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Gum Production and its Sustainable Harvest from Forest: a Review

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Abstract

Natural Resins and Gums (NRGs) are the major NTFP of Indian Forest products. These NRGs have a highly significant role in the paper, textiles, cosmetics and medicinal (to cure fevers, cough, cold, sexual debilities, dysentery) industries. Due to the increasing demands of NTFPs, sales of such products have been increasing significantly day by day. Now India is one of the top NRGs importers of the world though it has mega diversity hot spots. Improper tapping practices affecting a lot to the gum yielding plants. A proper and Continuous manner of research is required on the different physical, chemical and biological factors affecting gum production in different gum yielding plants to increase the production of gums along with decrease the damages facing the plants.

Introduction:

India is enriched with dense and diverse forest; the biodiversity of the country is so high that makes it a mega biodiversity center out of the 17 centers (Rewatkar, 2020). The variability in the edaphic, climatic, and topologic across the country makes it a favorable habitat for the highly diversified plant species and other life forms (Champion *et al.*, 1968). The average forest cover of the country is 7,12,249 sq km, (21.67% of the land area of India) (ISFR, 2019; Rintelen *et al.*, 2017). Apart from providing other ecosystem services (like regulating the climate, nutrient cycling, etc.), the forest provides subsistence to a large section of the population of our country. Millions of tribal people earn their livelihood from the collection and marketing of Non-Timber Forest Products (NTFPs). Particularly in developing countries like India, gums and resins provide a significant proportion of NTFPs (Sharma *et al.*, 2016). Collections of gums and resins provide livelihoods to millions of Indian people living in or around forests.

Gums and resins are planted exudations that result partly from natural phenomena and partly by injury by insects, animals, or human beings. Gums and resins are generally exuded by plants in liquid form and on exposure to the environment, it gets dry into translucent tears and remains attached to the bark of the stem or branch (Sinha *et al.*, 2005). These gums are otherwise known as tree exudates. These exudates (gums) have a historical background of about 5000 years, these are the composition of long chains of polysaccharides having a high molecular weight (Kaur *et al.*, 2009), these polysaccharides are mainly

composed of monosaccharides like uronic acid and some protein and fibers (Reddy *et al.*, 2011).

The population of gum yielding plants is decreasing day by day along with the increase of demand for these non-timber forest products in different industries like paper, textile, gas, cosmetics, etc. (Saha *et al.*, 2017; Choudhary *et al.*, 2014). The main reason behind this is the large gap in production and requirement of these gums. The shrinkage in forest cover and unsustainable methods of harvest leading to the death of the plants is the major cause of a decrease in the production of gum. India has almost 7800 medicinal Drug-Manufacturing Units that annually utilize about 2000 tons of plant and plant-based products (Wakdikar, 2004), a good percentage of which are gums and resins. It is reported that sales of non-timber plant products have grown by nearly 25% in India during the past ten years (Coppen, 1995).

These gum-resins have important medicinal properties. Several types of gum are used in Ayurvedic and Unani medicine systems for treating various diseases like fevers, cough, cold, sexual debilities, dysentery, etc. (Dhiman & Kumar, 2006). Nowadays gums are also used in paper, textile, and cosmetic industries due to their quality of emulsions ability, retain moisture and impart a smooth texture (Goldstein, 1954; Nussinovitch, 2009; Srivastava & Ray, 2015).

Gums and resins are produced as a natural phenomenon in the plant parts in which the internal tissues are damaged through the process of gummosis, this leads to form gum cavities or canals, which exudes a polymer of carbohydrates called gum. (Shah *et al.*, 1976) these cavities

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are also caused due to injury to the plant parts, sometimes a kind of bacterial and fungal attack also causes the production of gum in plants (Krishna, 1993).

Today gums are one of the ideal products that are used for multitasking functions like control physiochemical properties, increasing the solubility of poorly soluble drugs, to achieve a controlled drug delivery system (Avachat *et al.*, 2011). One of the greatest advantages of the use of gum is that as it is characterized by abundant availability, low toxicity, biodegradability, biocompatibility. They are also inert and cheap as compare to synthetic polymers (Reddy *et al.*, 2011).

Gum Tapping and Its Effect on the Plants

Gum tapping is the process of artificially (manmade) wounding the plant for gum production (Shiva *et al.*, 2006). The gum tapping is generally done by the tribal people dwelling in and around the forest areas. The gum tappers generally use the traditional tapping instruments like a sword, knife, and axe for wound formation and go on making a wound in an indiscriminate and unscrupulous manner, which sometimes kills the gum yielding plant. (Sinha *et al.*, 2005). Due to unscientific and excessive gum tapping, large mortality of commercially important gum-yielding plants occurs in natural forests. The destructive tapping methods and poor regeneration of the gum yielding plants are also the cause of the decline in populations of these trees, necessitating a ban on tapping. In this context, it is noteworthy to mention that tapping has been banned by some of the state forest departments as a result of which there is a sharp fall in foreign exchange earnings (Sunnichan *et al.*, 2005; Nair *et al.*, 1995). According to statistics provided by the major exporters till 2019, India exports \$7.04 million NRGs to Spain and \$26 million to the USA. India is one of the top NRG importers of the world (21% of the world imports; near about \$190 million expenses). India Imports NRGs from many countries like Indonesia (\$11.9 million), Thailand (\$8.5 million), etc. (World Merchandise Exports and Imports by Commodity (HS02, 2020). A decreasing trend in the production of gum has been noticed from time to time. A Major decline from 6838 Metric tons (MT) in 1975 - 1976 to 461.3 MT in 1990-1991 was observed, which results in a rapid inclined in price from Rs.7491 to Rs.83, 361 per MT (Gautami *et al.*, 1992). Reduction of annual gum production from 1148.59 tons (2011-12) to 683.83 tons (2015-16) has been reported in the ICAR report-2016. Yogi *et al.*, (2018) reported that total export Natural resin and Gum (NRGs) India (18963.48 billion in 2014- 15 & 17163.78 billion in 2015-16) has been decreased from 0.62% (118.95 billion) in 2014-15 to 0.33 % (56.72 billion) in 2015-16 with an annual deceleration of 52.32 % (Department of Commerce, GOI, 2016). This indicates that unscientific and unsustainable gum tapping has a great and indirect effect on our economy.

Thus, it is observed that the condition of the gum-

producing plants and their habitat (forest) is not in a good status (Silpi *et al.*, 2006; Rijkers *et al.*, 2006; Herms *et al.*, 1992) and this necessitates urgent attention for the conservation.

This review attempts to highlight the issues related to gum harvest and gum yielding plant species on the aspect like Seasonal impact on gum production, use of stimulators for gum tapping techniques and its standardization, the impact of different stress on gum harvest, etc.

Status of Gum Yielding Plants

The availability and age of the gum yielding plants determine the production of gum (Zas *et al.*, 2020). Therefore, the study on the population structure of all gum-yielding plants in their natural forests becomes a most necessary need. The regeneration potentialities of such plants can also be analyzed by a study of population structure. Few work reports on tree species and their natural regeneration in the sub-tropical forest in Shillong have been produced by (Barik *et al.*, 1996; 1992). Degradation of forest tree species is also a very common phenomenon in such natural forests, a report on sal forest in North-Eastern Uttar Pradesh is a living example of that (Pandey *et al.*, 2003). The reports of Bhuyan *et al.* (2001) on the tropical wet evergreen forest at Arunachal Pradesh and Ralhan *et al.* (1982) on the Kumaun Himalayas also showed similar information. But all these works are mainly on timber plants. Reports on the gum yielding plants and their status in Indian forest is very less. Work report on Pachmarhi Biosphere Reserve (Madhya Pradesh) by Kala *et al.* (2013) showed that the population of some gum yielding plants like *Sterculia urens*, *Anogeissus latifolia*, *Buchanania lanzan* was extremely affected by overexploitation. Factors like poor germination potential, lack of proper environmental conditions, etc. are considered as the main effecting causes for the critical situation of gum yielding plants, and such very poor seed germination has been reported in *Sterculia urens* (gum yielding plant) (Purohit *et al.*, 1995). Micro-propagation may be a solution to such a problem in *Sterculia urens*, Hussain *et al.*, (2008) reported that micropropagation increase the population status of *Sterculia urens* and that leads to the increment of its availability for the tapping and production of gum.

Effect of temperature on gum production

The study of Coppen (1995) concluded that the lowering of temperature normally caused a downfall in resin yield. Rodrigues *et al.* (2009) also supported Coppen's statement as they have been shown in their study on the Pinus plant and concluded that spring and summer influence more production of resin than winter. The study of Das *et al.* (2014) on *Acacia nilotica* and Adam *et al.* (2009) on gum production on *Acacia senegal*, reported that the higher environmental temperature during the tapping period

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produced a higher amount of gum whereas lower temperature causes to close the gum secreting tissues which leads to less or no yielding of gum.

There several kinds of research have also been performed in India. According to a study made by Singhal (2000), the month of March and June are the most appropriate time season for gum and resin collection (temperature of the environment is almost at its peak at this time). The study of Bhatt *et al.* (1987) also supports the view of Singhal that high ambient temperature accelerates gum oozing.

Effect of Stimulators on Gum Production

Many workers have tried to assess that if there is an effect of stimulators on the amount of gum produced by the gum-yielding plants. Ethephon a chemically synthetic compound responsible for the production of ethylene, is considered a good stimulator of gum production from plants. There some other stimulators like acid, paraquat, GA₃, ABA, etc. have also been tried by many workers.

Snow (1949) has reported that prolongation of the flow of oleoresin occurs due to stimulation by acid treatment. Such stimulation by acid resulted in 50 to 100% higher production of gum from plants belonging to Pinaceae.

It is also reported that Ethephon (2,4- chloroethyl phosphonic acid) and paraquat (1,1 dimethyl 4,4 bipyridium chloride) and other herbicides induce extensive oleoresin production from the stem of different plants (Abib *et al.*, 2013; Schmid *et al.*, 1976; Roberts, 1973).

The effect of different hormones on the production of secondary metabolites and gum production has also been studied by some workers Abbasi *et al.* (2012) have made a study on the effect of different concentration of GA₃ on hairy roots of *Echinacea purpurea* and observed that increasing concentration of GA₃ (0.01 to 0.1 μ M) enhanced the production of secondary metabolite and he also found the strongest effect while applying 0.025 μ M Ga₃.

There some studies were also made by Indian workers like, Nair *et al.*, (2004; 1995) has treated ethephon on *Sterculia* plants and observed a dramatic increment of gum production.

Tapping techniques on gum production

Tapping direction in plants concerning sunlight is a very important factor in gum yielding. A study was made by Adam *et al.* (2009) on *Accacia senegal* to see the effect of direction of the wound made on gum production. They made a wound in four directions (east, west, south, and north concerning sunlight) in *Accacia senegal* and measured the amount of gum produced. The study showed that the gum yielding was increased 60% when the tapping was in eastern and western site towards direct sunlight, as because these two sites receive the maximum amount of sunshine which help in rapid drying of the exudates accompanied by the high temperature facilitating high gum

production. In another study on *Boswellia papyrifera* made by Gessmalla *et al.*, (2015), also confirms the suitability of eastern and western sides for tapping the maximum amount of gum.

Along with the side direction, tapping position has also a valuable impact on the production of gum. The different position of tapping on *Acacia seyal* plant leads to different production of gum. The tapping on the higher stem and upper branches causes lower production of gum than the middle and lower stem of the plant (Kamal *et al.*, 2004).

Effect of Water Stress on Gum Production

Water content in soil is a major factor that regulate gum production in plants, mainly water stress condition is an up-regulator of gum production in plants, The wet areas where water content in soil is greater there the production of gum from *Acacia senegal* is lower than the plant situated in water stressed areas, in the wet areas the gum production is uncertain (Abib *et al.*, 2013), supportive reports where the secondary materials like essential oil content in sweet basil was noticed in water stress condition (Simon *et al.*, 1992).

Conclusion :

Nowadays, awareness of natural products is increasing among people. Natural gums are in use in day-to-day life as medicine, food, and cosmetic products as they have fewer side effects and non-toxic properties. Although a country like India possesses large forest resources only very little has been exploited so far. More detailed and clear scientific study and investigations are required to utilize the real potential and availability of natural gum yielding resources which has a direct effect on the commercial market. Modern practices are needed to increase the quantity of gum production with quality improvement.

Unlike synthetic gum, natural gum has not been commercially successful due to the unavailability of proper technical knowledge on the extraction and tapping technique. However, it is a concerning matter that the traditional knowledge of tapping, processing, and other practice of using natural gum has reduced to a great extent among the ethnic people due to the easy availability of cheap synthetic gums. It has been seen that the classical knowledge of plant gum is now very much confined among the surviving older people only and few practitioners in the local tribal communities of forest patches of different districts of Odisha. Unfortunately, serious attempts have not been made to proper documentation and preservation of this natural treasure of traditional knowledge of natural gum and its tapping associated with the indigenous people. Again, due to the least focus on conservation strategy also causing a steep depletion of this valuable resource.

Now it is the proper time to take steps towards documenting these treasures of traditional knowledge systems. Otherwise, the vital information on the utilization of natural resources around us will be lost.

From this review, it's clear that NRGs status of India is at high risk which is declining on an exponential scale. To revitalize the status, we must need some sustainable approaches such as Scientific tapping technique, proper collection methods, proper documentation, data assessment followed by clear constituent profiling of natural gum yielding trees and their gums, as well as a basic need to promote much more research on the field of commercial product formulation from plant gums. The use of AI and ML with GPS tracking systems for proper detection of gum-yielding trees may help in quick documentation and carry out faster research by the scientific community.

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