# Sustainable extraction of biopolymer using various gum enhancer in Rohina (*Soymida febrifuga* Roxb.) tree from Mungeli region of Chhattisgarh.

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Abstract: Gums are natural substances that exude *via* process of gummosis from trees as a response to injury, and collected by tapping, picking, or cutting the tree. *Soymida febrifuga* (Roxb.) is a large Meliaceous tree distributed mainly in the tropical areas of Asia and one of the most popular traditional medicines in India. A clear gum from the bark forms good adhesive mucilage. The commercial tapping of *Soymida febrifuga* is done by blazing, peeling, or by making deep cuts at the base of the bole using an axe. The harvesting methods currently used are traditional and injurious due to which often obtained inferior quality of products. Hence, the study was undertaken in ICAR Network Project to develop the scientific tapping technique for sustainable harvesting in major gum producing tree of Chhattisgarh state to enhance the livelihood of the rural areas as well as to protect the plant and generate the revenue of the government. The various gum Enhancer are used for tapping purpose, the experiment was laid out in three replications and five treatments *i.e.* Control (distilled water), Ethephon, $H_2SO_4$, ethephon with $H_2SO_4$, HCl was used for potential gum exudation. The ethephon with $H_2SO_4$ was found significantly effective for maximum gum. Ethephon was found useful in inducing gummosis and also the physiochemical properties of exudated gums were investigated pH, solubility (cold water, Hot water, ethanol, acetone) viscosity, protein (1.78%), Fat (%) was obtained in gum of chemical method (ethephon with $H_2SO_4$) as compared to other gum enhancers. .
Keywords: *Soymida febrifuga* (Roxb.), Ethephon, $H_2SO_4$, HCl, Gum enhancer

## 1. Introduction

Gum are the natural biopolymers (plant exudates) having number of applications in food and pharmaceutical industry. Most of them are regarded as safe by The FDA (Food and Drug Administration, USA) and biodegradable. Because of their biocompatibility, nontoxic, low cost, environment friendly processing and local availability, these are preferred over synthetic polymers in food, pharmaceutical and cosmetic industries. Gum trees are economically important and found in tropical moist and dry deciduous forests, produce a significant quantity of gum, which are widely used as industrial, food and medicinal purposes in India. 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. Chhattisgarh State is rich in forest and has vast variety of minor forest products to favourable agro climatic conditions resulting in good forest area *i.e.* 43.6 % of total (Bhattacharya *et. al.* 2012). Rohina (*Soymida febrifuga* Roxb.) Meliaceae tree distributed mainly in the tropical areas of Asia and one of the most popular traditional medicines in India, commonly called as Indian red wood is a monotypic genus endemic to India A clear gum from the bark forms good adhesive mucilage and a strong red fibre from it is used for making ropes (Wealth of India, 1952). A lofty deciduous tall trees, grows up to 22-25 m in height and 2.5-3.0 m in girth. Bark is very tough, exfoliating in large plates or

scales. Leaves 22-45 cm, impairpinnate, long, crowded at the ends of branches, branchlets with persistent leaf bases. Flowers are bisexual, greenish white in large axillary or terminal panicles. Fruit is a black, obovoid, woody, septifragally 5-valved capsule. Seeds winged at both ends. Sapwood is whitish and heart wood dark blood red to reddish brown with silver streaks with an oily feel, without characteristic odour or taste (Kirtikar and Basu, 2003). Flower is greenish white in colour, in large terminal or axillary divertically branched panicles often equating the leaves. Fruits are 2.5 to 6 cm long, black, woody in colour, obovoid in shape with 5 celled and 5 valved with winged seeds. Heartwood is dark blood red to reddish brown in colour. Bark occurs in the form of half quills of red brown colour and has astringent and anti-periodic properties (Kirtikar *et al.* 1984, "The wealth of India" 1988). Aqueous extracts were reported to have highest antioxidant activity and total phenolic content than hexane extract (Boreddy Srinivas Reddy *et al.*, 2008).

Trees are tapped to increase gum yield by making incisions in the bark or treating with stress hormone ethylene or ethylene-releasing compounds such as Ethephon (2-chloroethyl phosphonic acid).The gum yield increase with increase in concentration of Ethephon. Treatment of trees with Ethephon exceeding the optimum amount may cause die back and death. Ethephon concentration above 960 mg/4ml in *Acacia senegal* induces shoot desiccation and dieback.

Gum tapping using scientific methods of gum exudation not only increase the life span of the tree but also yields good quality gum of high international value (Gupta et al. 2012). The phytomedicines which can be derived from any part of the plant like bark, leaves, flowers, fruits, seeds, etc. i.e., any part may contains active components (Cragg *et al.* 2001). Ethylene release may be a causative mechanism in gum pocket or cavity or cyst formation because the incidence of this type of gummosis trees treated with the ethylene releasing agents. The loss of middle lamellar cohesiveness and the breakdown of the primary cell walls in phloem tissue in and around gum pockets suggested an ethylene -induced tissue deterioration in phloem and other tissues (Wilde *et al.* 1975).

## 1.2. Materials and Method

### Study Area

The study was carried out naturally grown trees at village Sanwatpur, under the ATR (Achanakmar Tiger Reserve) Lormi, Dist. Mungeli (Chhattisgarh). Whereas, laboratory work was done in Department of Plant Physiology, Agricultural Biochemistry and MAPs, College of Agriculture, IGKV, Raipur (Chhattisgarh). Mungeli is located at 22.07°N 81.68°E. It has an average elevation of 288 metres (944 feet). The experiment was laid out in three replications and five treatments are shown in Table 1.

### Chemical tapping technique

The tapping was done through chemical methods in two season winter and summer. Hence, the study was made *via* using various gum enhancers will be used for potential gum extraction, compared them for production and yield purpose. The study was done in December up to May.

**Treatment details:**

| | |
|---|---|
| **$T_1$** | Control (distilled water) |
| **$T_2$** | ethephon 3.9% |
| **$T_3$** | $H_2SO_4$ 1%) |
| **$T_4$** | ethephon @ 3.9% with $H_2SO_4$ @ 1%) |
| **$T_5$** | HCl @ 1% |

### Quality parameters and biochemical Analysis

All the analysis of gum samples was done in Department of Plant Physiology, Agricultural Biochemistry, Medicinal and Aromatic plants, Indira Gandhi Krishi Vishwavidyalaya, Raipur

(C.G.) laboratory. Each analysis was repeated three times and values reported in respect of the gum samples are actually the average of three replications.

**pH Value**

The sample powder was thoroughly mixed and 1 g and was dissolved in 100 ml of hot distilled water. The mixture was allowed to stand for 5 min at room temperature before the pH and temperature was recorded using a pre-calibrated pH meter. (Ameh, 2012).

**Determination of Solubility**

The solubility of collected gum sample was determined in cold and hot distilled water, acetone, and ethanol. 1.0 g sample of the gum was added to 50 mL of each of the above mentioned solvents and left overnight. 25 mL of the clear supernatants were taken in small pre-weighted evaporating dishes and heated to dryness over a digital thermostatic water bath. The weights of the residue with reference to the volume of the solutions were determined using a digital top loading balance and expressed as the percentage solubility of the gums in the solvents. (Eddy *et al.* 2012).

**Viscosity (cp)**

The viscosity of the gum was measured using a digital Brookfield DV-E viscometer (FAO, 1990a, b).The resistance to movement of a spindle is measured and expressed in terms of viscosity. The viscosity of the gum sample was determined in distilled water. The gum solutions were prepared by dispersing 50 mg of each gum sample separately in 100 ml of the distilled water in a 250 ml beaker at room temperature and mixed using a magnetic stirring overnight. If there were any lump in the solution, discard and prepare the fresh solution until a clear solution is obtained. Adjusted the temperature of the solution to $30^0$C and measured its viscosity with digital Brookfield DV-E viscometer at 10, 20, and 30 rpm per minute using spindle no. 63. The three readings were taken for each dilution and the average was obtained. The CGS physical unit for dynamic viscosity, the poise (P), is also named after Jean Poiseuille. It is more commonly expressed, particularly in ASTM standards, as centipoise (cP) since the latter is equal to the SI multiple millipascal seconds (mPa. s). For example, water at 20 °C has a viscosity of 1.002 mPa.

**Protein content**

Crude protein content of the gum was determined using the Kjeldahl method with the nitrogen content being multiplied by a factor of 6.25. (Rodriguez *et al.* 2004).

**Total Ash content**

Ash content of the gum samples was determined by burning 5 g of gum sample in a muffle furnace at $600^o$C for 4 hour. The ash content was expressed as a % ratio of the weight of ash to weight of the sample.

**Fat (%)**

Fat content of the samples was determined by employing solvent extraction using Soxhlet extraction unit.

$$Fat\ (\%) = \frac{Extracted\ fat}{sample\ wieght} * 100$$

## 2. Results and Discussions

Chemical method of tapping by using gum enhancers, the maximum rate of gum exudation was obtained in between February to March (8.10 to 5.54 g) in ethephon @ 3.9% with $H_2SO_4$ @ 1%. Their time February to march was also quite effective in exudation point of view in chemical method of tapping and treatment ethephon @ 3.9% with $H_2SO_4$ @ 1% (4 ml) was found to be significantly superior over other (15.58-30.01 g/tree). However, $T_2$, ethephon @ 3.9% was found useful in inducing gummosis during winter in December 3.99 g/tree to February 5.79 g/tree.

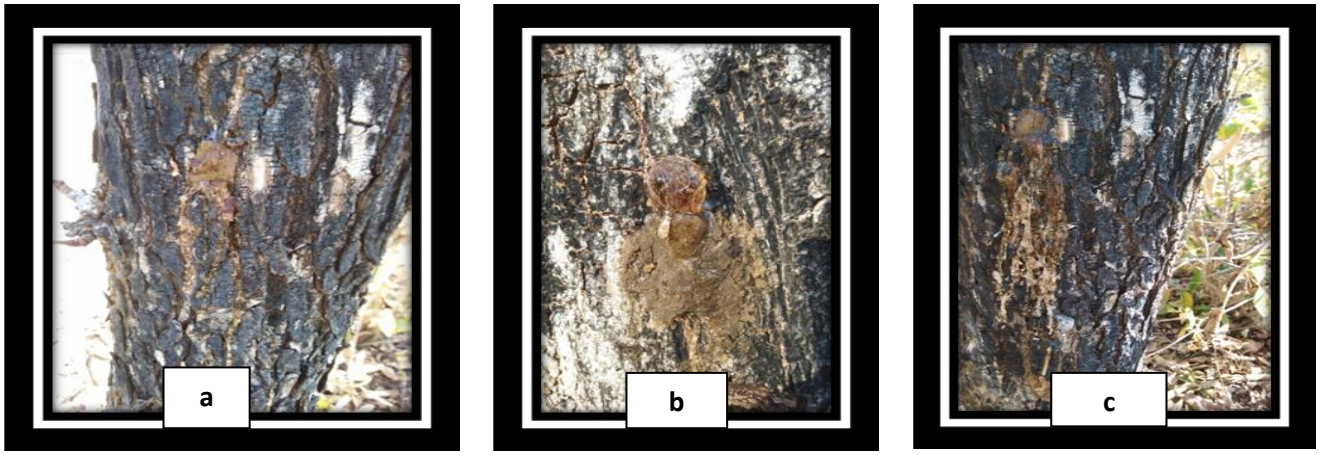


Figure. 1 Gum exudation in Rohina (*Soymida febrifuga* Roxb.) by using gum enhancer a) $H_2SO_4$ @1%, b) Ethephon @3.9%, c) Ethephon @3.9% + $H_2SO_4$@1

However, the combined effect of $H_2SO_4$ and ethephon $T_4$, ethephon @ 3.9% with $H_2SO_4$ @ 1% 4 ml was found to be superior over other treatments. Ethephon (2-chloroethyl-phosphonic acid) is ethylene releasing compounds and it is eco-friendlly and bio safe and use in agriculture and forest crop for various purposes.

**Biochemical analysis of *Soymida febrifuga* (Roxb.) gum**

The pH, solubility and protein content were evaluated and results obtained are summarized in Table 2. The range of pH of gum obtained by chemically tapped gum sample it was 4.89 to 5.94 in Rohina (*Soymida febrifuga* Roxb.). The chemically tapping method reduced the pH and made the sample acidic. However, in chemically tapped sample lowest pH obtained in $T_5$ HCl @1% (4.88) and maximum in $T_2$ (ethephon @ 3.9%) 5.94. The maximum solubility was obtained in gum sample of chemical method (ethephon @ 3.9% with $H_2SO_4$ @ 1%) as compared to other gum enhancers. The solubility as maximum in cold water followed by hot water, ethanol. However, it was not soluble in Acetone.

Murwan and Asma (2008) reported that the gum from *Acacia senegal* is a water soluble polysaccharide of the hydrocolloid group and comprised mostly of arabino galactan and protein, in addition to some mineral elements. It is insoluble in most organic solvents; however, limited solubility can be also obtained in ethanol (up to 60 %) glycerol and ethylene glycol. The average protein content was obtained gums is 1.78%.

**Table 1: Effect of chemical methods on tapping and rate of gum exudation (g) in Rohina *(Soymida febrifuga* Roxb.).**

| Treatment | | Dec | January | February | March | April | May | Total |
|---|---|---|---|---|---|---|---|---|
| | **Temp.($^0$C)** | **27.40** | **28.03** | **31.40** | **33.93** | **41.17** | **42.17** | |
| | **RH (%)** | **87.60** | **84.90** | **76.78** | **63.25** | **49.22** | **46.3** | |
| **$T_1$** | | - | - | - | - | - | - | - |
| **$T_2$** | | 3.99 | - | 5.79 | - | - | - | **9.78** |
| **$T_3$** | | - | - | - | - | - | - | - |
| **$T_4$** | | - | - | 15.58 | 30.01 | 8.5133 | 2.87 | **56.97** |
| **$T_5$** | | - | - | - | - | 6.37 | - | **6.37** |
| **Total** | | | | | | | | **73.12** |

**$T_1$ (Control, Distilled water), $T_2$ (Ethephon 3.9%), $T_3$ ($H_2SO_4$ 1%), $T_4$ (Ethephon @ 3.9% + $H_2SO_4$ @ 1%), $T_5$ (HCl @ 1%)**

**Table 2**
**Quality and Biochemical properties of *Soymida febrifuga* (Roxb.) gum**

| Analysis | *Soymida febrifuga* Gum |
|---|---|
| **pH** (1% gum sample) | 4.89 |
| **Fat (%)** | 1.8 |
| **Protein** | 1.78 |
| **Viscosity (cP)** | |
| 10 rpm | 522.33 |
| 20rpm | 486.00 |
| 30rpm | 84.33 |
| **Solubility** (2% w/v of solution) | |
| Cold water | 136.20 |
| Hot water | 104.80 |
| Ethanol | 101.20 |
| Acetone | 0.80 |

## 3. Conclusion

The all trees seem to have the capacity to exudates gum throughout the winter and summer in Table 1. They might be tapped through the use of chemical gum enhancer, it might be safe ensure sustainable yield. The tapping methods used are brutal and injurious to the plants, often leading to their death. The technology available is old and the innovations are essential for sustainable yield and quality control. The application of gum enhancer technique in simple needs no specialized skill and can be taught to unskilled people living in the forest fringes. Gum tapping can be done in winter (Dec to Feb) and summer (March to May) to ensure sustainable supply of gum and good economic return.

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*References:*

[1]. Ameh, Paul Ocheje. 2012. Physicochemical Properties and Rheological Behavior of *Ficus Glumosa* Gum in Aqueous Solution. *International J. of Modern Chemistry*, **2**(3): 84-99.

[2]. Bhattacharya, P. 2012. Linking gum harvesting, conservation and livelihoods: a case of participatory management in dry tropical forest of Madhya Pradesh. *State Forest Research Institute*.

**[**3**]**. Boreddy Srinivas Reddy, Boreddy Purushotham Reddy, Sapireddy Veer Raghavulu, Sistla Ramakrishna, Y. Venkateswarlu, Prakash V. Diwan. 2008. Evaluation of antioxidant and antimicrobial properties of *Soymida febrifuga* leaf extracts. *Phytother. Res.* 22, 943-947.

[4]. Cragg, G.M. and D.J. Newman, 2001. Natural product drug discovery in

the next millennium. Pharm. Biol., 39: 8-17.

[5]. Eddy, Nnabuk O., Ameh, Paul O., Gimba, asimir E. and Ebenso, Eno E. 2012. Rheological Modeling and Characterization of *Ficus platyphylla* Gum Exudates. *J. of Chemistry*. 1-10.

[6]. Gupta, R., Patel, S., Katiyar, P. and Modi, R.K. 2012. Harvesting, processing and value addition of natural resin and gum. Directorate of research services, IGKV, Raipur.

[7]. Kirtikar KR, Basu BD, 2003. Indian Medicinal Plants. Oriental Enterprises, Dehradun, pp1, 2, 559- 560, 778-780.

[8]. Kirtikar KR, Basu BD and An I.C.S. "Indian Medicinal Plants"; 2nd edition; edited, revised, enlarged and mostly rewritten by E. Blatter, J. F. Calus and K. branches. Hort. Science, 10: 79-81.

S. Mhaskar, Bishen Singh; Dehradun, India 1984; 1:559-560.

[9]. Murwan, K. A. Y. and Asma, A. A. 2008. Emulsion-stabilizing effect of gum from *Acacia senegal* (L) Wild, the role of quality and grade of gum, soil type, temperature, stirring time and concentration. J. Pakistan of Nut, 7(3): 395.

[10]. Rodriguez, G. O.; De Ferrier, B. S.; Ferrier, A.; Rodriguez, B. 2004. Characterization of honey produced in Venezuela, *Food Chem.,* 4: 499-502.
"The wealth of India" (Raw materials); Publication and Information Directorate CSIR; New Delhi; Vol. IX-Rh-SO, 1988; 471-472.

[11]. Wilde, M.H. and Edgerton, L.J. 1975. Histology of ethephon injury on "Montamorency" Cherry