Applied Ecology and Environmental Sciences, 2016, Vol. 4, No. 3, 61-65
Available online at http://pubs.sciepub.com/aees/4/3/2

DOI:10.12691/aees-4-3-2

Important Gum Yielding Species *Anogeissus latifolia* (Roxb.) Bedd., *Boswellia serrata* Roxb. and *Sterculia urens* Roxb.: Ethnobotany, Population Density and Management

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Abstract Natural gum is an important forest produce, which provides livelihood to the forest dwellers and also forms a vital raw material for various industries. India is one the major producers of gum as it endows with high diversity of gum yielding tree species. However, these tree species are less studied, especially with respect to their indigenous uses of gums, and also the existing information on gum yielding species are scattered. In this context, the present study aims to study three important gum yielding species such as *Anogeissus latifolia* (Roxb.) Bedd., *Boswellia serrata* Roxb. and *Sterculia urens* Roxb. with respect to their indigenous uses, harvesting practices, population density and management interventions. An extensive literature survey and fieldwork carried out in the central Indian states resulted in documentation of various indigenous uses of the selected species. The population density of *Boswellia serrata* and *Sterculia urens* was found extremely poor in the study area. Among all three gums yielding species *Anogeissus latifolia* obtains highest population density. The results of the study are further discussed with respect to the management and conservation of these important tree species..

Keywords: *natural gums and resins, indigenous uses, industrial applications, harvesting practices, management, conservation*

Cite This Article: Chandra Prakash Kala, "Important Gum Yielding Species *Anogeissus latifolia* (Roxb.) Bedd., *Boswellia serrata* Roxb. and *Sterculia urens* Roxb.: Ethnobotany, Population Density and Management." *Applied Ecology and Environmental Sciences*, vol. 4, no. 3 (2016): 61-65. doi: 10.12691/aees-4-3-2.

1. Introduction

Forests provide various ecosystem services to human beings, including ethnobotanical species for food, medicine and other human needs [1]. Historically, natural gum is one of the important forest produces which contributes in the livelihood and health care of rural communities [2]. In plants, the natural gums are formed through a process called gummosis in which internal plant tissues, mostly cellulose, are disintegrated and decomposed. They ooze out from the plant stems either naturally or when plant stems are wounded by external force [3]. They are insoluble in alcohol and ether but soluble in water [4]. Being important commodity humans have not only employed gums for ceremonial, esthetic and therapeutic uses but also in arts and industry, as a result they have been traded as the most sought material between the different cultures around the world from the earliest times [5]. Commercially, they are sold in the form of dried exudations.

In India, natural gums have been used traditionally for multiple purposes [6,7]. With due course of time, their industrial applications have been conceived in food, pharmaceutical and other industries. Unlike other non-timber forest produce, gums being a low volume high value produce, transportation is not a major problem for its gatherers in developing countries. It is relatively easy to transport such low volume gums even from the remote forest areas where road connectivity is poor.

Having produced annually about 281,000 tons of gums and about 1,500 tons of gum-resins, India ranks one the major producing countries of this important commodity [8]. About 120 gum and resin yielding plant species are known to grow in India, and they inhabit different eco-climatic zones. The forests in central India support a rich diversity of tree species, many of them provide valuable gums [9]. However, these tree species are less studied, especially with respect to their indigenous uses of gums, and also the existing information are scattered. Being an important commodity for livelihood generation, there are unsustainable harvesting issues, which impact the population of these species. At present, understanding the complex relationships between harvest and conservation of these species is a need of hour. In this context, the present study aims to document various uses and survey some selected gum yielding tree species in the central Indian states. Besides, the different harvesting and management practices of the selected gum yielding species are also studied.

2. Survey Methods

An extensive literature survey was carried out for compilation of ethnobotanical information on selected gum yielding woody plant species such as *Anogeissus latifolia* (Roxb.) Bedd., *Boswellia serrata* Roxb. and *Sterculia urens* Roxb. The data were compiled on the traditional uses of various plant parts of these species along with industrial applications and various management practices as adopted by the local communities and the concerned state departments.

The fieldwork was conducted in Madhya Pradesh and Chhattisgarh states of India as these two states are known for tapping of natural gums from these three species. An ethnobotanical survey was conducted eliciting information through personal interviews of villagers with the help of local assistants and also through direct and indirect observations made during the field surveys. Locals who practice traditional medical practices and local elder and knowledgeable people were interviewed for information on medicinal uses and availability of selected gum yielding species in both the Indian states. The morphological characteristics of selected species were noted down during the survey period. Various gum harvesting practices from the selected species were also recorded.

The population density of selected species was also estimated in view of understanding their availability in the natural habitats. To estimate the population density, quadrats were laid down in the forests of Chhindwara district of Madhya Pradesh and Sarguja district of Chhattisgarh. A quadrat size of 10×10 m was chosen for sampling standing trees. For sampling saplings and seedlings 5×5 m quadrat size was used. Individual trees were enumerated by species in each quadrat. Density per hectare of standing trees with their saplings and seedlings were calculated.

3. Result and Discussion

3.1. Ethnobotanical Significance

All three selected plant species (e.g., *Anogeissus latifolia*, *Boswellia serrata* and *Sterculia urens*) were tree species, of which *Anogeissus latifolia* attains maximum height. The bark colour of these species varies from yellowish or pinkish to grey white and reddish (Table 1). Traditionally, the gums of these species have been used by local communities for different purposes [6,7,9,10,11,12]. Though they are used for curing different diseases, their use for curing dysentery is common. The gum of *Anogeissus latifolia* is consumed as tonic, especially by the women after child birth [6]. Apart from general tonic, the gum of *Sterculia urens* is used to cure blisters, joint pain, stomach disorder and infection in throat [10]. The gum of *Boswellia serrata* has multiple medicinal uses [11], as it is used in curing skin eruption, ulcer, fever, bronchitis, asthma, cough, jaundice, arthritis, goiter, tumors and piles (Table 2).

Table 1. Morphological characteristics of *Anogeissus latifolia* (Roxb.) Bedd., *Boswellia serrata* Roxb. and *Sterculia urens* Roxb

Morphological characteristics	*Anogeissus latifolia* (Roxb.) Bedd.	*Boswellia serrata* Roxb.	*Sterculia urens* Roxb.
Habit	Tree	Tree	Tree
Height	Upto 33 m	Upto 18 m	Upto 15 m
Girth	2.4 m	2.4 m (usually 1.5 m)	-
Bark	Pale yellowish or pinkish brown; spotted with paler greenish or greenish yellow depressions	Greenish grey, yellow or reddish grey	Grey white or reddish
Leaf	Reddish when first appear and turning red before shedding	Imparipinnate; 30-45 cm long	Palmately 5 lobed, 20-30 cm; crowded at the end of the branches
Flower	Greenish yellow in globose heads	Small, white in axillary racemes or panicles	Greenish yellow, small in terminal pinnacles
Fruit	Yellowish brown or reddish brown, winged, single seeded	Drupes, splitting along 3 valves, winged	Follicle 2-5 cm diameter, red, covered with stinging hairs; seeds black

Several indigenous uses of gum-resin, when tested clinically, have given encouraging results. The gum-resin of *Boswellia serrata*, which produces boswellic acid, has shown analgesic activity in experimental animals [13]. The clinical testing of *Boswellia serrata*'s gum resin has confirmed its anti-asthamtic potential in humans [14], a good medicine for the treatment of diarrhea [15], Alzheimer [16], decreasing total cholesterol level, decreasing knee pain and increasing knee flexion [17].

3.2. Industrial Applications

Since the water soluble gums of plant origin have enormous industrial applications, the gums of selected plant species are also used by industries for multiple purposes. For instance, the gum of *Anogeissus latifolia* is used in calico printing and confectionery. Being a good emulsifier, stabilizer and thickener, it is used in ceramics. It is also used in pharmaceutical industries and petroleum industry [6]. The rosin of *Boswellia serrata* is used in paints, varnishes, soaps and perfume industries [11]. The gum of *Sterculia urens* is used as thickening agent, especially in printing-paste for the textile industry. Being a good pulp binder it is used in paper industry. It is also used in pharmaceutical, cosmetic and leather industries [10]. It is used as tablet binder and gelling agent in pharmaceutical industries [18]. The gum of *Sterculia urens* is also used commercially as food additives [19] (Table 2).

3.3. Harvesting Practices

For extraction of gums from the mother plants, people have adopted different harvesting practices. Generally, artificial incisions are not made in the trees of *Anogeissus latifolia* for tapping gums, which naturally ooze out mostly in summers. However, to increase the yield of gum sometime people make incisions in the tree bark. It is mainly harvested in March to mid June. Approximately, 1200 tons per annum of gum from *Anogeissus latifolia* is

harvested in India [8]. Unlike *Anogeissus latifolia*, incisions are made in the tree trunk of *Boswellia serrata* for gum collection. Once the incisions are made, gums start oozing out which continue for many days. However, maximum gum oozes out within the first day of incision. Approximately, 1500 tons of gum from *Boswellia serrata* is harvested annually in India [8]. The summer season (April, May and June) produces better quality of gum than the monsoon season.

Table 2. Indigenous and industrial uses of gum and stem bark of the selected gum yielding tree species in India

Species	Part used	Indigenous uses	Industrial use
Latin name: *Anogeissus latifolia* (Roxb.) Bedd. Local name: Bakla, Dhaura Family: Combretaceae	Gum	Edible, dysentery, tonic (post natal) to women after child birth	Calico printing, confectionery Emulsifier, stabilizer and thickener in ceramics, food and pharmaceuticals Petroleum industry – drilling mud conditioner
	Stem bark	Diarrhoea, dysentery, colic, cough, headache, liver complaints, skin diseases, snake and scorpion bite, stomach disorder	
Latin name: *Boswellia serrata* Roxb. Local name: Kullu, Karaya Family: Burseraceae	Oleo-gum-resin	Diarrhoea, dysentery, skin eruption, pulmonary disorder, sores, stomach complaints, ulcer, incense, fever, diaphoresis, convulsions, bronchitis, asthma, cough, stomatitis, jaundice, arthritis, goiter, tumors, piles, skin diseases	Volatile oil; Paints and varnishes, soap and perfumery industry Rosin: printing ink, high class paints, soaps Cosmatics – incense sticks
	Stem bark	Antiseptic, cough, cold, diarrhoea, dysentery, eye disorder, snake bite, scorpion bite, toothache, asthma, heamorroids, skin diseases	
Latin name: *Sterculia urens* Roxb. Local name: Salai Family: Sterculiaceae	Gum	Blisters, blood dysentery, dysentery, joint pain, stomach disorder, throat infection, tonic, jam, confectionary	Thickening agent in the preparation of printing-paste for the textile industry. Pharmaceutical industry – medicines preparations such as lozenges, emulsions, lotions, sprays and paste; denture fixation powder; cosmetics Paper industry – pulp binder Leather industry – ingredient of dressing compositions
	Stem bark	Cordage, facilitate child delivery	

Traditionally, for tapping gums from *Sterculia urens* artificial incisions are made in the tree trunk and the bark is slashed. The debarked area is freshened at the regular interval of 5-6 days. However, the quantity of gum increases when the holes made in the tree trunk is treated with ethephon. It can be 10 times higher than the gum tapped by using traditional method. Also the gum yielded by treating ethephon has high quality [20]. Annually, about 50 tons of gum is harvested from *Sterculia urens* in India [8], which is comparatively low than the other two gum yielding species. The production of gums from all three species varies from year to year. The gum tapping from *Sterculia urens* is started in November, which is continued to the end of May. The continuous overharvesting of these species may be critical not only for the survival of the species but also for the community dependant on these commodities.

3.4. Population Density

Anogeissus latifolia obtains highest density (11 individual per ha in Madhya Pradesh and 18 individual per ha in Chhattisgarh) among all three gum yielding species. The density of *Boswellia serrata* and *Sterculia urens* is extremely poor in the areas surveyed during the study (Table 3). Almost negligible occurrence of mature tree individuals of *Sterculia urens* in the sampling plots and extremely low density of *Boswellia serrata* witness the immense harvesting pressures on these important gums yielding species.

Table 3. Density per hectare of standing trees, saplings and seedlings of selected gum yielding species in Chhindwara district of Madhya Pradesh and Sarguja district of Chhattisgarh

Species	Madhya Pradesh (Chhindwara)		Chhattisgarh (Sarguja)	
	Standing tree density	Sapling/ seedling density	Standing tree density	Sapling/ seedling density
Anogeissus latifolia (Roxb.) Bedd.	11	191	18	423
Boswellia serrata Roxb.	1	[a] NA	10	NA
Sterculia urens Roxb.	NA	1	NA	176

3.5. Management of Gums

The gums extracted by all three plant species were notified in the state of Madhya Pradesh as the 'specified forest produce' under the Madhya Pradesh Van Upaj Act 1969. However, all gums except *Boswellia serrata* have been taken out of the list of specified produce in 2003. Being the nationalized minor forest produce, the monopoly of collection and trade in gums lies with the state government or its authorized agent. Both Madhya Pradesh and Chhattisgarh states have their own federation named as Madhya Pradesh State Minor Forest Produce (Trading & Development) Cooperative Federation Ltd. and Chhattisgarh State Minor Forest Produce (Trading & Development) Co-operative Federation Ltd.

In order to facilitate the collection of gums, the forest area earmarked for collection is divided into different units. Federations sell these units in advance through

tenders and auctions. The purchaser deposits 10% of the sale value as security deposit which is calculated based on the quantity to be collected as mentioned in the tender notice. The purchaser pays to the collectors at the rates fixed by the state government. Primary Forest Produce Cooperative Societies and the District Unions collect gums for the Federations in Madhya Pradesh and Chhattisgarh, as these Federations are authorized to collect and sell the gums, which they sell through invitations of tenders and auctions on behalf of the state government.

3.6. Rarity and Conservation Issues

Earlier, the gum was only tapped from the mature individuals of these species, especially from *Sterculia urens* and *Boswellia serrata.* With the commercialization of gums, local people began to tap gums from young and immature individuals, as well, which has subsequently declined the number of individuals of these species [9,21]. The faulty method of tapping gums, which include chopping out and debarking major parts of these tree species, is one of the factors responsible for declining populations. Apart from gum and resin these species are collected for other purposes, including fuelwood, medicine, timber etc. The multiple uses of these species impose serious threats on the existing plant populations as they are frequently collected for one or other uses [7,22].

Boswellia serrata and *Sterculia urens* are considered vulnerable as per the International Union for Conservation of Nature (IUCN) category for threatened medicinal plant species of central India [23]. Merely anthropogenic activities are not accountable for making these species threatened but there are natural causes, as well. The flowers of *Sterculia urens* do not produce nectar [24], hence the insect activities remain limited even during the peak flowering season, which hinders the process of pollination and so that the setting of fruits [25]. Apart from lack of successful pollination, there are other causes of low fruit set in *Sterculia urens*, including adjustment of maternal investment to match available resources [26]. Though, *Sterculia urens* and *Boswellia serrata* blossom simultaneously during December-March, the flowers of *Boswellia serrata* do not only have bright colour but they contain a substantial amount of nectar. Therefore, unlike *Sterculia urens*, pollination efficiency may not be a problem for *Boswellia serrata [25]*.

There are many inherent problems in management and conservation of these high value species, at present. There is continuous decline in following traditional management principles but the use of such commodity has been expanded over the years. Besides, there are conflicts among society for early collection of species. The lack of knowledge is another factor which needs to be looked into. All three species being very important for livelihood generation and health care, it is important to conserve such species, undoubtedly, in their natural habitats. Besides, restoration programme of these species must be launched at large scale by applying ex-situ conservation tools, including micro-propagation technology. The awareness campaign in the community on the dwindling plant populations and the resultant impacts on their livelihood may insist people to participate in the restoration and conservation programme.

Acknowledgements

Author acknowledges the help extended by the Indian Institute of Forest Management, Bhopal and the State Forest Departments of Madhya Pradesh and Chhattisgarh during the course of this study.

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