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Gum and Resin as a Non-Timber Forest Product

Nishant Ghode* and Sajiwan Kumar

Forestry & Wildlife, School of Studies in Forestry & Wildlife, Shaheed Mahendra Karma Vishwavidyalaya, Jagdalpur, District - Bastar, Chhattisgarh-494001, India

**Corresponding author*

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A B S T R A C T

Non-Timber Forest Products (NTFPs) form an integral part of the socio-economic fabric for forest dwelling and tribal communities in India as well as some other tropical countries. Gums and resins in particular have been highly valued due to their broad range of applications in the food, pharmaceuticals, traditional medicine, cosmetics and multiple industrial sectors. Sourced from natural exudation or induced tapping of specific plant species, these products are environmentally benign and provide a valuable source of livelihood for rural households. Broadly this paper gives a brief review on natural gums (Gum Karaya), resins (Pine resin) gum-resins asafoetida, salai gum etc., their utilization with present production status. The use of the traditional unscientific methods under which harvest of plant parts and whole tree uprooting, results in poor yield and creates a long term damage to the different species. It looks at each firm in the value chain, such as farmers, cooperatives, contractors and enterprises, and introduces structural market failures and barriers to entry related to environment issues, socio-political factors and legal constraints. The following sections will discuss processing, grading and transport issues and give policy recommendations to improve the sector efficiency. The paper suggests that there is an ample space for development, sustainable management and value addition to gums and resins for their better inclusion in predominant forest and livelihood policies.

Introduction

NTFPs remain an important component of forest-based economies, particularly in areas where livelihood strategies depend on forest ecosystems. They include fruit, seeds, fibers, leaves and flowers from non-wood biodiversity; medicinal plants and gums and resins. Gums and resins are the major driver among these, from ecological as well as commercial and socio-cultural point of view. Gums: Gums are polysaccharides from certain trees or shrubs that may spontaneously exude or be induced to do so by injury. These are all valuable properties of hydrocolloids that have use in the food, pharmaceutical, cream cosmetic and textile industries as gellable thickenings with water solubilities. The longer resins are hydrocarbon plant secretions that are most often not water soluble but may be in solution of an organic solvent. Resins are valued for the protection they confer on plants and are the source of products ranging from varnishes adhesives, incense, perfumes to glues. India has its vast and highly diverse forest cover, a fairly rich array of species that produce gums and resins such as *Sterculia urens* (Karaya gum), *Boswellia serrata* (Salai gum), *Acacia senegal* (Gum Arabic), and *Pinus roxburghii* (Pine resin). These natural products have, by and large, been able to support the rural economy, mostly

in the tribal belts of Madhya Pradesh, Chhattisgarh, Jharkhand, Odisha, Andhra Pradesh, and Rajasthan. In many of these areas, the collection and sale of gums and resins form the primary source of cash income for forest-dependent households. The harvesting and commercial sale of gums and resins is the main source of cash income for many forest-dependent households in a large part of this land. The global market for gums and resins has gained commercial value, stimulated by the new demand for natural or organic products. These are used commonly in Pharmaceutical industry, Food & Beverage as well as fragrance and also cosmetic industries. For example, gum arabic is used as a stabilizer in soda; karaya gum is found in dental adhesives and laxatives; pine resin derivatives are present in soaps, paints, and synthetic rubber. Indeed, these resins have long been recognized as having medicinal properties in traditional systems of knowledge to help cure ailments like indigestion and inflammation and respiratory problems. This sector though holds immense business potential considering resins and gums uses widely but in India it is not largely developed. One of the main issues arose in this case is the trees gets affected due to unsustainable and unscientific harvesting method which results ultimately in dwindling their productivity. The tapping techniques used in most of these areas are very crude and unscientific, often involving over-extraction which is likely to damage the potential for sustainable management of resources in the long term. Forest dwellers and primary collectors have not been properly trained on sustainable non-timber forest collection techniques, which means that they are obtaining poor quality produce which fetches at lower prices in the market. The second major problem was the lack of organized value chains. It is a value chain that has many intermediaries (who take most of the value) and the primary collectors (mainly tribal women and small farmers) get the bare minimum return for picking these herbs, smelly mushrooms. A number of cooperatives and forest-based enterprises have been launched in certain areas to gather and value-chain these products, although with extremely low coverage. Moreover, these enterprises. And an even more critical one is the absence of proper legal sector and policy support. The laws of Forest & Access to Non Timber Forest produce are very complex & mostly not practicable on a ground level as it is being enacted in different ways by various states. Collectors need a permit or license appropriate access to the forest lands and this can introduce conditions imposed by forest departments which together create an unstable legal environment hampering investment and introducing innovation. In turn, this fickle climate also worsens the availability of gums and resins due to environmental degradation. Since most of those species prefer semi-arid and dry deciduous forests, they are largely threatened by droughts, wildfires, overgrazing. Other factors, like over-harvesting or habitat loss could be additional explanations for lack of regeneration and have potential longer term sustainability implications for the production of gums and resins. This study explains about some significant provisions related to Gum and resin types with their importance in ecological and economic forms. The study also evaluated traditional harvesting practices, the behavior of some value chain actors, entry barriers in production and marketing, as well as processing and transportation issues. The paper ends with a discussion on current policy interventions and suggest what can be done to achieve sustainability and profitability in this crucial NTFP sub-sector. This research helps open up the multi-dimensional nature of gum and resin sector: changes in ecology and collection practices need to be understood within the context not only of market structures but also of governance if we are to understand sustainable forest management regimes and livelihood strategies centered around forests. This suggests that a more comprehensive approach is urgently needed where local science, institutional support, and market facilitation are integrated to scale up the use of gums and resins in rural and forest economy.

Important Natural Resins and Gums

Current Status

The center of genera from which natural gums and resins including their production was largely confined to India on account of its highly rich biodiversity and extensive forest cover. Importance of these materials gets triple folded, first; by the industries, second, medicinal and third means of livelihood for millions depending on forest life. The big category in gums and resins is gum karaya, gum arabic and pine resin from which about 95% is imported; asafoetida, salai gum are among others within the same group of India origin with copal & dammar batu being a small group. The gums and resins are mostly from the trees, which grow in dry deciduous to moist deciduous forests besides tropical areas, mainly in states like Madhya Pradesh, Chhattisgarh, Jharkhand, Andhra Pradesh, Odisha Maharashtra and Rajasthan. These forested lands are home to many tribal communities who depend on Non-Timber Forest Produce (NTFP) for their livelihoods. India has nearly 350–400

million people as working population and subsistence on forests (MoEF, 2009), in which gums and resins are major contributory. Gum karaya, developed from *Sterculia urens* and responsible in addition to gum ghatti (from *Anogeissus latifolia*) for major tonnage and export of gums among the gums. This compound is widely used in pharmaceuticals, food recipes and cosmetic products. Gum arabic, derived primarily from species of *Acacia senegal* and Acacia seyal but less known than in some parts of Africa also produced to a lesser degree in India and has food and beverage uses because the bark contains more tannin than most other acacia species. Gum ghatti, derived from *Anogeissus latifolia*, is a further Indian gum utilized in food products and textiles. Vayu (some natural resinous exudates) Pine-resin obtained from *Pinus roxburghii*, is one of the most commercially exploited natural resins in India. Zones of Himachal Pradesh, Uttarakhand, Jammu & Kashmir are identified for pine tapping. The resin of pines is one reduced to turpentine androsin, which are employed in the manufacture of varnishes, and for many other purposes-to a considerable extent also in some inks, soaps and adhesives. Salai gum, also known as Indian frankincense, is made from the plant *Boswellia serrata* and is gaining worldwide recognition for its anti-inflammatory and healing abilities. Likewise, Hing (Asafoetida), a gum-resin sourced from the Ferula species also falls in high value category and is imported as raw material and processes primarily in northern region of India. The gum and resin sector has huge economic potential but is strongly underdeveloped in India. To a large extent, this is due to the fragmentation and disorganization of the value chain. Most of the collection is done by untrained tribal workers using traditional methods, leading to damage to trees and reduced productivity in future. The absence of warehousing, grading and value addition infrastructure are very much there at the local level. It is bought from collectors at low prices who then sell them onward to middlemen or local contractors for the national and global markets. Similarly, the grassroots level has limited technical know-how. These sustainable collection methods should be preferable in the region, but many collectors are not aware of the best pruning or tapping seasons. Extensions agencies and forest departments barely provide basic training and equipment. The quality of the solution and gums obtained by collecting these gum resins are mostly un-uniform from site to site, which affects their market value and export. So the message is mixed, ultimately harking back to India's natural endowment and gum-resin history according to which the country has every reason for exploiting potential opportunity in this sector but due to poor organization leading to weak knowledge transfer and across sector ruinous investments in post-harvest processing. The sector is capable of providing ample rural employment and national income if strengthened well in infrastructure, capacity building and market linkages.

Natural Resins

Natural resins are solid or semi-solid complex mixtures of volatile and non-volatile terpenoid compounds secreted by various plant species, particularly trees. They are produced as part of the plant's defense mechanism against injury or infection. Resins are insoluble in water but soluble in organic solvents, making them highly valuable in numerous industrial applications, including adhesives, varnishes, incense, cosmetics, food coatings, and pharmaceuticals. India possesses a diverse range of resin-yielding flora, particularly in its dry and subtropical forests. The following are three of the most important natural resins with ecological, cultural, and economic relevance: Pine resin, Copal.

Pine Resin

Pine resin is one of the most extensively tapped and commercially important natural resins in India. It is primarily obtained from *Pinus roxburghii* (Chir pine), which is naturally found in the sub-Himalayan regions of Himachal Pradesh, Uttarakhand, and Jammu & Kashmir. Other pine species like *Pinus wallichiana* and *Pinus merkusii* also produce resin, though to a lesser extent. Pine resin exudes from the tree when it is injured or tapped using specific techniques. The bark streak method and borehole method are commonly used for resin extraction. The bark streak method involves removing a vertical strip of bark and making a V-shaped incision, which allows the resin to flow out and be collected. The borehole method, considered more sustainable, involves drilling small holes at an angle to reach the resin ducts, reducing tree damage and improving productivity (Sharma & Lekha, 2014). Once collected, pine resin is processed into two major derivatives turpentine (the volatile fraction) and rosin (the non-volatile residue). These derivatives are widely used in industries producing varnishes, sealing wax, soaps, rubber products, adhesives, printing inks, and even pharmaceuticals. The pine resin tapping industry is significant for rural employment generation, particularly in the hill states. However, unsustainable tapping, improper tree

management, and lack of value addition at the local level limit its full potential. Moreover, the sector often lacks organized infrastructure for resin processing in close proximity to collection areas, leading to post-harvest losses.

Copal

Copal is a resin obtained mainly from trees belonging to the genus Hymenaea, which are more common in Central and South America, but related species are also found in parts of Africa and Southeast Asia. In India, copal is not as widely harvested as pine resin but still holds niche importance in the NTFP landscape due to its cultural and religious significance. Unlike fresh resins, copal is often collected as a semi-fossilized resin. Over decades or even centuries, the resin hardens underground and becomes copal, which is then extracted by digging shallow deposits around the roots of resin-producing trees (Lee & Hong, 2002). The collection of copal involves both surface and sub-surface techniques and requires significant manual labor. Copal has been used for centuries as incense in religious and spiritual ceremonies across various cultures. It is valued for its clean-burning and fragrant smoke. Industrially, it is used in manufacturing high-quality varnishes, particularly for wood and artworks. It is also utilized in producing certain lacquers and coatings due to its excellent solubility and adhesive properties. One of the challenges in the copal trade is the lack of standardized quality grading, which hampers pricing and export. Moreover, since India imports a portion of its copal needs, there is potential to increase indigenous production through domestication and cultivation of suitable Hymenaea species.

Dammar Batu

Dammar batu is another important natural resin, primarily derived from tree species belonging to the genus Shorea, notably *Shorea robusta* (sal tree) and *Shorea javanica*. These trees are mostly found in the tropical forests of Southeast Asia and parts of northeastern and central India. The term "dammar" is derived from the Malay word for "resin" or "torch made of resin." Dammar is collected from naturally exuding tree bark or through incisions made by tappers. In many regions, the resin is picked from the forest floor after it hardens into roundish lumps known as "batu" (stone like), hence the term dammar batu. Dammar has widespread uses in the food, pharmaceutical, and cosmetic industries. In food, it is used as a glazing agent and in certain traditional sweets. In pharmaceuticals, it acts as a coating material for pills and tablets. It is also used in making incense, varnishes, and artistic paints due to its natural gloss and quick-drying properties (Chandel *et al.,* 2018). In folk medicine, dammar is believed to have healing properties and is used for treating wounds, skin infections, and respiratory ailments. Additionally, it plays a role in spiritual and religious rituals, particularly in Hindu and Buddhist traditions. There exist large Shorea species resources in India, primarily in states like Madhya Pradesh, Chhattisgarh, Odisha, and Jharkhand. Due to the low level of awareness, fragmented marketing channels, and absence of processing units in the vicinity of collection zones, commercial exploitation of dammar remains very low. Establishing collection centers and training tappers, coupled with marketing on the basis of quality, can strengthen the value chain and thereby establish the commercial value of dammar, consequently contributing to the livelihood of forest communities. In conclusion, pine resin, copal, and dammar batu are considered able candidate natural resins with diverse applications and far from being fully explored from an economic perspective. Pine resin has a fairly structured supply chain in India, whereas the other two natural resins barely have one. Given that copal and dammar have significant potential for income generation in tribal areas, with sustainable harvesting and marketing and village-level processing infrastructure being imperative over a period of time for resurrecting these natural resins in full.

Natural Gum-Resins

Some natural gum-resins comprise the two properties of gums (polysaccharides) and resins. These are semi-solid or solid exudates found mostly in the stems or roots of some botanicals. The Medicinal, aromatic and culinary properties of gum-resins have been known for centuries in ancient systems of medicines as Ayurveda–Unani and other traditional systems. The three most commercially significant natural gum-resins are myrrh, asafoetida (hing), salai gum.

Asafoetida (Hing)

Asafoetida is a pungent-smelling gum-resin derived from the root system of Ferula spp., particularly *Ferula asafoetida*. Although the plant is native to Iran and Afghanistan, India is the largest consumer and processor of asafoetida. Most raw asafoetida is imported and then processed in India, especially in regions like Uttar

Pradesh and Himachal Pradesh. The gum-resin is obtained by making incisions at the base of the plant's taproot. A milky latex exudes from the cuts and solidifies into a brownish or amber-colored mass upon air exposure. The collected resin is then sun-dried and powdered for culinary or medicinal use. Asafoetida is widely used as a culinary spice, particularly in Indian cuisine, where it acts as a flavor enhancer and digestive aid. Medically, it is known for its antibacterial, antiviral, anti inflammatory, and antispasmodic properties (Bhatnager *et al.,* 2015). Despite its strong odor, it is prized in Ayurveda for relieving indigestion, asthma, and menstrual disorders. India has recently initiated domestic cultivation in arid regions using imported seeds to reduce dependency on imports and boost local production.

Salai Gum (Boswellia serrata)

Salai gum, also known as Indian frankincense, is a gum-resin extracted from the tree *Boswellia serrata*, commonly found in the dry deciduous forests of Central and Western India especially in Madhya Pradesh, Chhattisgarh, and Rajasthan. Tapping involves making shallow incisions in the bark, from which the gum-resin exudes and hardens upon exposure to air. Harvesting is typically done two to three times a year.

Salai gum is highly valued for its therapeutic properties, particularly its anti-inflammatory and anti-arthritic effects. It is widely used in Ayurvedic formulations for managing joint pain, respiratory issues, and digestive problems (Khan *et al.,* 2014). Modern research has also shown its potential in cancer treatment due to its ability to induce apoptosis in cancer cells. In the global wellness and nutraceutical market, demand for Boswellia extracts is rising, but inconsistent quality and unsustainable harvesting threaten long-term supply.

Myrrh (*Commiphora* spp.)

Myrrh is a reddish-brown aromatic gum-resin obtained from trees of the Commiphora genus, especially *Commiphora wightii* in India. These thorny shrubs are typically found in arid and semi arid regions of Rajasthan and Gujarat. Myrrh is harvested by making incisions in the bark, allowing the resin to ooze out and solidify. It has a distinctive aromatic fragrance and a long history of use in religious rituals, perfumery, and traditional medicine. Traditionally, myrrh is used to treat wounds, inflammation, oral infections, and menstrual discomfort. It is also a key ingredient in incense and spiritual ceremonies (Marshall, 2003). The species *Commiphora wightii* is considered threatened due to overharvesting and habitat destruction, prompting conservation and cultivation efforts. In summary, natural gum-resins such as asafoetida, salai gum, and myrrh are not only culturally significant but also hold great promise in global health, wellness, and cosmetic markets. Promoting sustainable harvesting, local cultivation, and value addition can greatly enhance rural livelihoods while conserving these precious natural resources.

Harvesting of Gums and Resins

Traditional Harvesting Practices

Long-term tradition of gum and resin collectors, especially tribal communities, have developed skills to locate the exudated in forests. This depends on the species and local conditions. It can involve making incisions in the bark or stem of a tree with locally made tools such as knives, chisels and axes in some parts of India from trees like *Sterculia urens*, *Boswellia serrata* or *Pinus roxburghii* that naturally yield resins. The practices are highly seasonal and dependent on the climate, most commonly being gathered during dry season when exudates start to solidify due to a loss of moisture.

However, in the absence of scientific knowledge, traditional methods may require frequent deep incisions that can permanently injure a tree or reduce its productive lifespan. However, practices such as overharvesting or tapping trees before they are fully mature can at best reduce the yield and at worst kill the tree. Though there is effort to mitigate these risks through sustainable tapping practices promoted by several forest research institutes and NGO(s), the outreach remained confined due to low awareness, training and access of proper tools with local collectors.

Procedure

- Identify the appropriate tree species based on the gum or resin type desired, ensuring the tree is mature, healthy, and not previously over-tapped.
- Conduct the harvesting during the dry season when the resin flow is better and the exudates dry more effectively, usually between October and May.
- Clean the bark area where the tapping will be done to remove dust, lichens, or loose bark that may hinder proper flow of resin or gum.

- Select a suitable tapping height, typically 1 to 1.5 meters above the ground, which allows easy access for collectors and minimizes stress on the tree.
- Use sharp and clean tools such as chisels, knives, or bore drills to make incisions or holes, depending on the species and resin/gum type.
- For bark streak method, make shallow V-shaped or rectangular incisions without cutting too deep into the cambium or phloem to avoid permanent tree damage.
- For borehole method (as in pine resin tapping), drill a 1–2 cm wide and 5–7 cm deep hole at a downward angle to reach the resin ducts.
- Avoid overlapping or repeating cuts in the same area, maintaining a vertical distance of 15–20 cm between successive incisions on the same tree.
- Allow the resin or gum to naturally ooze out and harden on the bark or near the wound for 1 to 3 days, depending on the ambient temperature and humidity.
- Use spatulas, curved blades, or by hand (with gloves) to collect the hardened exudates gently to prevent contamination with bark or soil.
- Repeat tapping after a rest period of 15 to 30 days, giving the tree adequate time to heal and reaccumulate resinous material.
- In some species, tapping is done 2–3 times per year, while for others like asafoetida, a onetime deep root incision may suffice for the season.
- If possible, apply a paste made of clay or lime over the tapping wound to protect it from pests and fungal infections and to help healing.
- Collected resin or gum is sorted by appearance—color, size, and purity—and sun-dried for 1–2 days to reduce moisture content and improve shelf life.
- After drying, manually remove bark pieces, soil particles, and other impurities using sieves or hand sorting for better market value.
- Store the cleaned gum/resin in breathable containers like jute sacks or perforated baskets to prevent moisture accumulation and fungal growth.
- Avoid using plastic bags for storage as they trap moisture and lead to degradation or discoloration of the gum or resin.
- Label and record the quantity, tree species, and collection date to monitor productivity and traceability, especially for export-quality produce.
- Transport the dried and cleaned material to primary collection centers or cooperatives for further grading, pricing, and aggregation.
- Ensure minimal handling during transportation to preserve the integrity and cleanliness of the exudate, using clean sacks and avoiding direct contact with the ground.

Precautions

- Always identify and select only mature and healthy trees; avoid tapping young or diseased trees as it may stunt their growth or lead to mortality.
- Do not perform excessive or repeated tapping on the same spot of a tree as it weakens the bark and reduces resin/gum yield over time.
- Ensure tools used for tapping are properly sterilized and sharp to avoid infection at the tapping site and to minimize tree injury.
- Avoid deep incisions that penetrate the cambium layer, as this can permanently damage the tree's nutrient transport system.
- Refrain from tapping during the monsoon or humid seasons, as moisture causes fungal growth and contamination of the resin or gum.
- Do not tap during periods of active tree growth or flowering, as it can interfere with the plant's physiological processes and regeneration.
- Maintain sufficient spacing between incisions to allow proper healing and reduce tree stress; avoid overcrowding of tapping cuts.
- Always wear gloves when collecting resin or gum to prevent contamination with sweat, oils, or dirt from hands.
- Never use plastic containers or bags for storing freshly collected material, as they trap moisture and degrade the product quality.
- Avoid collecting resin or gum from the forest floor if it is mixed with debris, soil, or insects, as it compromises product purity.
- Do not harvest from trees located near polluted or chemically treated agricultural fields to prevent chemical contamination of the exudate.
- Use only recommended traditional or improved tools; avoid sharp or aggressive implements that cause large wounds or peel off bark excessively.
- Do not harvest resin or gum from trees showing signs of over-tapping, decay, fungal infection, or bark splitting.
- Avoid collecting during extremely hot afternoons; the high temperature may cause the resin to overharden and crack, making collection difficult.
- Always label the collected material properly to avoid confusion between different species or tapping batches, especially in mixed forest zones.

• Do not transport raw or wet resin/gum along with dry materials, as it can lead to spoilage and inconsistency in quality.
• Avoid using fire or heat sources near the resin collection area as many resins are flammable and can pose safety hazards.
• Never force the resin flow by widening incisions or using chemicals, as it reduces quality and harms the tree permanently.
• Prevent animals or livestock from accessing the tapped area, as they may disturb or damage the tree wounds and collected materials.
• Ensure that all tappers are properly trained in sustainable practices and are aware of local regulations and conservation guidelines.

Value Chain and Market Structure

The value chain of natural gums and resins encompasses several actors and processes, from forest collection to final market delivery. This chain includes primary collectors, local cooperatives, contractors, processing enterprises, wholesalers, and exporters. Despite the economic potential of gums and resins, the current value chain in India is fragmented, inefficient, and often exploitative, particularly for tribal and forest-dependent communities who form the backbone of the sector. At the primary level, the collection of gums and resins is carried out by a network of tribal households, marginal farmers, and forest dwellers. Collectors frequently work in relatively inaccessible regions and operation under deprived conditions using age-old harvesting techniques. They typically operate without modern tools or safety gear or scientific advice. Women are key players in the collection of especially gum karaya and salai gum.

Primary producers generally sell their produce at low prices to local contractors or middlemen because of a lack of knowledge about markets and bargaining power. Farmers and collectors form the first receiving link in the chain. In some localities, they may be organized into SHGs or Joint Forest Management Committees. Wherever such institutions operate, they can help negotiate better prices, pool resources for transportation, and ensure adherence to sustainable harvesting practices.

Yet, the reach of these institutions is patchy and varies from state to state. The next most important actors are cooperatives or forest-based organizations, sometimes operating as aggregators. In well-child cooperatives, raw gums and resins collected by the members are brought to a central warehouse where they are weighed and sold collectively, reducing dependence on middlemen and increasing bargaining power. Such cooperatives may also deal with grading, cleaning, and the basic processing of the produce hence elevating its quality and market value. Contractors and traders may generally act as intermediaries purchasing raw gums and resins either directly from individual collectors or their local aggregators; however, their role is prominent in supplying the material to regional markets. Since contractors tend to dictate prices and favorable terms, they are set against the interests of poor collectors; hence free market access remains elusive to primary collectors. In certain pockets, these local traders extend cash advances to poor families preceding the harvesting season; as these families have limited capacity to repay these loans in cash, they are bound, through a customary practice, to sell the purchased produce only at reduced prices. This mechanism is popularly referred to as "advance bondage". At the processing stage, small- and medium-scale enterprises transform raw gums and resins into commercial-grade products. This may include activities such as drying, cleaning, pulverizing, sieving, packaging, and in some cases, chemical treatment or formulation into end-use products. For instance, pine resin is processed into turpentine and rosin, while gum arabic is graded based on solubility and color. However, processing units are often located far from the forest collection areas, adding to transportation costs and post-harvest losses.

The wholesalers and exporters form the final commercial link. They procure bulk quantities of processed or semi-processed gums and resins for domestic and international markets. India exports significant quantities of gum karaya, salai gum, and processed asafoetida. However, the absence of standardized grading and quality control mechanisms limits India's competitiveness in global markets.

Primary Value Chain Actors

1. Farmers and Collectors – Responsible for identifying, tapping, and collecting raw gums/resins. Most lack training and market information, resulting in low returns.
2. Cooperatives and Forest User Groups – Organize collectors, facilitate aggregation, and sometimes support in marketing and primary processing.
3. Contractors and Traders – Intermediaries who dominate pricing and supply logistics; often act as monopolistic buyers in remote regions.

4. Laborers – Employed at various stages—tapping, carrying loads, cleaning, drying, or processing. They are typically low-wage and unskilled workers.
5. Enterprises and Processors – Add value through cleaning, grading, packaging, and chemical processing. Often located near urban centers or export hubs.
6. Wholesalers and Exporters – Buy in large volumes for retail or export; set quality benchmarks and influence demand trends in the market.

Challenges in the Current Market Structure

The market structure for gums and resins is riddled with inefficiencies. Price determination is non transparent, and primary producers are often unaware of the actual market value of their produce. Moreover, there is no formal price discovery mechanism, and quality standards vary across buyers, creating confusion among sellers. A major problem in the market is the absence of market infrastructure such as collection centers, drying yards, proper storage facilities, and transport logistics. This factor leads to huge post-harvest losses and compromises the quality of the finished product. Besides this, lack of working capital of most collectors forces them to make distress sale, which thereby minimizes their income potential. The Authorities' inadequate support in terms of market information, training and certifications has also impeded the development of the sector. In due course of proper intervention, India can lay claim to emerge as the important player of the global gum and resin industry. The gums and resins value chain are principally dependent on the tribal and rural communities' efforts. Without structural reforms, policy support, and investment in infrastructure, however, this chain will continue to be inefficient and inequitable. With improvements for cooperatives, farmers, and the entire microbial linkage between the collectors and buyers, these sectors can be further enhanced for income security and sustainability.

Entry Barriers

The sector is largely unexploited due to several entry barriers that restrict participation of new individuals, enterprises, and communities into the production and marketing process, despite the ecology-rich opportunities and commercial incentives for natural gums and resins in India. These barriers fall under three broad categories: natural environment-based, socio-political, and capital/legal. Natural environment-based: Each has a very important role in restricting equitable access to barriers, reducing profitability, and discouraging sustainability within the sector.

Natural Environmental Barriers: One of the biggest barriers to producers can be accounted for by natural and environmental constraints with regard to availability of resin-yielding tree species. These trees such as *Boswellia serrata, Sterculia urens, Pinus roxburghii,* and *Commiphora wightii* grow only in certain agro climatic zones. Thus, the distribution is scattered and many of these locations are in remote or difficult-to-access forest areas, hampering some systematic approach to tapping and collection. Most of the resin-yielding trees are also slow growers, and if mismanaged, their life span and output capacities can get considerably reduced. For example, so extensive has been the over exploitation of *Commiphora wightii* in its natural habitat, it is on the way of becoming threatened. Further, environmental degradation, deforestation, and climate variability impact the health of these species and their ability to regenerate, thereby limiting long-term feasibility and scaling of operations. Finally, there is a seasonal aspect, as harvesting can take place only during dry periods, thus narrowing the operational window and affecting the daily livelihood stability of the collectors.

Socio-Political Barriers: Another big barrier comes from socio-political factors, especially in the districts having pockets with a high concentration of tribal population, with tribes mainly engaged in marginal NTFP collection. However, these communities most often do not possess formal land or resource rights to forest produce, greatly limiting their legal access. Even though the Forest Rights Act (2006) tries to secure this right for them, in many states the manner of implementation leaves much to be desired. Besides, the monopolistic role of contractors and middlemen further diminishes the bargaining power of primary collectors, such that mostly these intermediaries have formed informal cartel and dictate the prices by taking advantage of the illiteracy of these collectors as well as their urgent need for cash. Local politics and corruption in forest permits and favoritism in lease allocation only make matters worse. Limited education among tribal communities and lack of awareness on sustainable practices, quality parameters, and value addition limit the ability of such a community to move up the value chain. Discrimination exists against women when it comes to access to resources and income.

Capital and Legal Barriers: Insufficient working capital, infrastructure, and institutional credit are the

greatest deterrents for potential gum and resin producers and processors. Many collectors do not have money to buy equipment for tapping, storage, or drying. Devoid of microfinance or subsidies, they usually find themselves having to enter onerous agreements with traders or contractors who provide credit in exchange for produce at low prices. Legal restrictions and bureaucratic problems also form certain entry barriers. In several States, forest produce is controlled under monopoly systems of the State, and it takes quite some time to even get a license or a transit permit. Unclear provisions, especially with regard to the trade of minor forest produce, only serve to confuse and discourage formal entry. Lifting these entry barriers could go a long way in realizing the potential that the gum and resin sector holds. There needs to be improved access to forest rights and institutional finance and in addition to training in sustainable harvesting and linking to markets for making this sector more inclusive, equitable, and commercially viable for rural and tribal communities.

Product Storage, Processing, Grading, and Transportation

Drainage

After collection, natural gums and resins contain residual moisture that can lead to microbial growth, discoloration, or loss of quality if not handled properly.

The first step is to drain excess moisture by spreading the exudates in a single layer over clean, raised platforms or mats under direct sunlight. This drying process typically lasts 1–3 days, depending on the climate and type of resin or gum. Proper drainage enhances product shelf life and reduces the risk of fungal contamination, ensuring better market acceptability and minimizing post-harvest losses during storage and transit.

Cleaning and Impurity Separation

Once dried, gums and resins often contain impurities like bark pieces, stones, soil, and insect fragments. Manual cleaning using sieves, handpicking, or light mechanical equipment is essential to improve product quality.

Cleaned material is then inspected for visual uniformity, and any visibly discolored, moldy, or damaged pieces are discarded. Maintaining cleanliness is especially crucial for gums used in food, pharmaceutical, or cosmetic applications, where purity standards are strict. This stage is vital for improving the grade of the product and ensuring a fairer price for the collector or enterprise.

Sorting and Grading

Grading is done based on color, size, purity, and solubility. For instance, gum karaya is graded into commercial categories like “Superior White,” “Brown,” or “Dust,” depending on the brightness and shape of the crystals. Similarly, pine resin derivatives are graded by rosin content and color index. Standardized grading allows for better market segmentation and pricing. Unfortunately, many local producers are unaware of these parameters, leading to poor pricing and rejection at later stages. Training and tools for simple grading practices can empower producers and improve their returns.

Transportation

Proper transportation is critical to preserving quality from forest to processing centers or markets. Gums and resins should be packed in breathable containers such as jute sacks or baskets lined with parchment or clean cloth to allow air circulation. Use of airtight plastic or moisture-retaining materials is discouraged, as it promotes mold. In remote areas, lack of roads and vehicles delays transport, reducing product quality. Cooperative-level aggregation and scheduling of transport in bulk can reduce individual costs and maintain product integrity during long-distance movement.

Policy Interventions

In essence, good policy measures must be implemented to harness greater potential of gums and resins as important Non-Timber Forest Products. While in India, the regulatory and institutional set-up for gums and resins is fragmented and underdeveloped and thus often come in the way of the livelihood potential of forest-dependent communities. Thus, in order to see sustainability, equity, and growth in this sector, policies must focus on forest rights, market access, sustainable harvesting, and enterprise development. Among the most important interventions has been the Forest Rights Act of 2006, which recognizes the rights of forest dwellers over Minor Forest Produce (MFP), which include gums and resins. The implementation of this Act has been irregular across

the states. It is imperative that institutional arrangements in the country be strengthened to ensure that community forest rights are not only granted but also instituted in ways that empower the collectors, particularly women and tribal groups. Market reforms are a second major intervention required to undertake. At present, the trade of certain gums and resins is controlled by forest departments in many states; they thereby create bottlenecks through permits required, levies, and monopolistic actions. The states of Chhattisgarh and Odisha have deregulated some of the MFPs, thereby allowing tribal cooperatives to collect, process, and market them directly on their own. Such initiatives deserve scaling up and replication throughout the country. Capacity building and training programs are a further must-have. These programs should help forest-based communities in sustainable tapping techniques, quality control, and grading practices. Government agencies, NGOs, and forest research institutions should come together to provide relevant hands-on training tailored to the local context. Further, investment in rural infrastructure—such as drying yards, storage facilities, and transportation—will reduce post-harvest losses and increase income. Clear guidelines should be laid down for community-based enterprises to attract private investment and entrepreneurship. These guidelines should cover the facilitation of the establishment of small-scale processing units, access to microfinance or subsidies, and market linkages to e-commerce and export channels. Certification and branding, meanwhile, are essentials that will ensure India competes well in the international market. Such certification will bolster trust for goods that are organic or sustainably harvested gums and resins, thus providing premium prices to the producers. Thus, in conclusion, a coordinated and inclusive policy framework, recognizing local rights, empowering grassroots institutions, and developing infrastructure and skills, remains a pivotal key to the sustainable and prosperous development of the gum and resin sector in India.

Opportunities for Development of Gums and Resins

The natural gums and resins industry in India presents vast possibilities for environmentally sustainable livelihood promotion, hence the economic development. Growing global demand for eco-friendly products of plant origin in foods, pharmaceuticals, cosmetics, and industries will place India at a strategic spot to being a global player in international gum and resin trade. However, it shall require some multi-pronged intervention that shall address scientific research and development, market development, community involvement, and institutional backing. Another potential area exists in sustainable harvesting promotion. Many of the traditional methods, while effective in their own right, are generally unsustainable if scaled up. Scientific tapping methods such as borehole tapping, proper spacing, and wound treatment can greatly improve yields and allow for the longer productive lifespan of trees bearing resins. There has to be widespread training, extension, and demonstration programs instituted by forest departments and NGOs alike. Value addition at the local level is another key opportunity. Most gum and resin collectors sell raw material at low prices due to lack of knowledge, tools, or access to processing facilities. Establishing decentralized processing units for drying, grading, pulverizing, and packaging can help tribal communities fetch better returns and move up the value chain. This will also encourage entrepreneurship and employment generation in forest-rich areas. There is growing scope for branding and certification of Indian gums and resins under organic, fair-trade, or sustainable forest management labels. Products like gum karaya, salai gum, and asafoetida can be marketed as Ayurvedic or health-promoting items in domestic and global niche markets. With proper certification and traceability, these products can gain entry into high-value export channels. The expansion of digital marketplaces and e-commerce platforms offers a new avenue for small producers and cooperatives to reach consumers directly. Government-supported initiatives such as TRIFED's "Van Dhan Vikas Kendras" and platforms like "Tribes India" are already moving in this direction, but further integration with logistics and cold chain infrastructure is necessary. Lastly, research and development (R&D) must be strengthened. Investment in plant genetics, agroforestry techniques, bioactive compound isolation, and resin-based product innovation will expand both scientific knowledge and commercial applications. Collaborative efforts between forest research institutes, universities, and private industry are essential to foster innovation and sustainability. In summary, with the right interventions, the gums and resins sector can transition from a subsistence-based activity to a thriving green economy segment, offering ecological, economic, and social benefits.

Gum and resin are the most important components of the Non-Timber Forest Products. It should be very helpful in raising the socio-economic status of the rural peoples as

well as the tribes of our country. As per the economic survey of India, the mostly tribe population in forest area is land less or very less land holding, in this situation, livelihood of these tribe families only depends on Non-Timber Forest Products. Gum and resin are very much demandable products due to their raw products of pharmaceutical industry, aesthetical value, preservation and other useful scope. For the sustainable continuous productions of these products are required the protection and conservation of forest area from deforestation and other natural calamities. The protection and conservation of forest is very helpful in the wild life saving as well as sustainable livelihood of rural as well as tribal peoples of India.

Suggestions for further works

a. Resource Mapping: Region-wise geo-mapping and inventory assessment of gum and resin yielding species to understand distribution, density, regeneration status. This will help in planning sustainable harvest and conservation strategies.
b. Work directly with suppliers to develop scientifically validated harvesting guidelines that are economically feasible for forest-dependent communities and field test new tapping tools and techniques on pilot plots.
c. Market Intelligence and Digital Platforms: Set up a digital platform that exposes real-time pricing information to collectors along with demand forecasts and ready buyer networks which may perform the role of an aggregation service. This will enhance transparency, minimize exploitation by middlemen and increase income security.

Author Contributions

Nishant Ghode: Investigation, formal analysis, writing—original draft. Sajiwan Kumar: Validation, methodology, writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

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