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## Van Sangyan

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### Note to Authors:

We welcome the readers of Van Sangyan to write to us about their views and issues in forestry. Those who wish to share their knowledge and experiences can send them:

by e-mail to

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or, through post to

The Editor, Van Sangyan,

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The articles can be in English, Hindi, Marathi, Chhattisgarhi and Oriya, and should contain the writers name, designation and full postal address, including e-mail id and contact number. TFRI, Jabalpur houses experts from all fields of forestry who would be happy to answer reader's queries on various scientific issues. Your queries may be sent to The Editor, and the expert's reply to the same will be published in the next issue of Van Sangyan.

**Cover Photo: Panoramic view of Achanakmar-Amarkantak Biosphere Reserve**

**Photo credit: Dr. N. Roychoudhury and Dr. Rajesh Kumar Mishra, TFRI, Jabalpur (M.P.)**

**From the Editor's desk**

*Forestry education has an important role to play in the future of the world's forests. The future decision makers, the students of today, will need to possess adequate skills to be able to meet the future challenges. Forests are significant to the well being of society, and therefore the foresters need to be able to serve the needs of society. The forestry curriculum in many universities is based on the traditional, forestry-related subjects. Without undermining the importance of teaching these basic elements of forestry, the content of the forestry curricula must be reconsidered. The perspective painted by the current forestry education is often narrow and outdated. The true importance of forests and forestry in the wider context is not necessarily well recognised. Sufficient working tools are required to meet the challenges of professional working life. Besides a good knowledge base of forestry, various complementary skills are needed. Good communication and language skills, along with technical knowledge, are the basic requirements in all professions. Higher forestry education needs to meet the new challenges of the changing world of forestry. It is possible either to adapt to the change or to become part of it. Universities wishing to play a role in redefining the role of foresters need to radically change their ways of working. The key issues to improve the representation of the universities are: ■ Participation: Due to the lack of representation of higher education in the national and international discussion, higher forestry education is often omitted from discussion into the future of the forestry sector. ■ Communication: Improved communication should be emphasised in both external co-operation and internal interactions of the universities. ■ Partnership: Competently functioning partnerships between the universities and other stakeholders in the forestry sector ensure not only a free and vigorous exchange of information, but also highlight the importance of education in the forestry sector.*

*In line with the above this issue of Van Sangyan contains an article on Forestry and education. There are other useful articles viz. Sandalwood - Expensive and medicinal tree, Hardwickia binata: a climate resilient multipurpose tree species for livelihood support in semiarid region of India, Mulberry fruit - Nutritional and health benefits, Banyan tree - Indigenous system of medicine, Pharmacological and traditional uses of Wrightia tinctorial and Environment-friendly & biodegradable alternatives to plastic.*

*I hope that readers would find maximum information in this issue relevant and valuable to the sustainable management of forests. Van Sangyan welcomes articles, views and queries on various such issues in the field of forest science.*

*Looking forward to meet you all through forthcoming issues*

**Dr. Pawan Rana**  
Scientist 'E' & Chief Editor

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## Forestry and education

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Every year World Forestry Day is celebrated on 21<sup>st</sup> March. The theme for 2019 “Forestry and Education” to educate and aware the people for importance of forest in era of climate change and global warming. National Commission on Agriculture (NCA) in 1976 recommended that the forestry education is an essential tool to increase shrinking forests in India. To overcome this issue technically sound and skilled person is needed in the administration and protection of the forest as whole. However only forest education cannot solve problems without utilizing it in forest services and administration.

### Forestry education

NCA (1976) recommended to introduce forestry subjects in the agricultural and other universities, which gradually widened from graduate to masters and doctorate degree courses in forestry. Out of 51 central/state agricultural universities in the country, 28 central/state agricultural universities are providing the quality forestry education at UG, PG and Ph.D. level after four decades of its introduction along with ICFRE institutes.

### Challenges

National Forest Commission (2006) recommended utilizing forestry graduates produced by universities imparting forestry education in forest services and administration by giving preference in recruitment of the forest services as forest officers. However these skilled and trained

persons are totally neglected and under-utilized during the recruitment process of Indian Forest services as well as State Forest Services by over ruling the Forest Policy and Forest Commission recommendation. Apart from this Forestry should be recognized as a subject for competitive examinations in state and All India Administrative Services. National Forest Policy (NFP), 1988 has also recommended that the forestry graduates should be kept in view for recruitment to the Indian Forest Service (IFoS) and the State Forest Service. But this recommendations are still not implemented owing to which forestry graduates are having a dark future despite having the most coveted service, “Indian Forest Service”. Unfortunately the forestry graduates have to go for non-forestry jobs and ultimately the object of doing graduation in forestry is defeated. The premier institute of Forestry, FRI, Dehra Dun was unable to introduce forestry graduation course in forest science on the recommendation of NCA (1976) since establishment of ICFRE in 1988. Many state forest departments not considered forestry graduates in recruitment in forest service. About 1600 forestry professionals are produced every year under ICAR and ICFRE forestry education systems in India and many states do not have proper recruitment policy to recruit forest graduates in forest services at

national as well as state level and hence to fails to utilize the educated, trained and skilled forestry graduates and ultimately the goal of National Forest Policy. However many posts in forest departments are still vacant.

Though objectives of forestry education in India is to develop technically qualified forestry professionals with sufficient knowledge and skills, prepare the human resources which enable to serve in the forest department and encourage young professional for forestry enterprise not a single objectives will be achieved without change in recruitment policy. Even UPSC is not providing any preference and weightage in recruitment of post of IFoS to forestry graduates. The other professional degrees do have the special recruitment department for the particular subject like for Indian Engineering Services needs Engineering graduates, Medical services needs MBBS, Veterinary services needs Veterinary graduates, Indian Geological services needs Geologist, State agricultural services needs Agricultural graduate, etc. Therefore likewise for forest service's Forestry graduates should be mandatory in the eligibility criteria in the recruitment process. There are clear cut recommendations and suggestions from the central policy saying that the forestry sector must employ forest graduates in different government program rather than hiring unskilled people

#### **Lessons should be taken**

After enactment of the National Forest Policy 1988 and by taking into consideration the recommendations of the National forest commission 2006, many states in India started giving reserved quotas or weightage to Forestry graduates during recruitment appointment for the post of RFO and ACF, in the state forest

department. 70% vacancies are reserved to forestry graduates for the post of RFO class-II in Himachal Pradesh, 50% in Odisha and Arunachal, 75% for RFOs, 50% for ACFs in Karnataka, 100% in Kashmir and Tamil Nadu. Many states and centre should take lesson from Tamil Nadu, due to good future of forestry graduates FCRI, Mettupalayam set an example and provide training and expertise to IFoS officers and other state forest officers. Recently FCRI launched Forestry Business Incubation Centre at Mettupalayam.

Though many states raised this issue while recruitment in the State Forest Department, in response to this few states come forward to include forestry graduates /professionals in forest services. Many agitation rose by forestry graduates in state like Maharashtra in 2016, Rajasthan in 2017 and recent in Kerala on 21<sup>st</sup> June 2019. Recently, Forestry Students Organization filed writ petition against state of Maharashtra and MoEF in Bombay HC. (Forestry Students Organization vs. state of Maharashtra case)

It is learned that the Maharashtra State Government spends around Rs. 6.5 lakhs on each forestry student for graduation. If the syllabus of B.Sc. Forestry is compared with that of training program of RFO and ACF, there is 80% similarity between them. When a candidate clears his exam conducted by Service commission for direct recruitment of RFO or ACF in the State Forest Department, he has to undergo comprehensive training of 24 months in case of ACF and 18 months in case of RFO which is around Rs.6, 03,000/- for ACF and Rs.3, 61,000/- for RFO. If the State Government follows the guidelines provided under the NFP 1988 and the recommendations of the NFC 2006

and by way of direct recruitment for RFO and ACF, select candidates with Forestry graduation as qualification, then there will be no need of comprehensive training program to such candidates. They will be required to only give intensive training for the subjects who are not there in the B.Sc. - Forestry syllabus. In case instead of comprehensive training, intensive training is offered, the State government can save huge revenue and time which is otherwise required for comprehensive training of RFO and ACF. If intensive training is offered to a candidate having B.Sc. – Forestry as qualification and selected for the post of ACF, the State will have bear the

expenditure of around Rs. 2,77,000/- and his training can be completed within 6 months. Similarly for intensive training of RFO the State will have to spend around Rs.2, 02,000/- and the said training can be completed within 6 months. Similar matter was decided by the High Court of Chhattisgarh, Bilaspur, directed to amend and change in the existing rules or policy and preference should be forestry graduates.

Government should formed committee to look into the issue of providing separate quota to forestry graduates in direct recruitment of RFOs and ACF in state forest as well as IFoS services.



Forestry students go on strike

Read more below

By PRIYA ABRAHAM

Published 12.31.10



Students of the College of Forestry, OUAT, sit on a dharna in Bhubaneswar. Telegraph picture

**Bhubaneswar, Nov. 11:** Students of the College of Forestry under the Orissa University of Agriculture and Technology (OUAT) called an indefinite strike today. They demanded recruitment to the state forest department.

Over 150 students squatted outside the college premises and demanded that the B.Sc (forestry) degree be made the minimum qualification for the range officer cadre of the department.

They demanded 100 per cent reservation for B.Sc (Forestry) degree holders for the range office cadres and 50 per cent reservation for the post of assistant conservator of forests for B.Sc, (Forest). They also called for immediate recruitment of forestry graduates as forest ranger officer against the one-third-backlog vacancy that has been there since 1994.

Despite large-scale vacancies in the department, many graduates in forestry are reportedly unemployed.

## Sandalwood - Expensive and medicinal tree

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Sandalwood (*Santalum album L.*) is a valuable tree associated with Indian culture. It is the second most expensive wood in the world. The heartwood of the tree is treasured for its aroma and is one of the finest natural materials for carving. The monopoly of sandalwood trade by the Governments of Karnataka, Tamil Nadu and Kerala and its consequences have resulted in severe exploitation, pushing *S. album* into the vulnerable category of the IUCN Red List.

Sandalwood (*Santalum album L.*) is a prized gift of the plant kingdom woven into the culture and heritage of India. It is one of the most valuable trees in the world. The natural distribution of sandalwood extends from 30°N to 40°S from Indonesia in the east to Juan Fernandez Islands (Chile) in the west and from Hawaiian Archipelago in the north to New Zealand in the south. The populations are more concentrated in the southern region, especially Karnataka, Tamil Nadu and Kerala. In Tamil Nadu, sandalwood trees are spread across several districts of Salem, Dharmapuri, Erode, Tiruvannamalai, Vellore, the Nilgiris, Villupuram and to certain extent in Madurai, Virudhunagar and Tirunelveli. For more than 5000 years, India has been the traditional leader of sandalwood oil

production for perfumery and pharmaceuticals. The aroma of the oil and the wood is esteemed by people belonging to three major religions of the world – Hinduism, Buddhism and Islam.

The tree flourishes well from sea level up to 1800 m altitude in different types of soil like sandy, clayey red soils, lateritic, loamy and even in black cotton soils. Trees growing on stony or gravelly soils are known to have more highly scented wood. It grows best where there is moderate rainfall of 600 to 1600 mm.

*Santalum album* is a small evergreen tree attains a height of 12 to 15 meters and girth of 1.0 to 2.4 meters with slender drooping as well as erecting branching. It grows well in early stages under partial shade, but at the middle and late stages shows intolerance to have over head shade. Tap root system is not deep and lateral root runs almost parallel to the ground and young rootlets produce haustoria which establish connections with neighboring host roots for absorption of mineral salts. The host plants are as many as 256 species to sandal.

The growth under natural forest conditions is slow. But under intensive cultivation practices, the growth could be substantially higher than in the natural forest areas.



**Classification of sandalwood sorted before being passed for sale**

Sl. No.	Class	Description
1	Vilayat Budh (Class I billets)	Sound billet weighing not less than 9 kg and not exceeding 112 pieces
2	China Budh (Class II billets)	Slightly inferior billet weighing less than 4.50 kg and not exceeding
3	Panjam (Class III billets)	Billets having small knots, cracks and hollows weighing not less than 2.2 kg and not exceeding 448 pieces per tonne
4	Ghotla (billets of short length)	Includes short and sound pieces. There are no limits of weights and numbers per tonne
5	Ghatbadla	Billets with knots, cracks, small hollows, weighing not less than 4.5 kg and not exceeding 250 pieces per tonne
6	Bagardad	Consists of solid pieces without limit as regards dimensions, weight or number
7	Roots (Class I)	Pieces weighing not less than 6.75 kg and not exceeding 150 pieces per tonne
8	Roots (Class II)	Consists of pieces weighing not less than 2.25 kg and not exceeding 448 pieces per tonne
9	Roots (Class III)	Consists of small and side roots below 2.25 kg in weight
10	Jajpokal or Badla (Class I)	Consists of hollow pieces weighing not less than 3.10 kg and not exceeding 320 pieces per tonne
11	Jajpokal (Class II)	Hollow pieces weighing not less than 1.3 kg per tonne

12	Ainbagar	Consists of solid, cracked and hollow pieces weighing not less than 450 g
13	China Sali or Large Chilta	Consists of pieces and chips of heartwood weighing not less than 2.25 g
14	Ain Chilta	Consists of small pieces of heartwood
15	Hatri Chilta	Consists of heartwood and chips obtained by planing billets with Hatri or Randha (plane)
16	Milva Chilta	Consists of pieces and chips having fair proportions of heartwood and sapwood
17	Basola Bukni	Consists of small heartwood and sapwood chips.
18	Saw dust	Sawn powder obtained while sawing the sandalwood

### Sandal Oil

Powder of heartwood upon steam distillation yields East Indian Sandalwood oil. Light coloured wood generally contains higher percentage of oil than dark coloured. The oil content varies from 3% - 6% Sandal Oil has earned a prominent place in agarbathi (incense stick), cosmetic, fragrance and soap industries. It also finds its use in medicine as antiseptic, antipyretic etc. Its use as a base of fragrance has far outweighed its use in medicine. The characteristics and composition of sandal oil are

- Colourless to golden yellow viscous liquid.
- Sp.Gr.: 0.962-0.985
- Alcohol content : Santalos > 90%
- Refractive index at 20°C = 1.504
- Solubility in 70 % alcohol 1:5 volumes
- Optical rotation 190-200
- Acid value – 1.9-2.2
- Ester value – 13-16
- Ester value after acetilation – 210-215
- Ester content 1.6-5.4%

Sandalwood oil is obtained by steam distillation of heartwood powder. Sandalwood oil is a pale yellow to yellow

viscous liquid, with a sweet, fragrant, persistent, spicy, warm, woody, animalic, milky and nutty notes. It is extensively used in perfumery, cosmetics, aromatherapy and pharmaceutical industry.

Most Indian attars (Atar, in Persian means a fragrant essential oil or aroma) use sandal oil as the base because of its inherent capacity to absorb most of the ethereal notes of other whole herbs or flowers, as it can enhance their perfumery status and stability. Perhaps one of the most precious perfumery materials from antiquity down to modern times, the popularity of sandalwood oil has shown no signs of waning. The oil is used as a flavouring substance in food products such as frozen dairy desserts, candy, pan masala, baked food, gelatin, puddings and also in alcoholic and non-alcoholic beverages.

### General uses

Sandalwood is commercially known as the East Indian sandalwood and its oil the East Indian sandalwood oil. The heartwood that constitutes the central part of the tree is valued for its fragrance. The outer wood (Sapwood) or any other part of the tree has no scent. The heartwood is described as astringent, bitter, moderately hard, heavy,

Sorted sandalwood billets of various classes (Numbers from 1 to 18)





durable, yellow or brown in appearance, with an oily texture and is an exquisite material for carving intricate designs. The carved images of gods and mythological figures have a high demand in the market. It is no wonder that sandalwood is the second most expensive wood in the world, next to the African Blackwood (*Dalbergia melanoxylon*). A wide variety of articles such as boxes, cabinet panels, jewel cases, combs, picture frames, hand fans, pen holders, card cases, letter openers and bookmarks are made from sandalwood. The sapwood is white or yellow and not scented, and is used in preparing turnery item and agarbattis.

#### Medicinal uses

- The sandal oil is very good as an antiseptic agent. It is safe for both internal and external applications. When ingested, it helps to protect internal wounds and ulcers from infections. Similarly, when applied externally it protects wounds, sores, boils and pimples.
- Both sandalwood paste and essential oil are very effective as anti-inflammatory agents. They have a nice cooling effect and provide relief from all types of inflammation in the brain, digestive, nervous, circulatory, and excretory systems that result from infections, side effects of antibiotics, poisoning, insect bites and wounds.
- Being both relaxant and sedative in nature, sandalwood oil works great against spasms. It relaxes nerves, muscles and blood vessels, thereby ending spasms and contractions.
- Sandalwood oil has astringent properties which induce contractions in the gums on the teeth, the strengthening of muscles and tightening of the skin.
- The essential oil of sandalwood soothes the skin and helps scars and spots to heal much faster. Sandalwood oil is now extensively used in skin care soaps, lotions and creams.
- Sandalwood oil being relaxant in nature induces relaxation in the intestines and abdominal muscles,

thereby facilitating the removal of gases.

- Due to its anti-inflammatory properties, it soothes inflammation in the urinary system and induces relaxation, thereby promoting the easy passage of urine.
- The disinfectant property of sandalwood essential oil that justifies its wide use in religious ceremonies and cosmetics. Its fragrance keeps away microbes and small insects.
- Sandalwood oil soothes the skin, relieves it from inflammation, irritation, cures infections and keeps feeling fresh and cool.
- Sandalwood oil behaves as an expectorant and particularly effective in treating coughs. It fights the viral infections which initially cause the coughing and flu.
- Sandalwood oil improves memory and stimulates powers of concentration. Santalol keeps the brain cool and relaxed and saves from undue stress and anxiety.
- This oil sedates inflammation, anxiety, fear, stress, and restlessness. Furthermore it induces relaxation, calmness, concentration, and positive thoughts.
- Sandalwood oil is a very good health tonic for growing children. Oil is soothing on the stomach and the digestive, circulatory and nervous systems.

### Conservation

Sandalwood is threatened due to over-exploitation and degradation of habitat. On account of its intrinsic worth, money value and importance in the forest economy, sandal is governed and protected by special laws and regulations. Therefore, *Santalum album* has been categorized as 'Vulnerable' by the International Union for Conservation of Nature (IUCN).

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## ***Hardwickia binata*: a climate resilient multipurpose tree species for livelihood support in semiarid region of India**

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### **Introduction**

*Hardwickia binata* Roxb. (Family: Leguminosae ; subfamily: Caesalpinioideae) locally known as anjan, kamara; commercially in Trade as Anjan is a medium to large sized tree of monotypic genus reaching up to 36 m height and 0.9 m to 3 m girth based on the locality and edaphic factors. It is found growing in habitat characterised by hot and dry summers with prolonged drought, intense sunlight and 250 to 1000 mm annual precipitation. *H. binata* grows on variety of soils formation including sandstone, quartzite, schist and gneiss and in areas with rocks underneath soil, its roots have capability to go deep inside through rock fissures reaching up to water table. It has capability to thrive on rocky shallow soil in dry regions where almost all the other species will struggle for survival and even die. *H. binata* can ascend from plains to 760 m altitude.

### **Distribution**

*H. binata* is found growing in Central and Southern India either as an isolated blocks or patches. In central India, it is reported to grow in the states of Madhya Pradesh, Chhattisgarh, Uttar Pradesh and Bihar while in Western and Southern India it is found in Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu. In southern India at some places it grows in gregarious patches especially on shallow hard gravelly soil over trap rock. Mostly it

grows as pure crop but is also found mixed with *Soymida febrifuga*, *Terminalia tometosa*, *Anogeisus latifolia*, *Pterocarpus santalinus*, *Albizia lebbeck*, *Albizia amara*, *Terminalia chebula* etc.

### **Silvicultural characters and phenology**

Silviculturally, it is moderate light demander tree species and can bear partial shade. Seedlings are sensitive to heat and drought but it becomes drought hardy after seedling stage. Its roots are capable of piercing solid rocks in search of water and develop straight tap root but shallow soils leads to development of twisted tap root. Seedlings are prone to excess watering. Phenomenon of die back is prevalent in this tree for few years due to fire and drought but seedlings pick of good growth easily once it recovers up. Besides this tree responds very well to pollarding operations.

New copper tinged foliage appear on tree in April month and mature leaves fall during end of winter season. During April and May month un-lignified portion of branches are also shed which is a strategy to protect sensitive un-lignified portion of the branches from extreme summer and drought. Flowering starts during July to September month; pods appear during November month and ripen in coming May month. Tree starts first flowering at the age of 20 to 25 years but trees grown via coppice start bearing seed at age as early as 7 years Kundu (2011). Good seed

year happen to occur after every 3 or 5 years and drought has been reported to induce good quality seed production (Luna 2005).

### **Propagation, growth and yield**

*H. binata* can be propagated through seeds. Fresh seeds give higher germination percentage and results in healthy seedlings. Seeds need to be soaked in cold water for 24 hours before sowing in nursery. Seeds are sown during initiation of monsoon season in sand for better germination and then at two leaf stage they can be shifted in polybags containing growing media (sand/soil/FYM 1:1:1). Proper tending of seedling during the initial growing phases especially weeding, shading and avoiding excess watering should be taken care of for quality seedling production. Seedlings are ready after one year or two year for planting out in field. Planting out is done in monsoon season by digging pits. Direct sowing of seeds in field can also be carried out but nursery raised quality seedlings give higher survival and performance rate. Wild trees of *H. binata* show slow growth but the plantations which are raised scientifically perform better than wild trees. Mean annual increment in girth has been reported to be 1.60 cm and maximum of 2.2. cm and mean annual increment in height is reported to be 29 cm to 30 cm. The coppice grown trees put higher growth and rotation is kept 40 years for timber purpose whereas for seed grown trees, more than 60 years rotation age is kept for timber purpose owing to its slower growth than coppice.

### **Suitability for semiarid area**

*H. binata* tree is best suited for drought prone areas as it can tolerate prolonged drought thereby can be grown successfully in semiarid regions characterized harsh

summers and shallow soil with rocky areas. Its tap root is capable to grow deep through hard soil and rocks crevices. Further, its multifarious uses and canopy structure make it suitable for agroforestry in semiarid regions especially degraded lands where it can reclaim the land and provide economic benefits. It can be

grown for fodder, charcoal making, firewood, furniture making, timber and for fibre extraction etc. Studies carried out in Bundelkhand under *H. binata* based agroforestry system revealed that when it was integrated with crops on degraded land, it reclaimed as well improved the degraded lands (Prasad et al, 2017).

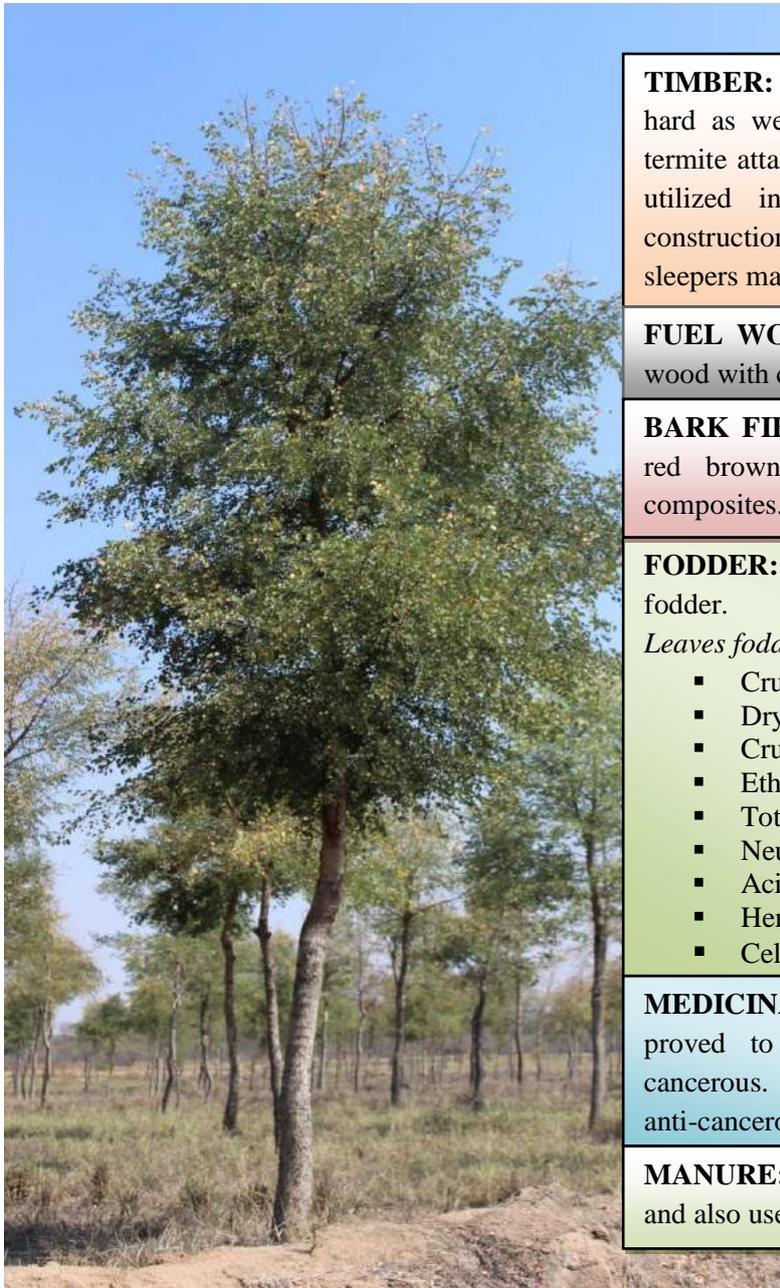
### **Suitability for agroforestry**

Semiarid region are going to be highly impacted by climate change owing to water scarcity, poor and degraded soils, lack of sufficient food, fodder and threatened livelihood security. Therefore, there is a need to develop climate resilient as well as climate change mitigating agro-ecosystem that can sustain livelihood, food and fodder supply, reclaim poor soils and conserves soil moisture. Thus, tree based develop agro-ecosystems are needed to be developed in these semiarid areas. *H. binata* is one of the potential tree species that can be integrated successfully in semiarid region on farmers' fields, wasteland, community land etc. This species has been proved to enhance soil quality and conserve soil moisture via reducing run-off. Hence, it can be integrated successfully with crops and grasses to develop food based and fodder based climate resilient agro-ecosystems. Being a large and long lived tree it has high carbon sequestration potential. A study carried on *H. binata* (30 years old trees) based silvipasture in semiarid region

reported that this fodder production system can sequester  $116.1 \pm 46.2 \text{ Mg CO}_2 \text{ ha}^{-1}$  (Gupta et al., 2019).

*H. binata* Roxb. being leguminous, multipurpose tree species (MPTs) and it

**Utilization**



canopy architecture, root system architecture and silvicultural characters make it well suited for agroforestry.

**TIMBER:** Wood is very heavy (density: 0.73), durable, hard as well as very highly resistant to decay as well termite attack and classified as class one timber. Wood is utilized in furniture making, beam making, house construction, agricultural equipment making, railway sleepers making, bridge making, carving etc.

**FUEL WOOD:** Tree is source of excellent quality fuel wood with calorific value of 4952 Kcal/kg

**BARK FIBRE:** Tree bark is source of excellent quality red brown fibre used for making rope and wood composites.

**FODDER:** Tree leaves are source of excellent quality fodder.

*Leaves fodder quality parameters* (Chitra, 2018):

- Crude Protein: 9.86% (on Dry matter (DM) basis)
- Dry matter: 42.21%
- Crude Fibre: 28.16% (on DM basis)
- Ether Extract: 6.17% (on DM basis)
- Total Ash content: 8.92% (on DM basis)
- Neutral Detergent Fibre: 50.64% (on DM basis)
- Acid DL: 15.85% (on DM basis)
- Hemi-cellulose: 16.43% (on DM basis)
- Cellulose: 18.36% (on DM basis)

**MEDICINAL VALUE:** Tree bark and leaf extract is proved to be as antifungal, antibacterial and anti-cancerous. Root bark exudates have also been proved as anti-cancerous.

**MANURE:** Leaves of the tree are used for manure making and also used for mulching.

*Characters making it suitable for agroforestry:*

1. Leguminous tree with nitrogen fixing capability
2. Deep tap root and less spreading lateral roots due to which its roots

do not pose high competition with understory crops.

3. Conical crown in young stages and later cylindrical which can be managed well with canopy management. Conical crown in early stage pose less shade on

understory crop and don't impact understory crop yield and growth.

4. Tree remains leafless for very short period of time during end of the winter; therefore, it is suitable for fodder production purpose as fodder quality is also high.
5. Its amenability for pruning practices, good coppicing and pollarding capacity.
6. Multiple uses: fuel, fodder, charcoal making, fibre, timber, furniture making, soil and water conservation potential.

Various studies support its suitability for integration in agroforestry. Ajit et al. (2001) advocated its suitability in agroforestry in semiarid regions. *Hardwickia binata* (200 trees ha<sup>-1</sup>) with intercropping of *Brassica campestris* (mustard) and *Glycine max* (soybean) has also been tried in semiarid region and found successful. Higher maize yield was observed under *Hardwickia binata* as it improved soil fertility, bulk density and pH (Tripathi and Hazra, 1997). Devaranavadgi et al. (2003) observed that due to minimum crown diameter of *Hardwickia binata* it is compatible with arable crops like *rabi* sorghum when grown in Agri-silviculture system. Intercropping of different crops such as oats, *Trifolium alexandrum*, pigeonpea-wheat, sorghum-wheat, mustard, chickpea, bengal gram, sunflower, castor and grasses like *Panicum maximum*, *Cenchrus ciliaris* and *Chrysopogon fulvus* were found suitable when intercropped with *H. binata*. Wider spacing in *H. binata* trees under agroforestry and plantations results in better performance of trees (Mohamed et al., 2017).

### Conclusion and Way forward

*H. binata* is a potential tree of semiarid region for reclamation of degraded lands, sustaining environmental security, livelihood security generation and for planning climate change mitigation as well as adaptive strategies. Being an excellent timber and multipurpose tree species with capability of thriving in semiarid region with poor soils, it can serve as a boon for semiarid region if promoted among farmers. Besides having huge potential it remained underutilized in semiarid region and is not popular among farmers. The best ways for deriving benefits from this potential species could be:

- Identifying of potential areas in semiarid region where it can be introduced in farmers' fields and awareness should be created among farmers regarding the usefulness of species for livelihood security and environmental security.
- Availability of quality planting material of *H. binata* should be ensured for farmers, afforestation and reforestation programs in semi arid region.
- Identification of elite genotype in term of fast growth, high biomass yield, higher fodder value and insect pest resistance for promotion among farmers.
- It can be promoted under agroforestry on farm bunds, as block plantation, as alley cropping, silvipastures, agrisilvipasture, etc. on community land and wastelands.
- Government policies should focus on linking tree growers with industries for maximizing sustainable use of tree products and benefits for farmers/growers.

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## Mulberry fruit - Nutritional and health benefits

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Mulberry fruits are sweet, hanging fruit from a genus of deciduous trees that grow in a variety of temperate areas around the world. The berries grow very fast when they are young, but gradually slow as their colour changes from white or green through to pink or red and eventually settling on dark purple or even black. For human consumption, the berries are delicious, but they are also composed of some unique nutritional elements that can have a serious impact on our health.

### **Nutritional value of Mulberry fruits**

Mulberry fruits are filled with nutrients that are important for our body, including iron, riboflavin, vitamin C, vitamin K, potassium, phosphorous, and calcium, as well as a significant amount of dietary fiber and a wide range of organic compounds, including phyto nutrients, zeaxanthin, resveratrol, anthocyanins, lutein and various other polyphenolic compounds (Singhal and Mohammad, 2013.).

### **Health benefits of Mulberry fruits**

The health benefits of mulberry fruits include their ability to improve digestive health, lower cholesterol, aid in weight loss efforts, increase circulation, build bone tissue, boost the immune system, prevent certain cancers, slow down the aging process, lower blood pressure, protect eye health, and improve the overall metabolism of the body (Masilamani *et al.*, 2008).

### **Digestive Health**

Mulberry fruits contain dietary fiber, approximately 10 per cent of daily requirements in a single serving. Dietary fiber helps to improve digestive health by bulking up stool, thereby speeding up the movement of food through the digestive tract, while also reducing occurrences of constipation, bloating, and cramping. Furthermore, fiber helps to regulate cholesterol levels and can boost heart health when mulberry fruits are regularly added to the diet.

### **Circulation**

The high levels of iron content in mulberry fruits, which is a very unusual mineral for fruits to contain, can significantly boost the body's production of red blood cells. This means that the body will increase its distribution of oxygen to important tissues and organ systems, thereby helping to boost metabolism and optimize functionality of those systems.

### **Cancer Prevention**

Between the high content of anthocyanins, vitamin C, vitamin A, and various other polyphenolic and phyto nutrient compounds, mulberry fruits are absolutely packed with antioxidant potential. Antioxidants are the main line of defense against free radicals, which form as a dangerous byproduct of cellular metabolism and can damage healthy cells, causing them to mutate into cancerous cells. The diverse range of antioxidants found in mulberry fruits which can

neutralize those free radicals quickly, before too much damage is done.

### **Vision Health**

One of the carotenoids found in mulberry fruits is zeaxanthin, which has been connected directly to a reduction in oxidative stress on certain ocular cells, including the retina macula lutea. Furthermore, zeaxanthin functions as an antioxidant and prevents certain damage to the retina, including from free radicals that can cause macular degeneration and cataracts.

### **Immune System**

Vitamin C is a powerful defensive weapon against any illnesses or foreign pathogens in the body. A single serving of mulberry fruits is almost the entire requirement of vitamin C for the day, but combine that with the minerals and vitamins that are in this fruit, and you have a true weapon against illness.

### **Build Bone Tissue**

Vitamin K, calcium, and iron, as well as the trace amounts of phosphorous and magnesium found in mulberry fruits, can all be beneficial for the creation and maintenance of bone tissue. As we get older, maintaining strong bones, speeding up the healing process, or even reversing the damage of bone degradation is important to prevent conditions like osteoporosis or other age-related bone disorders.

### **Antioxidants and Premature Aging**

Mulberry fruits boast a high level of vitamin A and vitamin E, as along with a

range of carotenoid components like lutein, beta carotene, zeaxanthin, and alpha carotene. All of these elements act as antioxidants that specifically affect the skin, tissue, hair, and other areas of the body where free radicals strike (Akbulut and Musazcan, 2009). Mulberry fruit can help keep skin looking smooth, reduce the appearance of blemishes and age spots, and keep hair shiny and healthy by preventing the oxidative actions of free radicals.

### **Conclusion**

Some mulberry fruits are very good at lowering blood sugar levels, which is beneficial for some, but also very dangerous for others. Also, there are rare cases of allergies to mulberry so use them in moderation and monitor your body's reaction if eating them for the first time.

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## Banyan tree - Indigenous system of medicine

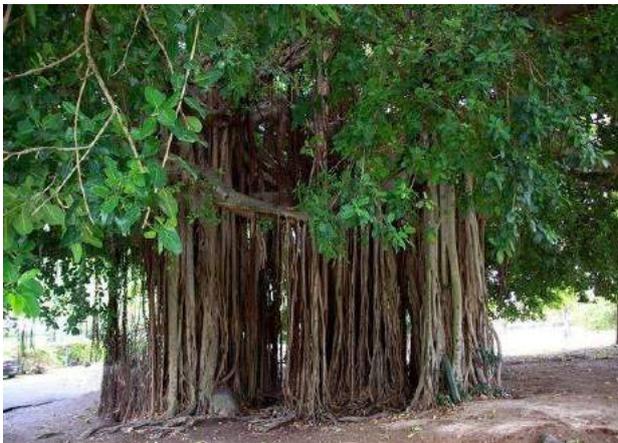
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The world population is likely to touch 7.5 billion by the year 2020. Health and disease are the two important areas, which have engaged attracted the attention of mankind since time immemorial. The primitive man did not know about the medicine. In ancient time, people primarily depended on plant, which they were able to procure most easily as therapeutic agents and remedies. India has a rich heritage of knowledge on plant based drugs both for use in curative and preventive medicine. India has a rich source of biodiversity (both flora and fauna) possessing tremendous medicinal properties. The ecosystem of ficus species in India is one of the important ecosystems

in the tropics and has tremendous economic and medicinal values.

Banyan (*Ficus benghalensis*) belongs to the Moraceae family is a large evergreen tree distributed all over India from sub Himalayan region to the deciduous forest of Deccan and South India. It is a member of four sacred trees Nalpamara (Ksirivksas) meant to be planted around the home and temples. It is a **National tree of India**. It is epiphytic when young. It develops from seeds dropped by birds on old walls or on other trees and is therefore, considered destructive to forest trees, walls and buildings. *Ficus benghalensis* plant parts like leaves, stem, bark, root and aerial root have different chemicals, so this plant is having medicinal importance.



**Banyan tree**

*Ficus benghalensis* is a tree with popular indigenous system of medicine like ayurveda, siddha, unani and homeopathy.



**Prop roots**

In traditional system of medicine various plant parts such as stem, bark, roots, bark aerial roots, vegetative buds, leaves, fruits and latex are used in dysentery, diarrhea,

diabetes leucorrhoea, menorrhagia, nervous disorders, tonic and astringent. The banyan tree is highly used in the area of its pharmacognosy, phytochemistry, pharmacological, traditional uses as antioxidant, antiatherogenic, antitumor,



**Banyan leaves**

The tree parts of banyan and its functional role in the curing of the diseases in the humans are

#### **Improving Fertility**

- Buds of banyan have been taken for improving fertility.
- **Leucorrhoea**
- Bark, fruit and milk of banyan is useful for Leucorrhoea.
- Bark of banyan with 'Triphla' powder has been taken up 20 days with the help of honey to cure Leucorrhoea.
- The bark of this plant after boiling with water locally used to cure leucorrhoea.

#### **Toothache**

- Bark of banyan and gum of cutch tree with black Peepal locally use as a pest is cure tooth problem, Pyria problem and clean teeth clearly.

#### **Improving Memory**

anthelmintic, anti-inflammatory, analgesic, anti-stress, antipyretic, anti-allergic, antidiarrhoeal, antidiabetic, ameliorative, hypoglycemic, hypoglydemic, immunomodulatory and wound healing properties.



**Fruits**

- Bark of banyan after drying and cruising take 5 to 6 g powder with cow milk it improved memory.
- The bark of banyan, whole plant of Bramhi (B.N.) and after cruising take 21 days daily it improved memory power.
- The young twigs of banyan cruised and prepare 21 tablets take one tablets daily with cow butter. It improved memory power.

#### **Dysentery**

- The extracted drop of banyan prop roots with honey daily three times it care dysentery.
- The young twigs of banyan cruised and take twice a day with the help of cure dysentery.

#### **Pimples**

- The milk of banyan is useful to cure pimples.
- Prop root of banyan and puls of (masoor) greed with milk and put locally on pimples it cure pimples.

- Leaf extract of banyan with butter potted on pimples it cure pimples.
- Prop roots of banyan with gulab jal potted locally on pimples it cure pimples.

#### **Piles**

- The bark of banyan after boiling with water mixed sugar and cow butter take 10 to 20 days early morning to cure piles.

#### **Arthritis**

- The milk of banyan locally use for Arthritis.

#### **Hair fallings**

- Prop roots of banyan mixed in coconut oil use locally in hairs it cures hair falling.

#### **Gyanic disorder**

- 5 to 10 drops of banyan milk with sugar candy up to 20 days before sunrise.

#### **Conclusion**

The environmental benefit and traditional medicinal value of the banyan tree awareness should be given to government agencies (Forest department) for taking up the mass planting programme in the common places. The banyan tree to be conserved not only for the above said uses, but it also helps in soil erosion, religious and sacred tree in many places, fruits as a food for birds and also as a timber.

## Pharmacological and traditional uses of *Wrightia tinctoria*

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Our nature has provided a very good source of drugs and especially plants have contributed most of these potential therapeutic agents. Plant kingdom still holds a very good potential medicinal value, which have are yet to be completely discovered. *Wrightia tinctoria* is an important medicinal plant used in the Indian system of medicine for the treatment of variety of diseases and it possess analgesic, antifertility, cytotoxic, homeostasis and antiulcer activity

*Wrightia tinctoria* is a small and deciduous tree which grows up to 10 meter with milky latex, scaly, smooth and ivory colored bark. The plant of *W. tinctoria* is widely distributed in Asia, Africa and Australia and are known to be the native of Australia, India, Myanmar, Nepal and Vietnam. The plant mostly occurs in the Western, Central and Peninsular India. Ascending to an altitude of 1300m. The plant grows well in arid, semi-arid and moist regions with a wide range of soil types. This plant is especially common along hillsides and valleys and is often found as undergrowth in deciduous forests. The timber **i.e.** white wood is of high quality and value for turnery, carving, toy making, matchboxes, small boxes and furniture. Leaves, flowers, fruits and roots constitute the source of an indigo-yielding glucoside, which produces a blue dye or an indigo dye

The whole plant of *Wrightia tinctoria* or its specific parts (Bark, leaf, seed and root)

are known to have medicinal properties and have a long history of use by indigenous communities in India. The medicinal value of this plant for the treatment of a large number of human ailments is mentioned in Ayurveda, Siddha, Unani and folk medicine. In the last more than three decades, several studies have been carried out on this medicinal plant species to facilitate evidence in favor of its conventional uses.

### Chemical constituents

The mature powdered pods of *Wrightia tinctoria* showed co-occurrence of  $\beta$ -amyirin, ursolic acid and oleanolic acid along with  $\beta$ -sitosterol. Methanolic extract of immature seed pods contain cycloartenone,  $\beta$ -amyirin, cycloeucalenol,  $\beta$ -sitosterol and a new terpene wrightial. A new sterol 14  $\alpha$ -methylzymosterol in addition to four rare plant sterols, desmosterol, cholesterol, 24-methylene-25-methylcholesterol and 24-dehydropollinastanol have also been isolated from seeds. Stem bark of *W. tinctoria* contains  $\beta$ -amyirin, lupeol, wrightiadione,  $\beta$ -sitosterol and a new triterpenoid.

### Traditional uses

#### i) Leaves

Fresh leaves are pungent and when crushed fresh leaf filled in the cavity of decayed tooth or chewed under tooth relieves toothache. In Karnataka and Tamil Nadu, the tree named as “jaundice curative tree”, since the juice of its tender leaves is

used as an effective drug for treatment of jaundice. Juice of leaves is also employed against serpent bite and considered febrifuge, stomachic and tonic. In Siddha medicine, the plant is widely used in the treatment of psoriasis and other skin diseases. Leaves soaked in coconut oil are kept in hot sunlight for a day and then this oil is used for the treatment of psoriasis. Oil prepared from fresh leaves of plant with coconut oil has been assigned to be analgesic, anti-inflammatory and antipyretic activities, to be effective in the treatment of psoriasis.

Psoriasis is a chronic recurrent problem affecting the skin, nails, and joints and it is one of the papulo-squamous disorders. The current treatments available for psoriasis include local application of emollients, moisturizers, tars, anthralins, topical corticosteroids, vitamin A and D analogs and systematic treatment in the form of corticosteroids, methotrexate, cyclosporine, etretinate and other immunomodulators as well as hydroxyurea. There are increasing research efforts to develop herbal formulations to treat psoriasis. Clinic and histopathological evaluation of ointment formulation prepared from *W. tinctoria* leaves and *Cocos nucifera* suggests superior efficacy of herbal formulation with a best result of formation of the granular layer and marked disappearance of the spongiform pustules, dermal vessel tortuosity and normalization. Flowers are used as vegetable. The leaves are a fodder for the cattle, goat and sheep. In south India, the plant is used for green manuring rice fields.

#### ii) Bark

Bark is used as tonic, anthelmintic, antidiarrheal, febrifuge and aphrodisiac; it is used in treatment of seminal weakness, flatulence, colic diarrhea, leprosy,

psoriasis, haemorrhoids dipsia, helminthiasis fever, digestive, stomachic, constipating, depurative, febrifuge, burning sensation and dropsy. Bark and seeds are used in bilous infections. In tribal villages of Tamil Nadu, the bark decoction is given to cure piles, whereas bark and seeds are used together to treat various ailments.

Dano: an herbal solution for dandruff from bark of *Wrightia tinctoria*. Dano, poly-herbal hair oil was studied for anti-dandruff activity using microbiological and clinical tests. There was a clear symptomatic relief from dandruff in all the volunteers after 10 days of use. Further, the isolation of *Pityrosporum ovale*, the causative organism of the dandruff in culture was not possible after use of the Dano oil. The plant extracts is from *Wrightia tinctoria* (Indrajiv), *Cassia alata* (Dadmari) and bitter fraction of *Azadirachta indica* (Neem or Nimba). Methylene blue reductase test was employed to study the anti-dandruff efficacy of the oil.

#### iii) Seeds

Seeds are useful as a tonic, carminative, anthelmintic, astringent, aphrodisiac and febrifuge and for treatment of stomach disorder. In Unani medicine, the seeds of *Wrightia* are differently known as "Lisanul-e-Asafir", Inderjao Shireen and Meetha Inderjao and have been reported to have used for cure disorders of central nervous system and claimed to have analgesic, aphrodisiac, tonic and emmenagogue actions. *W. tinctoria* have been recommended for the treatment of infections of the chest (In asthma), colic and as diuretic.

#### iv) Roots

Extracts of the root and leaves possess hypotensive activity. According to an

ethnobotanical information, the plant bark is of considerable medicinal value for bronchitis, piles and is used in scorpion sting and snakebite. In folk medicine, the dried and powdered roots of *Wrightia* along with *Phyllanthus amarus* (Keezhanelli) and *Vitex negundo* (Nochi) is mixed with milk and orally administered to women for improving fertility.

### Conclusion

*Wrightia tinctoria* is one of the plants, with a great medicinal potential claimed to contain the varieties of phytochemicals, which play an important role in one or other ways in different biological activities. The presence of high amount of active phytoconstituents such as phenolis, falvonols, alkaloids, steraol and several terpenes make the afore-mentioned plant extract a good candidate for more exploration in pharmacological activity. *W. tinctoria* represents a most valuable medicinal plant sheltering a variety of the important chemo -constituents which confer most of the characteristics of the plants. Based on the facts, it is concluded that this plant species may form a good potential source in the drug development.

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## Environment-friendly & Biodegradable Alternatives to Plastic

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More than eighteen trillion pounds of plastic has been produced till date and eighteen billion pounds of plastic flows into the ocean every year. It ensnares the marine animals we cherish and the fish we put on our plates, it appears in the table salt we use, and it is even found in our own bodies.

As more research on the impact of using so much plastic becomes known consumers and manufacturers are left scrambling for an alternative to the ubiquitous material, and bioplastics have emerged as a potential alternative.

About 90% of today's plastics are petroleum-based and not biodegradable, which is a major environmental concern. So far, attempts to make viable plastic replacements from renewable sources have not been very successful — mostly due to processing and economic constraints. Among the obstacles, products to date have been too brittle for food packaging.

Plastics are one of the biggest challenges the world is facing right now. Thanks to David Attenborough's Blue Planet, consumers are suddenly aware of the thousands of tones of plastic filling the ocean.

As plastic is so prolifically used, especially in packaging, brands are going to need to act quickly to find plastic alternatives. In fact, 25% of consumers are extremely concerned about plastic packaging, 42% think manufacturers should priorities making packaging recyclable and 21% think the industry should work toward entirely

plastic-free packaging (Kantar). This number is only going to grow as plastic continues to be covered daily in the press. Brands will need to seen for taking a responsible approach; otherwise, they will risk damaging their hard-earned equity.

With so many plastic alternatives being developed, we have rounded up 13 of the most exciting innovations in plastic replacement.



Plastic is very easy and convenient to use, but in today's day and age more people are becoming concerned about how much plastic we use as a society and what it does to the environment around us. A report by UN Environment assessed that plastic packaging and other single-use items form a large proportion of the plastic that are leaking out into our oceans. Plastic is not only harmful for the environment but also for our health. The chemicals in the plastic packaging leeches in to your food and when you absorb the product you absorb the chemicals as well. Today more ecofriendly and biodegradable alternatives to plastic products are used.

**Plant-based plastics**

A.K.A. Bioplastics are made from a variety of sources such as corn, which is broken down into PLA, or polylactic acid. This is incredibly sustainable to produce, as it is made from the waste products from the production of corn – which is also easy to grow. PLA can be used to make drinks bottles, various food grade containers, as well as films. Eco-heroes Innocent are now making their bottles from 15% PLA.

**Mushroom root**

With Mycelium (mushroom roots, funnily enough, the same stuff that Quorn is made from), packaging is literally grown. Evocative Design gather agricultural waste, mix it with the mycelium in moulds and then the packaging quite literally grows. You can see how it works here, though I'm not 100% sure it isn't magic.

**Bagasse**

Bagasse is a by-product of sugarcane processing. Due to its malleability and stickiness, it can be easily moulded into packaging suitable for food delivery and food service – similar to polystyrene. Unlike polystyrene, it's certified biodegradable and compostable, and being a by-product, much more sustainable to produce.

**Seaweed water bubbles**

UK startup Ooho have created an edible (and by default, biodegradable) water bubble made of seaweed. Their aim is “to provide the convenience of plastic bottles while limiting the environmental impact”.

They have developed manufacturing processes that make this both more efficient and cheaper than producing plastic bottles. The process produces 5x less CO<sub>2</sub> and uses 9x less Energy vs PET production.

**Shower-friendly paper**

Beauty behemoth L'Oréal have just launched an eco-beauty range, Seed Phytonutrients. The products themselves sound lovely (made from 93-100% natural ingredients, cruelty-free, paraben-free etc.) but the packaging is where the real innovation is.

Made by Ecologic, the outer card is recycled, recyclable, compostable, glue-free and water-resistant. The inner liner is made with recyclable plastic, and uses 60% less material than regular plastic bottles.

**Stone paper and plastic**

It might surprise you to know that paper can be made out of stone. It certainly did me. I have a stone paper notebook and it has the most beautiful smooth finish, almost cool to the touch. This incredible innovation has several possible packaging applications. It can be used as a paper or plastic alternative, being printable, recyclable, water-proof... and its eco-credentials look pretty good too. It is made from calcium carbonate, which is one of the Earth's most abundant resources and its production process uses less water, has a lower carbon footprint, and is more energy efficient than regular paper production.

Stone paper can also be used to make FDA certified food grade packaging. This can be used for making paper (supermarket singlet) bags, takeaway food cartons, greaseproof paper wraps as well as Ziplock bags.

**Palm leaves**

Holy Lama use palm leaves from the areca palm to create the oyster-like cases for their handmade soaps. The leaves fall naturally from the areca palm, then they are collected and moulded into the desired shape.

Brilliantly environmentally friendly as they use a natural waste product of the areca palm and the final packaging product is biodegradable.

A Berlin startup Arekapak is developing palm leaf packaging for food such as fresh fruit, vegetables and nuts.

#### **Corn starch and sorghum loose fill**

EcoFlo loose fill is made from corn starch and can be used the same way as regular polystyrene loose fill. This eco version – which can also be made from sorghum (a crop similar to popcorn) – is biodegradable, odour free, and maybe best of all; static-free!

#### **Edible six-pack ring**

Saltwater Brewery in America have developed a material for their six-pack rings which is not only biodegradable and compostable, but also edible. Made of barley and wheat remnants which are a by-product of the brewing process, if it's dropped in the ocean now, this packaging will actually benefit the sea life!

#### **Silber board – metalized paper**

Developed as a sustainable alternative to traditional composite metallised papers and boards, Silberboard is both recyclable and compostable. The paper weight can be used for food on-the-go and labelling, the card weight can be used for all kinds of boxes – for food, household goods, pharmaceuticals... etc. etc.

#### **Wood pulp cellophane**

NatureFlex is the sustainable younger brother of cellophane, which is made from FSC certified wood pulp, and certified biodegradable. It comes as Uncoated, which is perfect for chocolate and confectionery as well as household items; Semi-Permeable,

which can be used for fresh produce and dairy; and Barrier for bakery, snacks, coffee, tea, chocolate, confectionery as well as home and personal care items.

#### **Prawn shell plastic bags**

Scientists around the world are developing plastic alternatives out of the most unlikely things. One of these is chitosan, which is made from prawn and crab shells, which are usually a waste product. No-one has commercialised this technology yet – but the material has the potential to replace plastic in packaging for food and drinks.

#### **Milk plastic**

Casein – the protein found in milk – has been used to make plastic for over a century, but it went out of fashion in favour of the more hardwearing, long-lasting petrochemical variety. Lactips have developed tech that combines the protein with clay and a reactive molecule (glyceraldehyde) which make the plastic much stronger, but still biodegradable. Lactips already produce milk plastic for the detergent industry (you know those little bubbles you pop in the dishwasher?) and now are looking to move into the food and beverage industry, as well as pharmaceuticals and agrochemicals.

#### **Recycled cardboard and paper**



Paper and cardboard are easy replacements

for plastic in packaging. When in the grocery store, think about reducing plastic use and pick the cardboard box over the plastic bag. It is easier to recycle paper and cardboard and there is a big chance they are already made out of recycled paper. If the paper or cardboard has to be thrown out instead of being recycled, it still breaks down a lot faster and with a lot less chemical residue than plastic packaging every could.

### **Bio-plastic**

Bio-plastic is plastic made from plants. It is made from waste products from the production of corn (or other vegetable). The corn is broken down into polyactic acid and can be made to use drinking bottles and food grade containers.

### **Stone paper and plastic**

Paper can be made, not only from trees, but from stones as well. The paper is made out of calcium carbonate and is printable, recyclable and water-proof. It can be used to make FDA certified food cartons and can replace plastic in supermarket bags, takeout food cartons and zip lock bags.

### **Mushroom based material**



Plastic packaging can be replaced with packaging made from mycelium, a mushroom root. The fibers in the mushroom bind agricultural waste into an alternative kind of foam. Agricultural waste products such as rice hulls, cotton hulls or wheat

chaff are placed in a mold and then injected with mushroom spawn. About a week later the mushroom root has completed its growth using the agricultural waste as an energy source. The final product looks like foam and acts like foam without being as harmful for the environment as foam. It is organic, biodegradable and can be used as compost or mulch. Some companies are starting to use this product instead of Styrofoam, which makes for a much healthier and sustainable package.

### **Milk plastic**



Milk plastic is plastic made out of milk. Or rather casein, the protein found in milk. It actually has been used to make plastic for over a century, but newer technology made more sturdy long-lasting petrochemical plastic. Now milk plastic is making a comeback. Companies have developed technology that combine the casein with clay and a reactive molecule, which makes the plastic much sturdier. The packaging is also easy to break down, isn't harmful toward the environment and, if you wanted to, you could even eat it!

The alternatives to plastic are numerous. Usually they fall into the category of glass, stainless steel, or wood.

Also, as demand for alternatives to plastic rises, more options will become available.

Common plastics used	Alternatives to Plastic
Art supplies	Consider homemade play dough, paint, etc (to store in glass or metal); choose items such as colored pencils and charcoal or pastels that come in cardboard boxes instead of plastic containers
Baby bottle	Glass or stainless steel, and silicone nipples
Bags, food storage (i.e. Ziplock)	Glass or stainless steel containers
Bags, shopping	Canvas or reusable shopping bags (homemade or bought)
Beverage container, store-bought	Drink water instead; Homemade beverages stored in glass carafes; buy milk in glass containers or from a local farm
Brush, scrub or bottle	Tampico fiber or Horsehair brushes
Brush, toilet	Pig-hair wooden toilet brush
Calculator	Bamboo calculator
Carpet (much of it is plastic-based)	Natural wool carpet, real wood floors, sealed concrete
Computer keyboard	Bamboo keyboard
Cooking utensils (spatulas, spoons, etc)	Invest in wood (naturally antibacterial!), stainless steel or silicone when necessary
Cups, drinking	Glass or stainless steel for toddlers
Dishwashing soap	Skip the store-bought and make your own homemade dishwashing detergent to store in a glass jar or stainless steel container.
Dustpan	Sweep out the door or use a stainless steel dustpan
Food storage	Glass and/or stainless steel containers
Hard hat	V-Gard GREEN Helmet (non-petroleum "plastic", made from sugarcane)
Ice cube tray	Stainless steel is best; also silicone, or natural rubber (if you're using an automatic ice cube maker, you're out of luck)
Lighters	Look for a metal lighter, such as a Zippo
Lint roller	Wooden and natural rubber lint brush
Lunchbox	Fabric lunch bags or stainless steel
Media cases (CDs, DVDs, etc)	Purchase digital through iTunes or Amazon, or watch online through Amazon Instant Video or Netflix
Microwave cover	Ditch the microwave, or just clean up the few splatters to save yourself from the plastic off-gassing
Office supplies	Check out paper tape (skip the dispenser); Many pens come with metal shells; you can often find all-metal scissors at craft stores (check the sewing department); choose moldable or square erasers (as well as single pens) from bins instead of in plastic packaging; look for metal thumb tacks, etc.
Popsicle mold	Stainless steel and silicone molds
Razors, disposable	All-metal razors and blades (non-disposable)
Rugs (much is synthetic polyester or recycled)	Natural wool, hemp, jute, or cotton; choose a silicone non-slip pad underneath

plastic)	
Seasoning containers	Choose seasonings that come in glass with a metal lid, recycle the plastic topper inside, and consider growing and drying your own in the future
Shower curtain	Choose cloth, bamboo, or hemp instead
Skin care containers	Use coconut oil, essential oils, homemade sunscreen, and other homemade skin care options.
Straws	Glass or stainless steel; be sure your order includes a free straw brush for easy cleaning
Toothbrush	Plastic-free wooden toothbrushes
Toothpaste	Make your own homemade toothpaste and store in a glass or stainless steel jar.
Toys, misc	Replace with wooden, cotton, hemp, porcelain, metal, and other natural materials (tip: search "Waldorf" or "natural toy _____" to find specific alternatives
Trash bags	First be sure to precycle, compost, and recycle. With the small amount left, try going without a bag, using paper bags, or compostable bags (such as BioBags).
Utensils (especially when eating out)	Choose bamboo carry-out utensils and keep them in your vehicle
Water bottle, drinking size	Stainless steel, or glass with silicone or padded case to prevent breaking (these usually only come with plastic lids; if you find a quality bottle without any plastic at all please let us know!)
Water bottle, 5 gallon	5 gallon glass carboy
Water filter, refrigerator	Instead of the fridge filter, use a stainless and charcoal filter, such as Berkey filters
Yoga mat	Bamboo, hemp, jute, or natural rubber mat

And the only way to ensure that happens is to vote with your dollar by buying non-plastic items whenever possible, as well as requesting companies make switches to natural substitutes.

Since these new materials are not ready for use, and biodegradable plastics are far from ideal, the necessary course of action is still clear. If we want less plastic in our oceans and landfills, then we need to use, and waste, less plastic.



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