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Gum karaya (*Sterculia urens* Roxb): A potential gum tree

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Abstract
The results of this study showed that a mixture of natural gums can contain about 60 percent neutral sugars (rhamnose and galactose) and 40 percent acidic sugars (glucuronic acid and galacturonic acids). Karaya gum is mostly used as an ingredient in the preparation of emulsions, lotions, powders for fixing dentures, bulk laxatives, as a pulp binder in the preparation of thin papers and suspension properties. Traditionally, India is the largest producer and exporter of karaya gum and Europe is the largest importer of karaya gum. Since karaya gum is vital to the tribal economy and its commercial value is considerable, there is an urgent need to develop a scientific and sustainable tapping method to increase yield and ensure the survival of harvested trees.

Keywords: Karaya gum, gum tapping, *Sterculia urens*, propagation, uses and pharmacology

Introduction
Gums and resins occupy a prime place among Non-Wood Forest Produce (NWFP/NTFP) and are known to mankind since time immemorial. 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 (Bhattacharya, 2012) [1]. Tree gum exudates of the natural acid polysaccharide have attracted significant attention among researchers because of their immense potential application in the food industry, biomedicine and material science. Among the different tree gum polysaccharides, Gum karaya (GK) is an important partially acetylated natural polysaccharide having a branched structure with a high molecular mass of 16×106 Da and is grouped under the substituted rhamnogalacturono glycan (pectic) type of tree gum. The gum exudes 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. 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) [2].

Distribution
It comes from the tropical Himalayas and southern India. Globally distributed in India (Assam, Bihar, Eastern and Western Peninsulas, Northeast of Belgaum, Maharashtra, Madhya Pradesh and Southern Gujarat) Kumar (2016) [3], Kumar and Desai (2016) [4], Sri Lanka, Australia, Pakistan, Panama and Malaysia. Karaya gum has been used commercially as an additive or alternative to gum tragacanth for over 100 years. The recovered rubber is processed into various grades as per the requirements of the buyers and exported via Mumbai to various countries *i.e.* USA, UK, Japan, France, Germany, Italy, Singapore, Thailand and Malaysia. Almost 100% of the Karaya rubber purchased in the state and even the country is exported as its domestic consumption is negligible. Annual world production is estimated at 5500 tonnes, while India's share is around 3000-3500 tonnes. Senegal, Sudan and Pakistan are emerging as other important suppliers. Today, the gum is used in a variety of products including cosmetics, hair sprays, and volumizing lotions.

Description
Sterculia urens is a medium to large sized deciduous tree belonging to the family of Sterculiaceae, which grows wildly deciduous forests of dry rocky hills lands having tropical climate at elevations between 300-750 meters.

Dry, tropical deciduous forests, often associated with *Boswellia serrata*, on hilltops, exposed ridges, rocky crevices, eroded slopes and similar habitats with several industrial application and up to 15 m height with 48 cm diameter (Kumar *et al*., 2013) [5]. The trunk appears whitish or pinkish after leaf fall, such peeled bark makes trunk appear like a beautiful carved marbled structure. Leaves on long petioles, crowded at the ends of branches, palmately 5-lobed, 20-30 cm diameter; tomentose beneath, glabrous above, entire, acuminate; stipules caducous. It is reported that the flowering season - December to January month; fruiting season- April to June while flower is greenish yellow having unpleasant odour, a few bisexual flowers mixed with large number of male flowers. Seed oblong brown coloured 6 mm long; 3-6 in each follicle and seed weight varied from 5291 to 6360 seeds/kg (Chacko *et al.*, 2002) [6]. The ripe fruits are collected from the tree when they start to dehisce. Seeds are recalcitrant nature and can't store for more than a year while maximum seed germination (77-88%) has recorded overnight soaking in normal water as pretreatment. The seeds are roasted and eaten by Madhya Pradesh tribes. The dehulled seeds consist of 35% protein and 26% oil. The seed oil is reported to be edible and also used in soap manufacture (Yesodharan and Sujana, 2007) [7]. The bark gives a fibre and wood makes a poor fuel. The majority of commercial karaya gum is obtained from *S. urens*, all parts of tree excude a soft gum when injured. Karaya gum is produced by charring or scarring the tree trunk and removing a piece of bark or by drilling holes into the trunk. The gum seeps from the scars and is collected, washed, and dried. The gum is then graded. A mature tree may yield 1 to 5 kg of gum per season (Verbeken *et al*., 2003) [8]. Chemical composition of *Sterculia urens* seed from different regions with varying protein content (11.5-30.8%) and oil (24-29%) has been reported by Vishakha and Bhargava (1999) [9]. Chemical, mineral composition and protein solubility of defatted *Sterculia urens* seed flour was studied by Narsing Rao and Rao (2010) [10] who found that the seed was a rich source of protein (20%) and crude fat (29%). Satyanarayana, Subhashini Devi, and Arundhati (2011) [11] reported that *S. urens* seed is a rich source of protein, lipid and carbohydrates.

Gum karaya is vital for tribal economy and its trade value is substantial, there is a pressing need to develop a scientific and sustainable tapping method to increase the yield and ensure the survival of the tapped trees. A simple and safe technique of tapping with substantial increase in the yield is developed using ethephon to enhance gum yield and wound healing (Gupta *et al.* 2012) [12].

Propagation

Seeds-germination takes 10-15 days and gives almost 100% seedlings that reach 15-20 cm in height n three months. The physical dormancy caused by the hard seed coat of mature seeds of many species of this genus can be overcome by scarifying the seeds. This is done by cutting or grinding off part of the seed coat to allow water to penetrate, although great care must be taken not to damage the embryo. The wedge surrounding the seed should also be removed - this is easiest when it has been softened by soaking in water. Seeds germinate optimally at temperatures between 20-30 °C. They can be sown in the nursery or in containers. If the seed has been properly treated, a germination rate of about 95% can be expected, which will occur within about 2 weeks.

Gum tapping

Tapping of gum from gum yielding trees is done by blazing and stripping off the tree bark. Maximum amount of gum is produced within first 24 hours of blazing and continued for few days. It solidifies in the form of gum tears. Except during rainy season tapping can be resorted to throughout the year. Though the gum exudes from the blazes all the year around; the flow is more copious in the hot weather. The best quality of gum is produced during January to June. In rainy season the gum produced is either washed off and does not get dried easily and also poor in quality *i.e*., darker in colour with high moisture content and impurities. Blazing of the trees has an important bearing on the tree health and heavy tapping is believed to impair the seed fertility and thus regeneration. Therefore, tapping should be done with the least possible harm to the trees. Precaution should be taken while tapping gum, the Gum karaya tree should be of at least 3 ft. in girth and blazing should be confined to main stem above 3 ft. from the ground level. The blazes of the rows should be alternate and depth of the blaze should not exceed 1/2" till second layer is exposed and each blaze should be a semicircle with 6" wide base. In the 2nd and 3rd year, tapping can be continued by extending the 1st year blaze, 5 cm, above the previous years treated area. Old wounds should not be reopened. In order to keep the longevity of the tree and for better quality of gum, tapping should not be done continuously and trees should be given long periods of rest before retaping so that the blazed portion gets enough time to heal and resume normal activity. Excessive tapping of the tree may also deteriorate the gum quality. The wound is completely healed 60 days after tapping. The yield has increased about 20 to 30 times over the control and about 10 times more than the traditional tapping methods used by the local people. There was a marked difference in the yield among individual trees, presumably due to heterozygosity.

Karaya gum producing states

Madhya Pradesh, Maharashtra, Gujrat, Orissa, Rajasthan, Karnataka and Bihar.

Uses and pharmacology

Karaya gum is not digested or absorbed systemically. Gum karaya's main use is as a bulking laxative due to its ability to form a mucilaginous gel when in contact with water. For their use, Gum is ground to a granule size of 8-30 mesh. These granules have the ability to absorb and then swell to 70-100% times their original value. Gum is also used to a limited extent as a wet end additive in papermaking in conjunction with starches. It is widely used in various completely unrelated industries due to its properties such as water absorption / moisture absorption, gel and film formation, adhesive ability. It is highly resistant to hydrolysis by mild acids and degradation by most microorganisms.

Industrial applications

In petroleum and gas producing industries the Gum karaya is used in formulations of drilling fluids in removing calcareous deposits in the wells. Gum karaya added to the lime-base drilling fluids to prevent water loss after reducing its viscosity by heating at 90 °C for 10 hrs.

Paper and pulp

Gum karaya is used in the paper industry for the manufacturing of certain special quality papers. It

deflocculates the fibres and serves as binder for fibres. Use of Gum karaya results in light weight sheets of improved formation and strength.

Leather and allied products: In leather industry it is employed as an ingredient of dressing compositions and in proportions for accelerating the tannin action weighing compositions. Gum karaya is also used in the manufacture of collagen fibre material.

Miscellaneous industrial products: Low grade gum served as a more efficient binder in the briquette (a block of compressed coal dust).

Textile: Gum karaya in powder form is used as a binding material in many of the textile industries.

Agroforestry uses: A useful plant for reclaiming and reforesting bare, rocky land.

Medicinal Uses: Karaya gum is also used for constipation, liver disease and as a laxative. It is also used for osmotic support through gum, which is powder, paste, ring, disc, plate, only other adhesive patches and cements are preferred, especially immediately after the post-operative core of the skin / sensitive skin or when the skin is calmed, less likely to create softness. Darker ones encourage microbial growth.

Ulcers and Wounds: Application of powdered Gum karaya has been found to stimulate granulation and heal stubborn bedsores in several patients. Gum karaya powder packed into open wounds increased normal granulation tissue and also led to good epidermal growth. Karaya gum is also used in dentin adhesive, medical adhesive tapes for the treatment of stomatitis and also used in the preparation of pressure sensitive masking tapes, medical jellies, pastes. The gum is also used to treat throat infections.

Cosmetics

The film forming property of Gum karaya makes it useful in the hair setting preparations of hair dressing lotions and finger wave lotions for the beauty trade.

Food industry

Sugar: Acceleration of settling rates of first carbonation juice in beet sugar manufacture can be accelerated by the addition of small amount of a dilute solution of a natural gum such as Gum karaya. The addition of gum / stabilizer improves the quality of juice.

Meats: Karaya gum serves as a less sticky water absorber in final ground meat products and as an emulsifier and binder in meat processing. The rubber also gives the product a smooth look. During meat processing such as chopping, curing, smoking, cooking, chilling, added Gum karaya acts as an emulsifier and binder by absorbing moisture and stored product.

Salad dressings: In salad dressing Gum karaya is used as a stabilizer by increasing the water, oil emulsion and thereby preventing or slowing separation.

Sauces, Condiment Bases, Ketchups, Sweet pickle and liquor: In the above items Gum karaya acts as a stabilizer on 0.1% to 1% by increasing the viscosity. It retards the movements of solid particles or liquids of different density.

Baked Foods: A mixture of karaya and Arbic gums gave some good results as an emulsifying agent, Gum karaya mixture and biscuits improves the appearance, symmetry, grain and tenderness whereas in bread it increases the volume and improves the softness, symmetry, extreme, cream color, taste, odour.

Karaya gum can be used in making synthetic pulp for fruit juices because of its cold water swelling property.

Other uses: Also used in linoleum, Ice creams, Jellies, Varnishes, Inks, Rubber compositions, Oil cloth, Paper coating, Polishes and Engraving process. The bark can be stripped off the tree easily and yields a useful fibre suitable for making coarse cloth and ropes.

Export policy: Exports are currently registered through the Tribal Co-operative Marketing Development Federation (TRIFED), under the Ministry of Tribal Affairs, Govt. India, New Delhi, State Tribal Development Cooperative Corporations and Forest Development Corporations have monopoly rights to purchase chewing gum in their respective states.

Threats of *Sterculia urens*

1. Exploitation of gum with unscientific tapping techniques.
2. In adequate and insufficient studies on Seed Source Variation (SSV) and Seed Viability (SV) and Seed Germination (SG).
3. Relatively slow growth of tree and tapping of gum at various stages of tree growth hinders the overall performance of the species.
4. Individuals outside the protected areas are comparatively more prone to become threatened due to lack of protection to the species.
5. In the absence of cultivation of these trees in regular plantation, there is a grave concern about the loss of wild germplasm of *S. urens*.

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