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Sustainable gum tapping techniques for *Lannea coromandelica* (Houtt.) Merr. to obtain higher gum production in tropical dry deciduous forests

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Abstract

Gum collection from trees is important sources of livelihood for Tribes residing in Chhattisgarh. The industrial application of natural gums has been expanded tremendously in recent years. The Jhingan gum obtained from *Lannea coromandelica* Houtt. Merr. (Anacardiaceae) is important gum yielding tree and having lot of economic value particularly in chocolate industries. Its demand is increasing in western countries due to its industrial applications. The unsustainable methods of gum extraction leading to death of trees. The unscientific harmful tapping practices lead to reduce the populations of gum yielding trees like, *Lannea coromandelica* Houtt. Merr. from its natural habitat. This causes loss of wild germplasm from natural forest stands. The present experiment were conducted for one year to standardize the tapping methods, tapping seasons, chemical concentration on trees having girth of 80-150 cm in natural forest stands of Deopur Forest Range under Balodabazar Forest Division of Chhattisgarh. To obtaining the maximum gums from this species, different tapping techniques have been applied to enhance the gum production without harm to trees. The Maximum gum production was obtained in Mechanical + Chemical tapping techniques by using V shaped cut, However in mechanical tapping techniques maximum gum was obtained by square shape cut method. Ethephon used as catalyst to enhance the metabolic activities to ooze out the maximum available gum in the gum canals for this in all the 24 treatments in both the season concentration of 4ml Ethephon found much effective for the highest gum production of 140.59 grams/tree in summer (March-May) and 51.13 grams/ tree in winter (October – December) by using V4 30% concentration. High temperature in month of March to May was found significantly effective for maximum gum production. The quality parameters of exudates gum were investigated and gum was found to be mild acidic in, high moisture content 16.9% and moderate ash content was 2.5%. This technique is simple and safe ensure sustainable yield, regeneration and survival of the tapped trees having no harm and mortality.

Keywords: Jhingan gum, sustainable, germplasm, tapping, concentration, quality parameters

Introduction

Forests are the nature's most attractive and versatile renewable resources providing simultaneously a wide range of social, economic, cultural, environmental services and benefits. Historically, natural gum is one of the important forest products which contributes to the livelihood and health care of rural communities. Gums used as a principal element in pharmaceutical industries, food and play a key role in source of income for tribal residing in side and fringes of forest areas. In plants, the natural gums are formed through a process called gummosis in which internal plant tissues, mostly cellulose, are disintegrated and decomposed. The gums ooze out from the plant stems either naturally or when plant stems are wounded by external force. The gum exudates from trees and shrubs in striated nodules or amorphous lumps, tear-like structure. It dries in contact with air and sunlight and forms hard, glass-like lumps. Gum production increases at high temperature and limited moisture (Sao, 2012) [1]. They are insoluble in alcohol and ether but soluble in water. Commercially, they are sold in the form of dried exudates. India ranks one of the major gum producing countries of this important commodity. Several gum supplying factories under the Department of Small Scale Industries or State Forest Development Corporations have been established in several States of India. The forests in central India support a rich diversity of tree species, many of them provide valuable gums. The major commercially important gums in good quantity are sourced from the central Indian forests, consisting of states like Madhya Pradesh, Chhattisgarh, Andhra Pradesh, Orissa, Jharkhand and Bihar and to some extent Gujarat and Rajasthan. However, these tree species are less studied, especially with respect to their indigenous uses of gums, and also the existing information is scattered. Being an important commodity for livelihood generation, there are unsustainable harvesting issues, which impact the population of these species and mortality.

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Lannea coromandelica is a moderate-sized to large deciduous tree with spreading crown and stout branches, attaining a height up to 24m., found throughout the greater part of India and the Andaman Islands, ascending to an altitude of 1,500 mt in the Himalayas. Bark grey or whitish, smooth, exfoliating in irregular rounded plates. A mucilaginous gum, known as Jhingan gum, exudes from wounds and cracks in the bark. The gum occurs in round tears or colourless fissured angular fragments like Acacia gum. It is yellowish white when fresh, turning brown and ultimately black on drying. Fresh gum is soluble in water, forming rather thin mucilage with good adhesive properties. It is used in calico-printing, paper and cloth sizing, inferior varnishes and inks, in plastering and white washing and for preserving fishing nets. It is mostly used in confectionery; but small quantities of the gum are reported to be exported from India from this purpose.

The gum production and quality from the existing extraction methods is poor. No integrated efforts have been made so far to revolutionize the extraction techniques so that the tree and human dependant on them for their livelihood could be protected and a sustained yield is achieved without harming the tree. Application of different chemicals for enhancement of extraction of gum, time of extraction, age of tree, diameter of tree to get the maximum yield and season of extraction needs to be standardized. The use of Ethephone as a gum inducer enhances gum production by Prasad *et al.* (2012)^[10]; and Nair (2003).

Materials and Methods

The study was conducted in natural forest stands of *Lannea coromandelica* at Compartment no 281 of Deopur Forest Range in Balodabazar Forest Division (Chhattisgarh) at 21° 23' N Latitude and 82° 33' E Longitude with an altitude of 319 M meters above the mean sea level during winter 2018 and summer 2019. This dry deciduous forest has rich diversity of tree species of *Lagerstroemia lanceolata*, *Ixora pavetta*, *Diospyros melanoxylon*, *Chloroxylon swietenia*, *Gardenia resinifera* including wildlife.

The potential gum yielding trees of *Lannea coromandelica* having 80-150 cm girth 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

A. Mechanical tapping technique

Three mechanical cut as Square shape, V shape and Hole shape incision were made on trees of *Lannea coromandelica* in Winter 2018 and Summer 2019 season details of these incision is given below.

- In Square shape cut width of 8 cm and length of 8 cm was made with help of carpenter wood Chisel having depth of 1-2 cm on trees of 80-150 cm girth class at GBH.
- In V shape cut of length 9 cm and width 3 cm having depth of 1cm depth was made on trees of 80-150 cm girth 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 was made on tree of same girth class with the help of battery operated drill machine at GBH.

B. Mechanical + Chemical Tapping Technique

Nine chemical treatments were used for Mode (*Lannea coromandelica*) in each season. The chemical gum tapping of selected trees was initiated using different doses of gum enhancer Ethephone (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 gum enhancer Ethephone was injected in the tree trunk to tap the gum in selected all the tree by making Square shape, V shape and Hole shape cut made in the tree.

The treatments are as follows:

1. Tapping Technique

- a. Mechanical tapping technique
- b. Mechanical + Chemical tapping technique

2. Tapping Season

- a. Winter (October-November), 2018
- b. Summer (March-May), 2019

3. Chemical Concentration

- | | |
|----------|----------------------|
| Ethephon | a. 10% Concentration |
| | b. 20% Concentration |
| | 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. Gums were collected in intervals of 15 days during experimental months and weight of samples was taken with help of weighing balance.

Results and Discussion

a. Season wise and Treatment wise gum exudation in *Lannea coromandelica* in winter 2018 and summer 2019 by various shapes Method. (g/tree/season)

For Mechanical Tapping Technique

In present investigation the highest rate of gum exudation in mechanical method was observed in the summer season (March- May) i.e 16.49 g using square shape cut and 7.43 g in winter season (October –December) using square shape cut. By using other mechanical tapping method of cutting in *L. coromandelica* gum obtained was very less in quantity so the other two method i.e V shape and Hole shape not much effective for sustainable production of gum. Square shape tapping method is better for sustainable gum production in both the season. Bhatt *et al.* (1989)^[4] reported in *Commiphora wightii* that April and May are the peak months for gum tapping.

The debarked area was freshened 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)^[3] also reported in his experiment that the Gum yield was positively correlated with tapping intensity, rainfall, and minimum and maximum temperature. The results obtained by 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.

For Mechanical + Chemical Tapping Technique

In *L. coromandelica* highest total quantity of gum obtained by using V₄ 30% i.e 140.59 gm in summer season and lowest amount of gum obtained by using H₂-10% and the yield was 15.57 g. Similarly in winter season highest quantity of gum obtained was 51.13 g by using V₄ 30% and lowest quantity was obtained by using V₂ 30% i.e. 12.71 g. 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 is developed by Bhatt (1987). The similar results obtained in the present study that the gum exudation increases with the application of higher concentration of Ethephon i.e 30% concentration injected in tree trunk gave maximum yield as compared with the 10% concentration this confirms the results with the above worker. Babu and Menon (1989) [2] 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 cover the incision made on the tree trunk. The result of effect on Season and Treatment wise gum exudation in *Lannea coromandelica* in winter 2018 and summer 2019 by using various shape Methods (g/tree/season) presented in table 1

Quality parameter analysis

The study of quality analysis of gum samples was done in Department of Forestry, College of Agriculture, Indira

Gandhi Krishi Vishwavidyalaya, Raipur (C.G.).

1. Colour

The collected gum sample was analyzed visually for colour determination.

2. Odour

The collected gum sample was analyzed by aroma for odor determination.

3. pH

pH of 25% aqueous gum solution (w/v) was measured with the help of glass electrode pH meter in which 10 g of gum sample was dissolved in 40 ml of distilled water and then solution was used for pH measurement as described by Yusuf (2011) [12].

4. Ash content

Ash content of the gum samples was determined by burning 1g of gum sample in a muffle furnace at 550 °C for 4 hour. The ash content was expressed as% ratio of the weight of ash to weight of the sample.

5. Moisture content

Moisture content of gum samples was determined by drying 5g of the gum sample to constant weight at 80 °C using hot air oven. Dried samples were cooled in desiccators before weighing. Moisture content was expressed as% of mass loss from the original mass as described by Yusuf (2011) [12]

Table 1: Season and Treatment wise gum exudation in *Lannea coromandelica* in winter 2018 and summer 2019 by using various shape Methods. (gram/tree/season)

Shape	Mechanical Tapping	<i>L. coromandelica</i> (winter) g/tree	<i>L. coromandelica</i> (Summer) g/tree	Total Yield (g)
Square Shape	S1-0%	7.43	16.49	23.92
	Mechanical+Chemical			
	S2-10%	18.45	49.09	67.54
	S3-20%	22.05	63.26	85.31
V Shape	S4-30%	35.14	75.61	110.75
	Mechanical			
	V1-0%	0	0	0
	Mechanical+Chemical			
Hole Shape	V2-10%	12.71	68.57	81.28
	V3-20%	42.75	112.36	155.11
	V4-30%	51.13	140.59	191.72
	Mechanical			
Hole Shape	H1-0%	0	0	0
	Mechanical+Chemical			
	H2-10%	28.33	15.57	43.9
	H3-20%	33.49	60.85	94.34
	H4-30%	47.64	76.18	123.82

Month wise rate of gum exudation (g) in *Lannea coromandelica* during year 2018 and 2019 by various shape. (g/tree/month)

Mechanical Tapping Technique

In present investigation the maximum rate of gum production in mechanical method was observed in the month of May during summer i.e 7.35 g and 3.88 g in the month of October in winter by using square shape incision. It was due to gum production was positively correlated with low relative humidity and high temperature. The average temperature during month of May and October was comparatively higher than other months so the gum yield was more in this 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 cut however, not a single drop of gum produce in other shape of cuts in winter and summer season of 2018 and 2019.

The result on effect of mechanical tapping rate of gum exudation for the month of October to May both the seasons presented in table 2

Table 2: Effect of temperature and relative humidity on rate of gum exudation in *Lannea coromandelica* 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 (%)	66.5	60.0	65.0		50.5	35.5	32.5	
T1	3.88	3.55	2.12	7.43	4.93	4.21	7.35	16.49
T2	0	0	0	0	0	0	0	0
T3	0	0	0	0	0	0	0	0
Total	3.88	3.55	2.12	7.43	4.93	4.21	7.35	16.49

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

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

Gum Tapping Through Mechanical + Chemical Tapping Technique

The variation in rate of gum exudation was observed from October 2018 to May 2019. The highest rate of gum exudation was obtained in October month of winter season i.e Maximum 36.89 g/tree/month treatment H4 30% conc and in the month of May i.e Maximum yield i.e 92.65 g/tree/month was obtained treatment V430% conc. During December month by treatment V210% minimum amount of gum i.e 2.87 g/tree/month was obtained. However, in mechanical and

chemical method ethephon was used as gum enhancer. The Maximum Average temperature rises up high in the month of May 2019 (35.2 °C) and Relative humidity was (32.5%). During summer season month of May observed the best month for significantly higher gum exudation followed by April and March month of the year. Katiyar *et al.* (2014) [6] also observed that 4ml E-Super (0.39% ethephon) was significantly effective to produce high quantity of gum in the month of May in *Acacia nilotica* (33.32 g/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 3 times high as reported by Katiyar *et al.* (2014) [6] observed in case of *Acacia nilotica* it may be the DBH of the tree was 90-125 cm compared with the *Lannea coromandelica* 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 study.

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 3

Table 3: Effect of temperature and relative humidity on rate of gum exudation in *Lannea coromandelica* during summer & winter seasons 2018-2019 by using Various Mechanical+ Chemical Treatments. (g/tree/month).

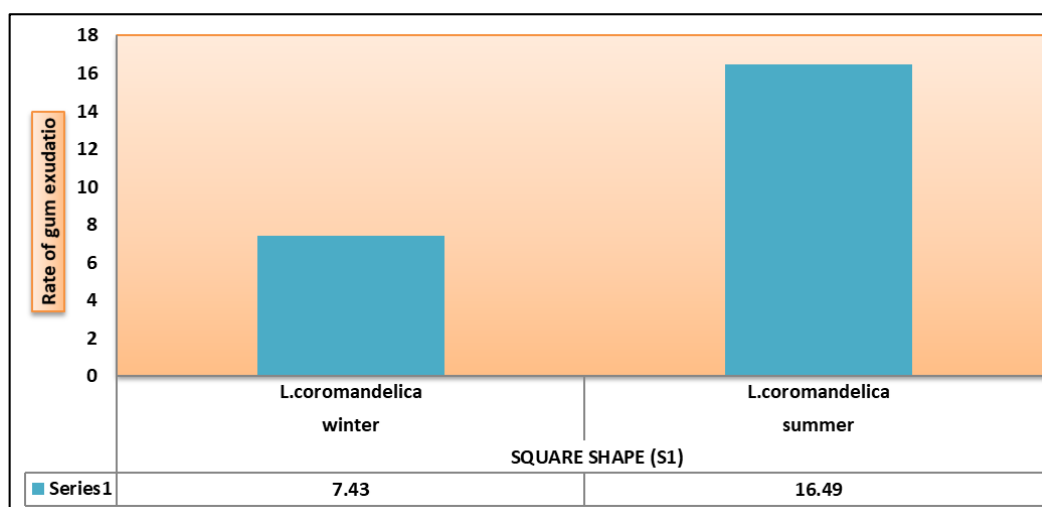
Treatment	2018 (Winter)			Total yield (g/tree)	2019 (Summer)			Total yield (g/tree)
	Oct	Nov	Dec		Mar	Apr	May	
Temp (°C)	27.10	23.65	19.15		27	32.4	35.2	
Rh (%)	66.5	60	65		50.5	35.5	32.5	
T4	7.42	6.25	4.78	18.45	13.83	15.12	20.04	49.09
T5	5.69	4.15	2.87	12.71	13.02	25.06	30.49	68.57
T6	13.92	10.47	3.94	28.33	4.25	3.12	8.20	15.57
T7	18.07	4.02	3.98	22.05	10.92	13.45	38.89	63.26
T8	30.14	6.25	6.36	42.75	20.06	21.63	70.67	112.36
T9	21.62	5.21	6.66	33.49	11.31	14.25	35.29	60.85
T10	15.48	7.24	12.62	35.14	22.64	18.16	34.81	75.61
T11	31.18	12.81	7.14	51.13	20.12	27.82	92.65	140.59
T12	36.89	5.12	5.63	47.64	15.38	14.29	46.51	76.18
Total	180.41	61.52	53.78	291.69	131.53	152.9	377.55	662.08

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.

**Fig 1:** Season and Treatment wise gum exudation by Mechanical tapping Technique.(gram/tree/season)

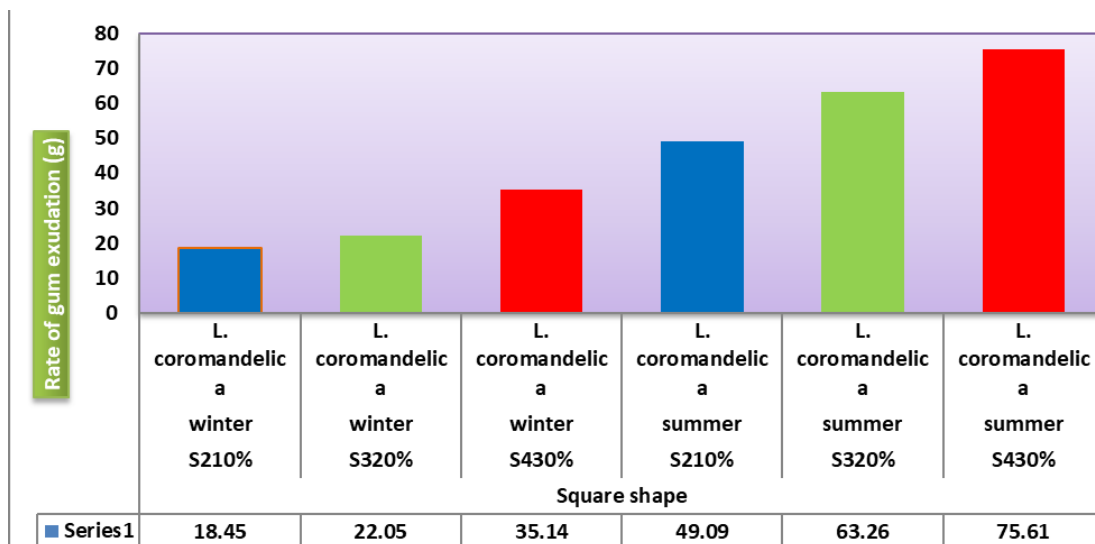


Fig 2: Gum exudation from *L. coromandelica* by Mechanical +Chemical tapping technique in winter 2018 and summer 2019 by Square shape cut Method (g/tree/season).

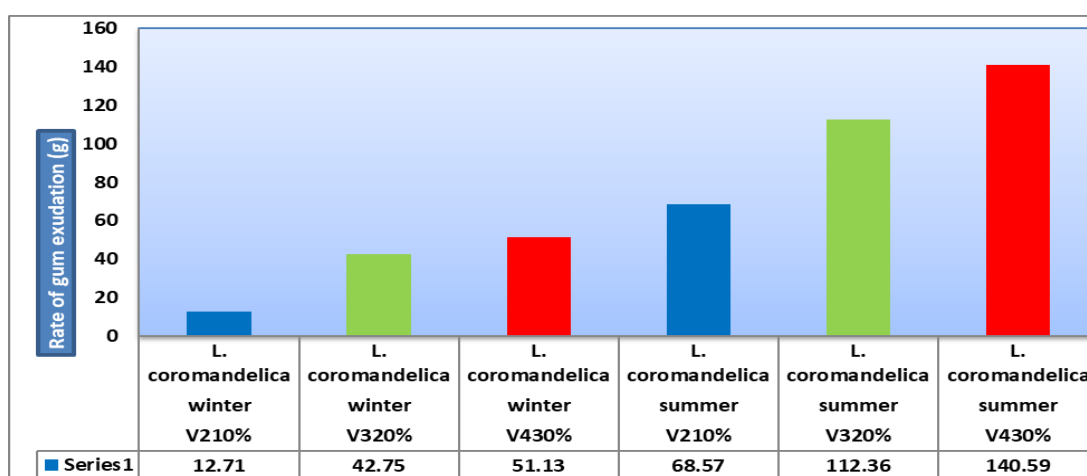


Fig 3: Gum exudation from *L. coromandelica* by Mechanical +Chemical tapping technique in winter 2018 and summer 2019 by V shape cut Method (g/tree/season).

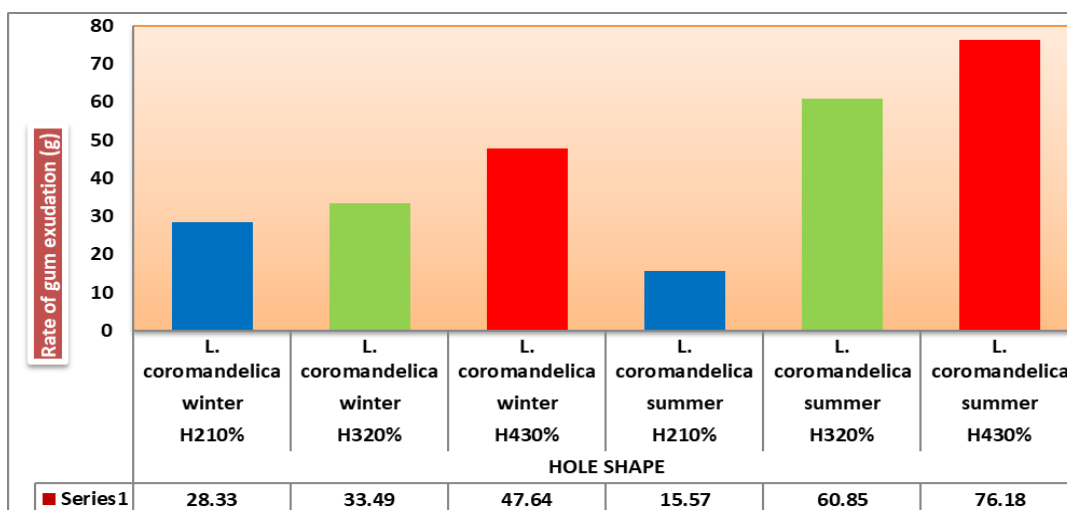


Fig 4: Gum exudation from *L. coromandelica* by Mechanical +Chemical M tapping technique in winter 2018 and summer 2019 by Hole shape cut Method (g/tree/season)

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

Quality Parameter analysis of *Lannea coromandelica* (Houtt.) Merr.

1. Colour

The gum was noted brown in colour. The similar colour also determined by visual observation by (Waghmare 2014) [13] in *Lannea coromandelica*. The results obtained in the experiment were almost same confirms the finding is correct and there is no difference or variation was recorded.

2. Odour

Lannea coromandelica have no odour as Kaur R *et al.* (2012) [8] also reported the same observations in case of Jhingan gum.

3. pH

The pH value of Jhingan gum was 3.4. recorded in our experiment as Duppala *et al.* (2017) [5] reported in his report microbial studies of *Lannea coromandelica* gum and the pH obtained from this gum was 6.1-6.5. The acidity of plant gums is not unexpected since many of them contain various salts like (Ca, Mg, K, Na and Fe) of acidic polysaccharides, the acidity of which is due to uronic acids in their structures reported by Abu Baker *et al.* (2007) [1]. The same reason of will be considered for *Lannea coromandelica* gum. The pH value of *Lannea coromandelica* gum was observed more acidic than the above workers report.

4. Moisture content

In case of *Lannea coromandelica* 16.9%. Moisture was recorded. However Duppala 2017 [5] reported 8.52% moisture content the higher moisture content in our experiment may be rain showers occurred during collection of gum as reported by other author

5. Ash Content

Lannea coromandelica it was 2.5%. As Gupta (2011) [10] observed the value of ash content 0.6% this variation may be because of polysaccharide available in the gum sample. The results confirm the results obtained by the above worker.

Table 4: Quality parameter tests of *Lannea coromandelica*.

Parameters	<i>L. coromandelica</i>
1. Colour	Brown
2. Odour	Without any characteristic odour
3. pH	3.4
4. Moisture content	16.9%
5. Ash Content	2.5%

Statistical analysis

The yield of gum showed statistically significant ($P < 0.05$) by use of chemical ethephon as compared to Mechanical Treatment because the ethephon act as a catalyst which activate the gummosis processes fast in trees. Season was also showed statistically significant ($P < 0.05$) the difference was due to high temperature and low relative humidity and the maximum amount of obtained from the trees in the month of May, 2019(Summer) and October, 2018(Winter).

Conclusions

The Jingan gum obtained from *Lannea coromandelica* is the important Indian gum and highly economic. Its demand is

increasing 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 day by day. To overcome with this problem, proper tapping method known as V shape cut of length 9 cm and width 3 cm having depth of 1cm depth given maximum yield trees of 80-150 cm girth and confined nearer to breast height with the help of chisel and gum inducer is sprayed at the lower portion This technique is simple and safe ensure sustainable yield, regeneration and survival of the tapped trees.

In this tree *Lannea coromandelica* by using Mechanical + Chemical Tapping technique total quantity of gum produced was highest in both the season by using V₄30% conc. the yield was 140.59 gram/tree in summer season and 51.13 gram/tree in winter season. However minimum quantity of gum obtained by using H₂10% conc *i.e* 15.57 gram/tree in summer (March –May) and V₂10% conc in winter (Oct-May) the yield was 12.71 gram/tree. Whereas in Mechanical tapping techniques maximum gum was obtained by square shape cut method. the other two method *i.e* V shape and Hole shape not much effective for sustainable production of gum. Square shape tapping method is better for sustainable gum production in both the season. Temperature and Relative humidity play a significant role in flow of gum through gum canals available in sap wood.

Using Mechanical+ Chemical taping maximum gum exudation of 140.59 grams/tree in summer (March-May) and 51.13 grams/ tree in winter (October – December) by using V shaped cut with 30% concentration of ethephon However in Mechanical tapping maximum gum was obtained by square shape cut method.



Gum exudation in *L. coromandelica* in hole shape and square shape cut



Excess rate of gum exudation in *Lannea coromandelica* by using V shape cut in summer season



Leafless *L. coromandelica* trees in month of may of summer season

A View of *Lannea coromandelica* tree in different season at compartment no 281 of Deopur Range



Creating V shaped incision on tree

Marking of trees from 80-150 cm girth class

Gum solution prepared for pH Measurement

Analysis of pH through pH meter

Gum collection from tree during Winter and Summer season.

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