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Medicinal value of *Sterculia urens* Roxb. under different agroecological regions in India

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Abstract
Sterculia urens Roxb, commonly known as Indian tragacanth or Karaya gum, is a tree species native to India and widely distributed across agroecological regions. Its medicinal value has been recognized in traditional Indian medicine systems such as Ayurveda and Unani. The medicinal properties of *Sterculia urens* vary depending on the agroecological region; it is cultivated in the arid and semi-arid ecological regions of India. It is traditionally used for its mucilaginous and emollient properties. The gum obtained from its stem treats gastrointestinal disorders such as constipation and diarrhoea. Additionally, it possesses anti-inflammatory and wound-healing properties, making it valuable in traditional wound care. In India's eastern and north-eastern regions, *Sterculia urens* is utilized for its medicinal bark extracts, which are known for their antimicrobial and antifungal activities. These extracts have been used in traditional medicine to treat skin infections and fungal diseases. Furthermore, in the southern regions of India, *Sterculia urens* is recognized for its anti-diabetic properties. Studies have shown that extracts from its seeds have hypoglycaemic effects, potentially beneficial in managing diabetes. *Sterculia urens* exhibit diverse medicinal properties across different agroecological regions of India. Its versatility in traditional medicine systems highlights its importance as a valuable natural resource with potential applications in modern pharmacology. However, further research is warranted to explore its pharmacological properties comprehensively and elucidate its potential in developing novel therapeutics.

Keywords: *Sterculia urens*, medical value, agroecological region, human health

1. Introduction
India is renowned for its rich biodiversity, encompassing a vast array of flora and fauna. Among its botanical treasures, *Sterculia urens* Roxb, commonly known as the "Karaya gum tree" or "Indian tragacanth," stands out for its medicinal properties and ecological significance (Chauhan *et al*., 2019) [3]. Distributed across different agroecological regions of India, *Sterculia urens* has been a subject of scientific inquiry owing to its diverse pharmacological potential and traditional uses in Ayurveda and other indigenous medicinal systems. By understanding its significance in different ecological contexts, we can appreciate its role in traditional healing practices and explore avenues for its sustainable utilization in healthcare (Dhiman *et al*. 2019) [6]. Tribal species use *Sterculia urens* Gum as traditional medicine to cure various ailments.While almost every part of the plant has therapeutic value, the collection of the gum-*Sterculia urens*-serves as a means of subsistence and employment because it has a long history of significant importance in the waste management, food, pharmaceutical, paper and textile, composite fibre, and leather industries. This tree's gum exudate is highly valuable globally (Dhiman *et al*., 2019) [6]. *Sterculia urens* gum is utilised as a commercial food additive and a thickening agent, especially in textile printing paste.
Customary applications of several strains of *Sterculia urens* Resin and gum: Bark produces gum, which is utilised in tanneries, drugs, garbarti production, and other industries (Omkar *et al*. 2012) [29]. Exudes from the *Sterculia urens tree* are utilised as thickeners, stabilisers, and emulsifiers in food products (Oak *et al*., 2015) [30]. Blisters, blood dysentery, diarrhoea, joint discomfort, stomach disorders, throat infections, tonic, jam, and confections can all be treated with Karaya gum. Emulsifier Dental adhesive and thickener. As an antidote for snakebite, a little bit of gum and a combination of CaCO3 are helpful both topically and inside. Gum extract is administered topically to cure peptic ulcers and leucoderma by removing the spine from the skin. Menstrual abnormalities should be regularised (Jain *et al*. 2005) [32]. Particularly in printing paste used in the textile industry, it aids in the removal of blisters, joint discomfort, throat infections, and thickening agents. It is utilised in the paper industry as an excellent pulp binder. Additionally, the leather, cosmetic, and pharmaceutical sectors employ it (Kala, 2016) [27].

In the pharmaceutical industry, it serves as a gelling agent and tablet binder (Nath and Nath, 2013; Kala, 2016) [28, 27]. In the paper industry, it serves as a pulp binder. It's also used in the pharmaceutical, cosmetic, and leather industries as a tablet.

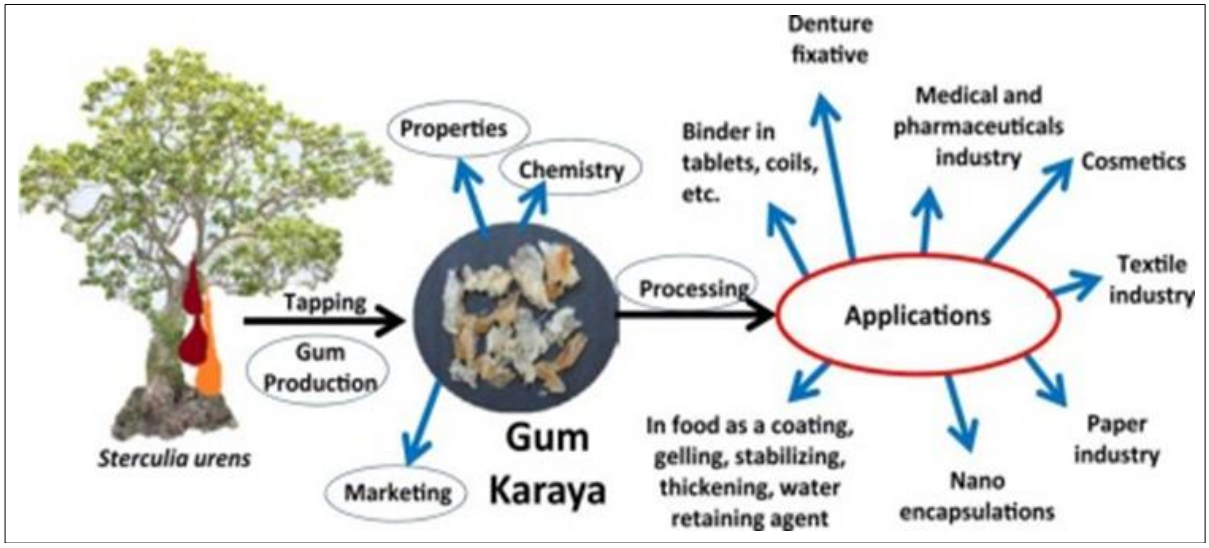

Fig 1: Properties and applications of karaya (*Sterculia species*) gum Prasad *et al*., 2022 [14]

This paper aims to explore the medicinal value of *Sterculia urens* Roxb across various agroecological regions in India. The discussion will encompass its traditional uses, phytochemical composition, pharmacological properties, and potential applications in modern medicine.

2. Agroecological Variability

The medicinal value of *Sterculia urens* may vary across different agroecological regions of India due to variations in climate, soil type, and other environmental factors. The plant is predominantly found in tropical and subtropical regions, thriving in semi-arid to arid conditions.In the northern regions of India, such as Rajasthan and Gujarat, where arid and semi-arid climates prevail, *Sterculia urens* is well-adapted to drought conditions. Here, the plant serves as a valuable source of gum and fodder for local communities. Traditional healers in these regions utilize *Sterculia urens*to treat ailments prevalent in dry, desert environments, such as heatstroke, skin infections, and gastrointestinal disorders exacerbated by hot weather. In contrast, in the eastern and north-eastern regions of India, characterized by humid subtropical and tropical climates, *Sterculia urens* may exhibit differences in growth patterns and chemical composition. These regions' rich biodiversity and unique environmental conditions may also influence the plant's pharmacological properties. Similarly, in the western and southern regions of India, where coastal and tropical climates predominate, *Sterculia urens* may encounter different ecological challenges and opportunities. Coastal areas may offer specific microclimates and soil conditions conducive to plant growth, impacting its medicinal properties and yield.

Table 1: Different agroecological regions of India

S. No.	State	Availability
1.	Andhra Pradesh	Throughout Andhra Pradesh
2.	Telangana	Throughout Telangana
3.	Karnataka	Ballari, Kolar, Chamarajanagar
4.	Kerala	Kozhikode, Malappuram, Palakkad, Thrissur, Idukki, Thiruvananthapuram
5.	Maharashtra	All districts of Maharashtra
6.	Odisha	Angul, Balasore, Bargarh, Bolangir, Boudh, Cuttack, Deogarh, Dhenkanal, Gajapati, Ganjam, Kalhandi, Kandhamal, Kendrapara, Keonjhar, Khurda, Koraput, Malkangiri, Mayurbhanj, Puri, Rayagada, Sambalpur, Sundergarh
7.	Tamil Nadu	All districts of Tamil Nadu

3. Botanical Description

This is a medium sized tree which attains a height of around 15-20 meters and is enormously bushy (Goldstein, 1954) [22]. Stem bark of this tree is grayish-white to red in color, having shiny appearance. It is a diploid (2n) plant having chromosome number 40 (Darlington and Wylie, 1955) [23]. Long petioled, pentalobed, palmately compound leaves (20-30cm in diameter) crowded towards the end of the branches. Lower surface of the leaf bear short, thick tangled hairs (tomentose) while the upper surface does not have hairs (glabrous), stipules caducous and tapering to a point (Kala, 2016) [27]. Flowers are pedicellate, high in number, small in size, and greenish-yellow in color with complex branched panicle inflorescence. The tree is andromonoecious having a mixture of bisexual (0.3-7.8% in number and are functionally female) and male flowers in greater abundance than the former. It exhibits cryptic monoecy and entomophilic pollination. The only medium of pollination is Apis indica (Sunnichan *et al*., 2004) [21]. Flowers do not produce nectar. The gynoecium is penta-capillary and apocarpous. Each ovary comprises a total of 30 ovules, out of them only 8-26 develop into seeds with a solitary embryo (Sunnichan *et al*., 2004) [21]. Strict self-incompatibility results in sustaining genetic variability. Ripened follicles appear red, ovoid oblong approximately 7-8cm in length, and without peduncle/stalk (sessile), coriaceous (having leather like texture), ovate to lanceolate. Coriaceous carpels contain 3-6 seeds (ap prox. 6mm) and have stiff shiny bristles on the outer covering.

Seeds have oblong shape and an outer brownish-black hard seed coat. Radicle of the embryo oriented towards the chalazal end. Phenological responses further play an important role in char factorization of the type of vegetation. *Sterculia urens* usually shows various phenological activities throughout the year.

Table 2: Morphological characteristics of *Sterculia urens* (Rathod *et al*., 2022) [15]

Characteristics	Details
Habit	Deciduous Tree
Height	Up to 15 m
DBH	2 m
Bark	Grey white or reddish (10-12 mm thickness)
Leaf	Palmately 5 lobed, 20-30 cm; alternate, crowded at the end of the branches
Flower	Greenish yellow, small in terminal pinnacles, bisexual
Fruit	Follicle 2-5 cm diameter, red, covered with stinging hairs
Seed	3-6 seeds, brown or black color, oblong

4. Traditional Uses

Sterculia urens holds a prominent place in traditional Indian medicine systems like Ayurveda and Unani. The gum extracted from its bark, known as "Karaya gum" has been utilized for its medicinal properties for centuries. In Ayurveda, it is regarded as a valuable remedy for various ailments due to its cooling, demulcent, and anti-inflammatory properties. Traditionally, Karaya gum has been used to treat digestive disorders, skin ailments, respiratory issues, and as a binder in herbal formulations. In addition to the gum, various parts of the *Sterculia urens* tree are utilized in traditional medicine. The leaves, bark, seeds, and roots contain bioactive compounds with therapeutic potential. For instance, the decoction of *Sterculia urens* bark is used to alleviate diarrhea and dysentery, while the seeds are employed for their laxative properties.

Table 3. Traditional uses of *Sterculia urens* Roxb

Plant Part	Traditional Uses
Leaves	Fodder for livestock
Bark	Making rope and rough cloth,
Gum	Removing blisters, Thickening agent, Food additive, Tablet binder and gelling agent
Seeds	Eaten after roasting * Seed oil for edible purposes and soap making
Branch Stalk	Used as a toothbrush to relieve toothache

5. Phytochemical Composition

Sterculia urens is rich in bioactive compounds that contribute to its medicinal properties. Studies have identified various phytochemicals present in different parts of the plant, including flavonoids, tannins, phenolic compounds, saponins, and glycosides. The gum obtained from the bark primarily consists of polysaccharides, including galactose, rhamnose, arabinose, and glucuronic acid. Furthermore, the seeds of *Sterculia urens* are a rich source of fatty acids, proteins, and sterols. These bioactive constituents contribute to the plant's pharmacological activities and therapeutic efficacy. *Sterculia urens* phytochemical composition, with the concentration of specific compounds differing depending on the plant part studied.

General Composition: Major Classes: Plants in the Sterculia genus typically contain flavonoids, terpenoids, phenolic acids, phenylpropanoids, alkaloids, and other metabolites like carbohydrates, lipids, lignans, and lignin. Specific Parts: Leaves: Studies have identified up to 27 bioactive phytochemical compounds in leaf extracts, including phytol with potential anti-tuberculosis properties. Roots: Research suggests the presence of tannins, flavonoids, alkaloids, phenols, saponins, glycosides, and proteins, although the exact profile needs further investigation. Limitations: More research is needed to fully characterize the phytochemical makeup of different *Sterculia urens* parts. The amount of each compound can vary depending on factors like geographical location, growth conditions, and extraction methods.

6. Pharmacological Properties

Sterculia urens exhibits a wide range of pharmacological properties, which validate its traditional uses and highlight its therapeutic potential. Research indicates that the plant possesses.

1. **Anti-inflammatory Activity:** The gum and other parts of *Sterculia urens* demonstrate significant anti-inflammatory effects, attributed to the presence of flavonoids and other bioactive compounds. These properties make it beneficial in the management of inflammatory conditions like arthritis and skin disorders.
2. **Antioxidant Potential:** Phytochemicals present in *Sterculia urens* exhibit antioxidant activity, scavenging free radicals and protecting cells from oxidative damage. This property is crucial in preventing various chronic diseases and delaying aging processes.
3. **Gastrointestinal Benefits:** Karaya gum is known for its demulcent and laxative properties, making it effective in the treatment of constipation and other digestive disorders. Additionally, the bark decoction is used to alleviate diarrhea and dysentery, indicating its gastro protective effects.
4. **Wound Healing Properties:** *Sterculia urens* has been traditionally used for wound healing due to its antimicrobial and tissue repair properties. The application of Karaya gum promotes the formation of granulation tissue and accelerates the wound healing process.
5. **Respiratory Support:** In Ayurveda, *Sterculia urens* is prescribed for respiratory ailments like cough and asthma. Its expectorant and bronchodilator properties help alleviate respiratory symptoms and improve lung function.

7. Phytochemistry

Besides traditional applications of its different plant parts, efforts have been made to validate these applications scientifically. Nanadagopalan *et al*., (2015) [20] have authenticated 27 compounds from GC-MS (Gas chromatography-mass spectrometry) analysis of Sterculia leaves, among these compounds, phytol (peak area-21.34%); sucrose (peak area 11.49%); 2,4-dihydroxy-2, 5-dimethyl-3(2 H)-furan-3-one (peak area; 8.10%); 5(2H)-Oxazolone, 4-(phenylmethyl) (peak area; 6.97%); 2, 3-dihydro-3, 5-dihydroxy-6-methyl-4H-Pyran-4-one, (peak area; 6.78%); Megastigmatrienone (peak area; 5.93%), and 2 Methoxy-4-vinylphenol (peak area; 5.27%) are major ones.

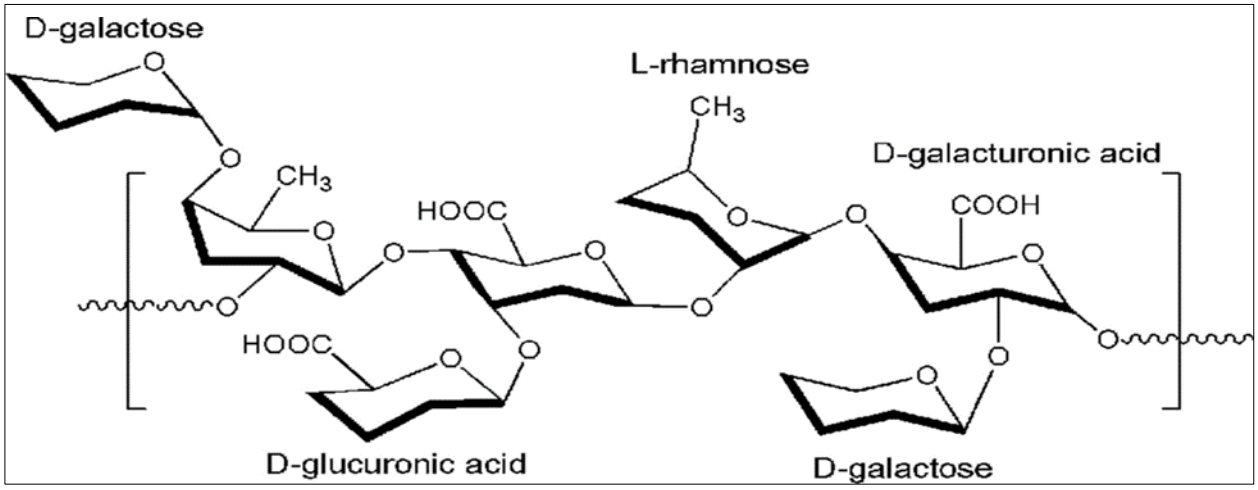

Fig 2: Gum karaya molecules

The pharmacological applications of phytol are extensively described in literature. Several papers studied the anti-inflammatory, antitumor, antioxidant, antiplasmodic, antitoxic, antidepressant, and antidiabetic activities, among others (Silva *et al*., 2014) [17].

Phytol, a natural compound is used as a fragrance ingredient and is widely used in cosmetic as well as non-cosmetic products like per fumes, cleaners, detergents etc. Presence of sucrose indicates sweetener properties which add nutritional value to this plant species. 2,4-dihy droxy-2, 5-dimethyl-3(2 H)-furan-3-one, an acetyl formoin intermediate is principle flavoring compound present in Pineapple and Miracle berry. It is the fundamental intermediate for the production of 4-hydroxy-2, 5-dimethyl-3(2 H)-furanone, which is the chief flavourant contributing to sensory properties of thermally processed food products. 2, 5-dimethyl-2, 4-dihydroxy-3(2H)-furanone plays important role in gustation and can be used in food and pharmaceutical industries as flavourant (Chukwu, 2017) [4].

2, 3-dihydro-3, 5 dihydroxy-6-methyl-4H-Pyran-4-one (DDMP) holds strong antioxidant activities (Ban *et al*., 2007) [2].

According to previous reports DDMP is supposed to reveal various pharmacological properties i.e. oxygen radical scavenging, antitumorus, anti-cancerous, anti-mutagenic, anti α Glucosidase in diabetics etc. (Compton *et al*., 2000; Quan *et al*., 2003; Ban *et al*., 2007) [5, 8, 2]. According to studies, DDMP moiety attached to the soyasaponin derivative is the key reason for scavenging of reactive oxygen radicals. 5(2H)-Oxazolone,4-(phenylmethyl) possess five membered heterocyclic nucleus and play significant role in designing biologically active compounds like peptides, amino acids, α-keto acids, aryl acetic acids, etc. Oxazolones are re cognized to have promising photophysical, photochemical as well as pharmacological applications. Their intermediates act as anti-HIV, anti-cancerous, anti-tumor, analgesic, anticonvulsant, pesticidal, anti-microbial, anti-angiogenic and cardiolonic agents (Mesaik *et al*., 2004; Bala *et al*., 2011) [12, 1]. Megastigmatrienone speciously has odoriferous properties, and is the main flavoring agent with sweet aroma present in Burley tobacco (Ohloff, 1978) [13]. Presence of megastigmatrienone in wine is evident in adding tobacco aroma (Slaghenaufi and Ugliano, 2018) [18]. Megastigmatrienone concentration in wine rises with maturation 2-methoxy-4-vinylphenol (2M4VP) is a natural phenolic compound used as flavoring agent. 2M4VP has been reported in buckwheat, apple, etc. (Dhiman *et al*., 2019) [6]. Major bioactive molecules characterized from *Sterculia urens* leaf through GC-MS analysis by Nanadagopalan *et al*. (2015) [20]. Peanut, clove, and curry. It regulates cyclin-cdks expressions in cell cycle and is anti-carcinogenic in nature. It has been evaluated that 2 methoxy-4-vinylphenol contributes in regulation of NF-κB, MAPK & histone acetylation, and thus exhibits potent anti-inflammatory properties (Jeong *et al*., 2011) [10]. Additionally, chemical characterization of *Sterculia urens* gum and other plant parts i.e., leaves & seeds, proves its pharmacological, cosmetic, non-cosmetic as well as nutritional importance.

8. Conclusion

In conclusion, *Sterculia urens Roxb* exhibits significant medicinal value across diverse agroecological regions in India. Its gum serves as a versatile therapeutic agent, addressing a wide array of health issues ranging from gastrointestinal disorders to skin ailments. The widespread utilization of *Sterculia urens* in traditional medicine underscores its importance as a valuable resource in healthcare, while ongoing research suggests promising applications in modern pharmaceutical formulations. Embracing the traditional knowledge surrounding *Sterculia urens* can contribute to the development of effective and accessible healthcare solutions, particularly in regions where access to conventional medicine may be limited.

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