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Establishment of Sustainable Gum Tapping Techniques in Dhawda (*Anogeiussus latifolia)* Using Ethephon

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ABSTRACT

Gum and resins are natural bio-polymers having number of application in food and pharmaceutical industries. Most of them are regarded as safe and bio-degradable, because of their bio-compatibility, non-toxic, low cost, environmental friendly, processing and local availability, there are preferred over synthetic polymers in food, pharmaceutical and cosmetic industries. It is viable income source for thousands of forest dwellers, especially tribals in India. Dhawda(*Anogeissus latifolia)* or Indian gum is a complex non-starch polysaccharide. The tree grows extensively all over the country in Madhya Pradesh, Chhattisgarh Bihar and Orissa.The commercial tapping of Dhawda is done by blazing, peeling, or by making deep cuts at the base of the bole using an axe. These methods often lead to the death of the tapped trees. On account of crude tapping methods and over exploitation the population of Dhawda trees has markedly declined. The harvesting method currently used is traditional and injurious due to which often obtained inferior quality of products. Hence, the study was undertaken in ICAR Network Project for Ph.D. research work at village Khargadih, district Raipur (Chhattisgarh)to develop the scientific tapping technique for sustainable harvesting in major gum producing tree of Chhattisgarh state during year 2015. The various chemical methods are used for tapping purpose. Chemical tapping method using ethephon and IAA injected by battery operated drill machine. However, temperature and relative humidity also play significant role in gum exudation. The ethephon @ 2.34% in 4 ml in two consecutive doses in 45-60 days intervals at high temperature in month of April to June was found significantly effective for maximum gum production. The physiochemical properties of exudated gum were investigated and gum was found to be mild acidic, least soluble in cold water but absorb water and swell,soluble in hot water but insoluble in organic solvent.

Key words *Anogeissus latifolia, Gum yield, Ethephon, IAA, Gum tapping*

Gums are important natural biopolymers demand from biological system under stress situation *i.e.* disease injury to bark etc. being used as a principal components in food, pharmaceutical industries and play a key role in social and livelihood of tribal communities. Gums are metabolic by-products of plant tissues either in normal course or often as a result of disease or injury to the bark or wood of certain plants and it can not be re-entering with plant system. The gum exudates from trees and shrubs in tear-like, striated nodules or amorphous lumps. It dries in contact with air and sunlight and forms hard, glass like lumps. Gum production increases at high temperature and limited moisture. (Sao *et. al.* 2012) India is a rich center of plant biodiversity having more than 15,000 plant species including about 120 gum yielding plants. India produces annually about 2,81,000 tons of gum (Anonymous, 2013).

Dhawda (*Anogeissus latifolia)* or Gum ghattior Indian gum is a complex non-starch polysaccharide. The tree grows extensively all over the country, more commonly in the dry deciduous forests in Western Ghat and dry plateaus of Vindhyachal, Satoura and Western Ghat range of mountains extending in Madhya Pradesh, Chhattisgarh Bihar and Orissa.Trees have a greyish bark and leaves that turn red in dry season. The exudate tears are normally less than one cm in diameter and often occur in large vermiform masses. The gum has a glassy fracture and thecolourof the exudate varies from nearly light brown to dark brown. Generally, color varies in relation to the age of the exudate(Al-Assaf *et al.,*2008). It has been widely employed in food, pharmaceuticals, paper and other industries due to its excellent emulsification and thickening property (Deshmukh *et al.,* 2012). Time course experiments involving mechanical injury to both young and old stems indicate that gum ducts are also formed in the xylem within 30-40 minutes. These ducts, called as traumatic ducts, are formed as a result of breakdown of xylem cells. A traumatic duct shows an irregular lumen without any distinct epithelial cells. Histochemical test reveals that the nature of the gum produced in these ducts is similar to that in the normal ducts. (Setia *et al.*1983).

Traditionally trees are tapped by blazing, stripping of the bark or making deep cuts in the base of the tree with axe. Trees are tapped to increase gum yield by making incisions in the bark or treating with stress hormone ethylene or ethylene-releasing compounds such a ethephon (2-chloroethylphosphonic acid). The idea to use ethephon as gum inducer came from the thought that if ethylene is supplied artificially to the tree *via* the application of ethephon, the developmental response to stress could be accelerated, and, consequently, more gum exudates could be obtained. Ethephon can mimic the effect of water stress, as it releases the stress hormone ethylene in plant tissues. The gum yield increase with increase in concentration of ethephon. Indole-3-acetic acid (IAA) is the most common, naturally-occurring, plant hormone of the auxin class.The development of induced vertical ducts in response to auxin exogenous application does not initiate immediately after applying this phytohormone but only approximately a month, similar to the time gap observed between the beginning of vascular activity and the formation of duct in natural conditions (Fahn 1979). In addition, auxin promotes the expression of ACC synthase gene which encodes for a key enzyme regulation ethylene production (Chae and Kieber, 1999).

Dhawda *(Anogeissus latifolia)* tree

1. Making hole with battery operated drill machine

2. Injected gum inducer ethephon

3. Covering the hole by moistened clay

4. Exudated gum tears

Plate: 1. Chemical tapping method in Dhawda*(Anogeissuslatifolia)* tree

MATERIALS AND METHODS

An investigation was carried out at village Khargadih, Tilda block of Raipur (Chhattisgarh) during 2015. The experiment was laid out in Randomized Block Design with three replication and six treatment *i.e.* T_1 control (distilled water), different Ethephon concentration (T_2 0.78%, T_3 1.56%, T_4 2.34%) and IAA ($T_5$400 ppm $T_6$800 ppm) for potential gum production in Dhawda *(Anogeissus latifolia)*.

Gum tapping method

Two slanted hole of about 5mm diameter with 1" deep is made at one feet above the collar of the tree with the help of battery operated drill machine. After that,4 ml (2 ml each hole) dose of ethephon and IAAgum inducer injected in the hole with help of syringe and immediately the hole is covered (patched up) by moistened clay. It is observed that the tree starts exudating gum tears after 8-10 days of treatment (Plate 1). The exudates gum was picked by hand as large stalactic mass. The quantity of gum exudation was measured by collecting the gum at different time interval in a month and adds them, which was divided by number of treated trees. The yield data obtained was compared to check monthly variation in gum exudation per trees.

Physiochemical analysis

The physiochemical analysis of gum samples study

Table 1. Effect of gum inducing chemical ethephon and IAA in quantity of gum exudation (g) *Anogeissus latifolia* during year 2015

Treatments		March	April	May	June	Total (g/tree)
	Temp.(^{0}C)	34.45	38.1	42.15	35.88	
	RH (%)	48.25	38.4	39.75	56.12	
T_1		0	0	0	0	0
T_2		28.74	44.25	70.79	53.88	197.66
T_3		67.96	121.95	129.32	74.93	394.16
T_4		135.54	186.42	202.7	137.59	662.25
T_5		13.02	46.96	41.24	30.88	132.1
T_6		6.6	10.11	19.42	6.74	42.87
CD at 0.05% level						32.05
SEm±						25.11
CV (%)						11.56

Note: T_1 control (distilled water), Ethephon concentration (T_2 0.78%, T_3 1.56%, T_4 2.34%) and IAA (T_5 400ppm, T_6 800ppm).

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.

Determination of pH

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 the gum 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 preweighted evaporating dishes and heated to dryness over a digital thermostatic water bath. The weights of theresidue 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)

Determination of Protein

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).

RESULTS AND DISCUSSION

The data pertaining to the month wise effect of gum inducing chemical ethephon and IAA in quantity of gum

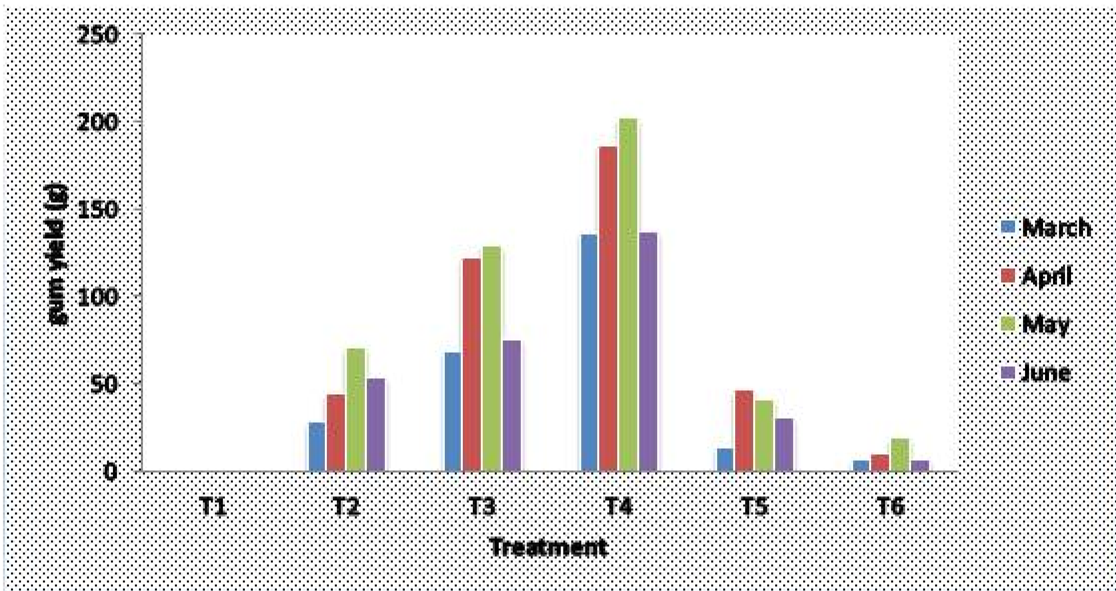

Fig. 1. Monthwise quantity of gum exudation (g) *Anogeissus latifolia* in year 2015

Table. 2 Effect of gum inducing chemical ethephon and IAA in physiochemical properties of *Anogeissus latifolia*

Parameter *Anogeissus latifolia* gum	
pH	4.49
Solubility (2% w/v of solution)	
Cold water	80%
Hot water	88.60%
Acetone	0
Ethanol	0.20%
Protein	4.71%

exudation (g) of *Anogeissus latifolia* shown in Table.1 and Fig.1.

The significant maximum rate of exudation was achieved in the month of May followed by April, June and March during the year 2015. It might be due to the variation in temperature and relative humidity that was found to be significantly effective on tapping and consequently gum yield. Giri *et al.* (2008) reported that the trees of *Anogeissus latifolia* for tapping gums naturally ooze out mostly in summers. However, to increase the yield of gum sometimes people make incision in the tree bark. It is mainly harvested in March to mid-June. Similar findings also reported by Kramer and Kozlowski (1979).The quantity of gum was found significantly maximum in T_4(ethephon @2.34 %) (662.25g) followed by T_3 (ethephon @1.56 %) (394.16g) and T_2 (ethephon @0.78 %) (197.66g).The minimum exudation was observed in T_6 (IAA@800 ppm) (42.87 g). However in control T_1 (distilled water) were no exudation at all. This indicated that the gradual increases in ethephon concentration also increase the process of gummosis and ultimately increased the quantity of exudation in Dhawda *Anogeissus latifolia*. Bhatt (1987) reported that the gummosis is enhanced by ethephon application and 466 fold increases in gum yield was recorded in plants treated with 1600mg of active ethephon substance during April-May when plants becomes leafless.

Physiochemical analysis of Dhawda *(Anogeissus latifolia)*

The pH, solubility and protein content were evaluated and results obtained are summarized in Table 2.

The pH value (4.49) of gum samples noticed mild acidity in *Anogeissus latifolia* gum which might be due to the presence of acidic sugars. It is composed of L-arabinose, D-galactose, D-mannose, D-xylose and D-glucoronic acid. Similar results were also reported by Ahmed *et al.* (2009) in *Anogeissusleicarpous*.

The gum samples of *Anogeissus latifolia* obtained through chemical tapping techniques wereanalysed for their solubility using different solvent. The chemically tapped gum samples average solubility percentage were noticed in cold water (80 %) and in hot water (88.60 %). Whereas, gum samples were recorded in acetone (0.00 %) and in ethanol (0.20 %). The *Anogeissus latifolia* not completely soluble in water and insoluble in 90 % alcohol. It forms a viscous dispersion in water when in concentrations of 5 % or greater. The dispersion is thixotropic and non-Newtonian in behavior (Sao, 2012). Dell and McComb (1978a) also reported that the natural gum is soluble in cold or hot water (or at least it swells to form a gel), but insoluble in organic solvents such as hydrocarbons, ether or alcohols. Similar results also reported by Davidson (1980).

The protein content of Dhawda gum was found 4.71%. It may be due to the superior emulsification performance and stability of *Anogeissus latifolia.* The studies on characterization of gum ghatti and comparison with gum arabic found that the protein content of gum ghatti (3.4%) as compared to protein content of gum arabic (2.1%) (Al-Assaf *et al.,* 2008).

CONCLUSION

The future of natural gum industry is uncertain and therefore, a thorough economic study of the national and international trade is necessary. Synthetic products are preferred by the industry because of the uncertain supply and cost of natural gums. However, unstable oil prices, decreased production and high costs of the synthetic material create a promising future for natural gums and resins. In spite of the competition from synthetic products, natural gum and resins are preferred in certain industries as they are superior.

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. A concerted effort by researches and agencies such as research institution, Universities and non-governmental agencies is urgently needed to improve all aspects of the industry such as tapping, collection, processing, grading, classification and marketing. R and D are completely lacking in the area of utilization of natural gums and resins. The industry completely depends on traditional and certain ad hoc investigations by individuals. Research into genetic improvement and selection of species for production of gums and resins should be initiated which may lead to establishment of plantation of these species. Gum and resin industry can provide employment and a steady additional income to rural people and thereby stop their migration into the towns and cities.

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