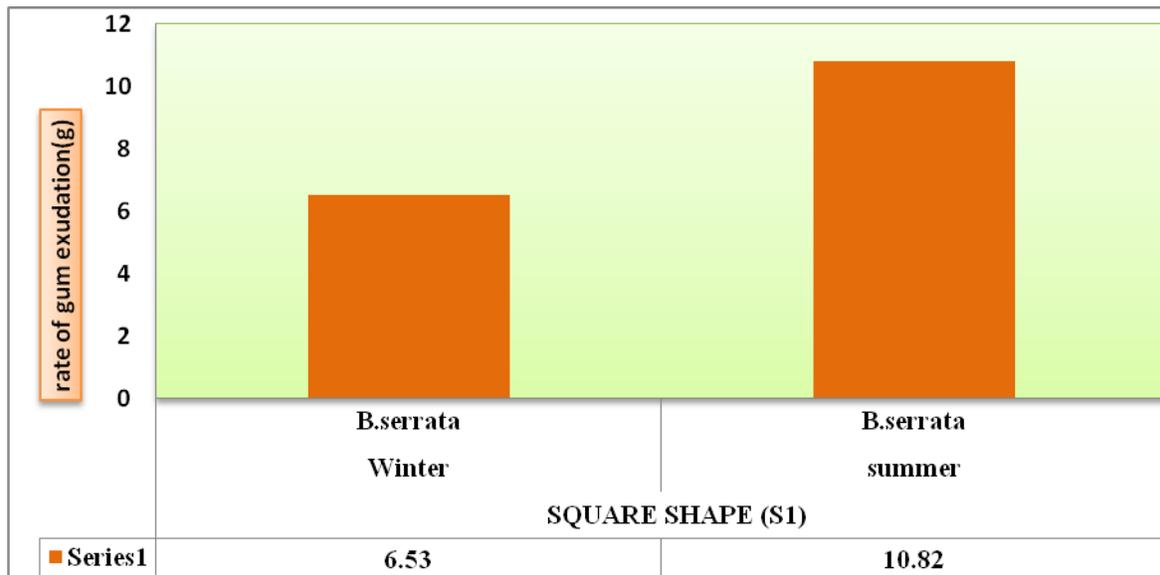


Figure.4 Comparison of Maximum oleo gum resin exudation rate with Season and Treatments in Mechanical tapping method. (Gram/tree/season)

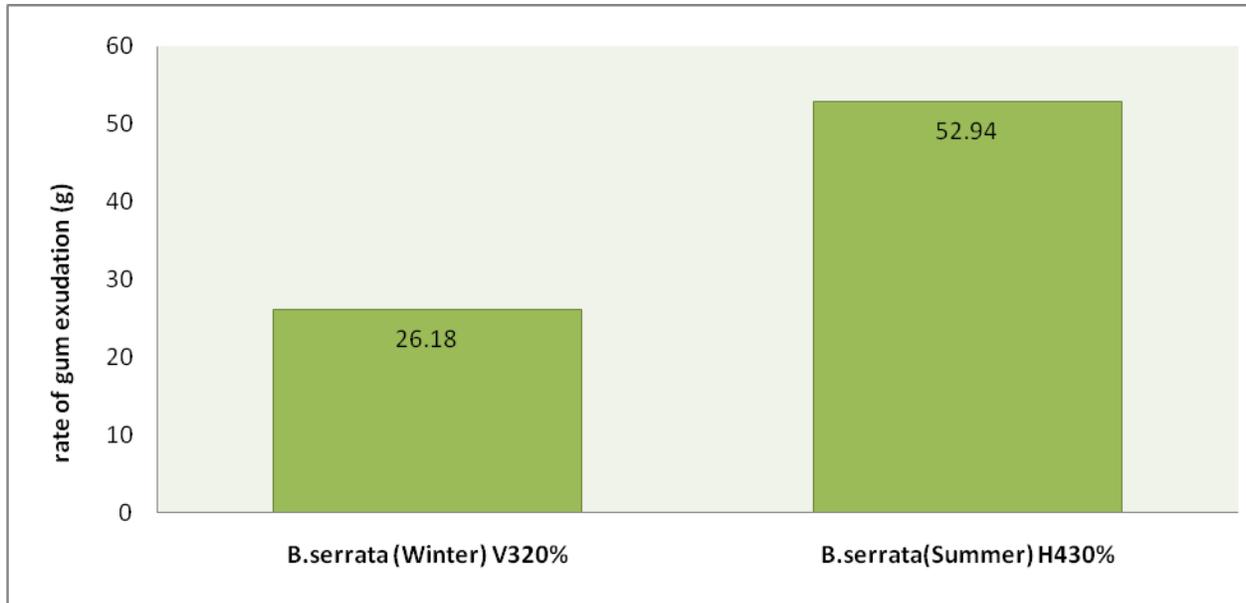


Figure.5 Comparison of maximum oleo gumresin exudation rate with Season and Treatments in Mechanical + Chemical tapping methods (Gram/tree/season)

- Winter (October-December)
- Summer (March-May)



Plate.2 *B.serrata* standing tree in forest stands



Plate.3 Gum exudation from *B. serrate* tree in hole shape cut Making incision in *B.serrata* tree



Plate.4 Square shape incision treatment on *B.serrata* tree White yellow colour of gum *B.serrata*



Plate.5 Quality parameter analysis from *B serrata* sample



Plate-6: Gum exudation from V shape cut

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