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Economically viable and ecologically sustainable tree of heaven “*Simarouba glauca*”

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Abstract

Simarouba glauca commonly known as paradise tree is a versatile fast growing multipurpose oilseed tree belonging to the Simaroubaceae family. It is considered as a potential source of edible biodiesel and also known for various medicinal properties having ability to check the soil erosion and improvement in the ground water balance.

Keywords: ‘Laxmitaru’, *simarouba glauca*, ‘paradise tree’, ‘*Simarouba medicinalis*’, ‘dysentery bark’ ‘bitter ash’ and ‘oil tree’

Introduction

Some of the tropical regions with fertile soils, receiving good rainfall, have rich rainforests with a great treasure of flora and fauna. Agriculture is lucrative in these regions and here the farmers are generally happy and love farming. However, there are less privileged geographical regions in the tropics, which receive low and erratic rainfall that cannot support good vegetation even though they are blessed with plenty of sun light. Cultivation of traditional crops adopting recommended packages is very much uneconomical and often disastrous to agriculturists in these regions^[1].

Several measures are suggested for mitigating this problem. Among them, recommending a low cost input technology for cultivating hardy perennial crops that can grow well even with erratic and low rainfall, still giving assured returns is of great significance. In this context, cultivation of *Simarouba glauca*, paradise tree, Lakshmi taru, a multipurpose tree that can grow well under a wide range of hostile ecological conditions, offers a great hope^[2].

Aim: This paper provides a review of the scientific literature on

- Botanical Features
- Ethnobotanical Uses
- Benefits Of *Simarouba* Cultivation

Methodology

The following electronic data bases: MEDLINE, PUBMED, EMBASE, COCHRANE, PROQUEST were searched to identify relevant articles. The articles were reviewed to include details pertaining to the uses and benefits of *Simarouba glauca*.

Inclusion criteria

1. Publication from the earliest available date to June 2016;
2. Language: English
3. Only documents for which full text could be obtained were reviewed.

Exclusion criteria

Studies were excluded if they provided insufficient information to allow adequate interpretation, or if they were only found in abstract form, in abstracts or posters from conference proceedings.

Some of the abstracts and full-text documents were searched by traditional Web searchers and documents that seemed to be relevant but did not have a digital version were hand searched. The search strategies included subject headings and subheadings combined with keyword searching.

Botanical Description

Simarouba is indigenous to the Amazon rainforest and other tropical areas in Mexico, Cuba, Haiti, Jamaica and Central America. Simarouba is a medium sized evergreen tree (height 7-15 meters) with tap root system and cylindrical stem. Its trunk is 50 to 80 cm in diameter. It produces bright green leaves 20 to 50 cm in length, small white flowers, and small red fruit. Flowering is annual beginning in December and continuing up to February. The trees start bearing when they are 4-6 years old and reach stability in production after another 4-5 years. The drupelets are blackish purple in Kaali genotypes and yellowish green in Gauri genotypes and they are ready for harvesting by April/May ^[1-4].

Tree of Heaven: Uses

The leaves and bark of Simarouba have long been used as a natural medicine in the tropics. Simarouba was first imported into France from Guyana in 1713 as a remedy for dysentery. When France suffered a dysentery epidemic from 1718 to 1725, simarouba bark was one of the few effective treatments. French explorers "discovered" this effective remedy when they found that the indigenous Indian tribes in the Guyana rainforest used simarouba bark as an effective treatment for malaria and dysentery - much as they still do today. Other indigenous tribes throughout the South American rainforest use simarouba bark for fevers, malaria, and dysentery, as a hemostatic agent to stop bleeding, and as a tonic. Simarouba also has a long history in herbal medicine in many other countries ^[5-6]. In Cuba, where it is called gavilan, an infusion of the leaves or bark is considered to be astringent, a digestion and menstrual stimulant and an antiparasitic remedy. It is taken internally for diarrhea, dysentery, malaria, and colitis; it is used externally for wounds and sores. In Brazil the tree is called negrito or dysentery bark. There the bark (and occasionally the root) is boiled in water to yield a powerful astringent and tonic used to wash skin sores and to treat dysentery, diarrhea, stomach and bowel disorders, hemorrhages, and internal In India It was first introduced by National Bureau of Plant Genetic Resources in the research station at Amravati in Maharashtra in 1966 and to the university of Agricultural Sciences, Bangalore in 1986. In India it is cultivated in Orissa, Maharashtra Anand Jodhpur, Andhra Pradesh, Karnataka, Tamilnadu, West Bengal and Bhubaneswar.

All parts of the plant namely, seed, shell, fruit pulp, leaf, leaf litter, unwanted branches, stem, bark, and root generate products that are useful in the production of food, fuel, manure, timber, medicine etc. In traditional herbal medicine systems the bark, wood and leaves of simarouba have been used for their amoebicide, analgesic, anthelmintic, antibacterial, antidysenteric, antimalarial, antimicrobial and astringent properties.

Chemistry

The main active group of phytochemicals in simarouba are the quassinoids, which belong to the triterpene chemical family. Ailanthinone, glaucarubinone and holacanthone are considered some of the main active quassinoids in simarouba. Other chemicals include: benzoquinone, canthin, dehydroglaucarubinone, glaucarubine, glaucarubolone, melianone, simaroubidin, simarolide, simaroubin, simarubolide, sitosterol and tirucalla ^[7].

In vivo and In vitro Research and Pharmacological Actions**Anticancerous Activity****Antitumor Activity ^[8]**

A methanol extract of the bark had an LD50=7.38 ppm in the artemia salina assay system; a system that predicts antitumor activity

Cytotoxic Activity ^[9]

An ethanol-water extract of simarouba root demonstrated cytotoxic activity towards human oral epidermoid carcinoma Ca-9KB at ED50<20 mcg/ml. A water extract of the seeds showed activity towards the same tumor cell line at ED50<20 mcg/ml. A water extract of the bark was cytotoxic at 10% towards human cervical adenocarcinoma (hela) cells.

Antimicrobial & Antiprotozoal Activity**Antiviral ^[10]**

Bark water extracts are active *in vitro* towards the herpes virus, influenza virus, poliovirus and vaccinia virus.

Antiamebic ^[11]

Hot water extracts of the bark given orally to humans with *Entamoeba histolytica* cured 3 out of 7 cases after 7 days of treatment.

A water extract of the seed given orally to humans with *Entamoeba histolytica* was 91.8% effective.

In vitro various extracts of the stem were active against *Entamoeba histolytica* at IC50=2.9 - 52.5 mcg/ml.

Antibacterial ^[12]

Water-ethanol bark extracts at 50 mcg/plate were active against *Salmonella typhosa* and *Shigella flexneri*.

Antimalarial ^[13]

Chloroform and water extracts of the wood, bark and twigs of simarouba demonstrated strong antimalarial activity when given orally or subcutaneously to chickens infected with *Plasmodium gallineceum*. Active doses given ranged from 1.5 mg/kg - 500 mg/kg

Skin Hydration Effect ^[14]

A water extract of the rootbark at 10 mcg/ml increased cholesterol sulphate, cholesterol and ceramide content in keratinocyte cell cultures. At 25 mcg/ml transglutaminase activity was stimulated.

Used externally in human female adults the extract (at 0.2%) had a skin moisturizing effect.

Duration of Administration

Duration of administration varies per complaint and individual. No adverse effects have been noted in the literature with long-term ingestion of simarouba.

Traditional Preparation

For diarrhea or dysentery, the traditional remedy calls for preparing a standard decoction with the bark. A teacup full (about 6 ounces) is taken 2-3 times daily. Five to ten ml of a bark tincture twice daily can be substituted if desired.

Side Effects

Side effects at high doses (approximately three times the traditional remedy) include increased perspiration and urination, nausea, and/or vomiting

Contraindications

Reported side effects at high dosages (approx. three times the traditional remedy) include increased perspiration and urination, nausea, and/or vomiting.

Pregnancy and Lactation: No adverse effects during pregnancy and lactation are reported, however, simarouba is bitter and the effect of the quassinoids during pregnancy and lactation is not known. It is advised that this plant not be used during pregnancy and lactation.

Drug Interactions

None reported

Other Uses**Food**

Oil: Simarouba seeds contain 60-75% oil that can be easily refined, bleached, deodorised and fractionated. It is suitable for edible and non-edible purposes.

Edible: From 1950 onwards, in El Salvador and other Central American countries the oil is marketed for edible purposes under the trade name "MANTECA VEGETAL NIEVE", (Manteca = butter; Vegetal = vegetable; Nieve = snow).

Non-edible uses of the oil: The oil and its derivatives are useful for making pharmaceuticals, surfactants, detergents, soaps, shampoos, cosmetics, plasticizers, stabilizers, lubricants, grease, emulsifiers, paints, varnishes, candles etc.

Beverages and jam from fruit pulp

The fruit pulp contains about 11% sugars. The pulp (about 8-10 tons/ha/year) can be used in the preparation of squash, beverage and jam, which are very well accepted because of their attractive natural color, flavour, and good taste. The fruits can be a source of natural colourant.

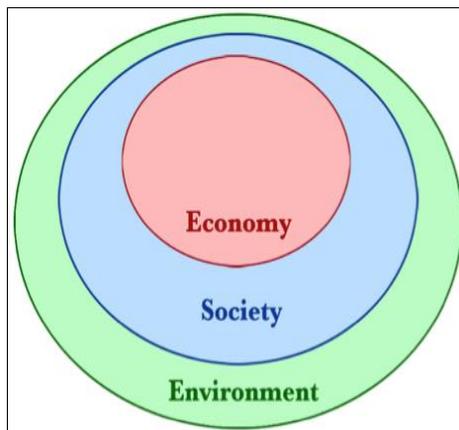
Fuel

The filtered crude oil can be used to blend with diesel @ 5-10%. The surplus oil produced can be subjected to transesterification to manufacture biodiesel, a 100% substitute for diesel. The oil-cake, fruit pulp, leaf litter, and unwanted wood can be used to generate biogas. The shell and waste wood can be used in thermal power generation.¹⁵

Timber: The main trunk of a ten-year old tree has 5 – 10 cubic feet of wood. The wood is light, attractively grained, moderately strong, generally less preferred by wood eating insects, light furniture, toys, packing material, pulp (for paper industry) and matches. Waste wood is good fuel.

Manure

The press cake is rich in nitrogen (7.7 - 8.1%), phosphorus (1.07%) and potash (1.24%). There are also traces of calcium, magnesium, and sodium. It is valuable organic manure. Leaf litter makes good manure, improving the fertility status of the soil. As earthworms relish it very much, it can be valuable in the manufacture of vermicompost. The addition of leaf litter also increases the organic carbon content of the soil.



Benefits of Simarouba Cultivation

Benefits to economy

At macroeconomics level, nations attain self-sufficiency in the production of edible, industrial oils, biofuels and timber on a long-term basis.

At microeconomics level farmers, owning the marginal and wastelands in semi-arid zones, start getting some income after five years of planting. They get a regular income from nutlets + from timber+ from vermicompost

Benefits to society

- Employment generation Simarouba cultivation generates on farm employment to crores of farmers especially rural women. The establishment of industries such as oil, biofuel, timber, etc. in the rural areas, generates agro-industry based off-farm employment in the villages and cultivation helps in the poverty alleviation of small and marginal farmers owning unproductive lands all over the tropical world.
- Infrastructure development

- Self-governance
- Self-sufficiency

Benefit to environment

This ecofriendly tree with well-developed root system and with evergreen dense canopy efficiently checks soil erosion, recharges groundwater, supports soil microbial life, and improves soil fertility. The addition of biomass to wasteland @ 10-15 tones/ha/year helps in the improvement of soil health and fertility in a natural course^[1].

- Lakshmi taru has a wide range of adaptability.
- It grows reasonably well in areas with more than 300 mm erratic rainfall and withstands
- Summer temperatures up to 48-50 °C.
- It can grow well in soils with 5.5-8.5 ph without any amendment.
- Its cultivation effectively combats desertification of wasteland.

- The cultivation of Lakshmi taru does not require excessive application of chemical fertilizers. It is a tree with no major pests and diseases and thus requires no pesticide application. Thus its cultivation does not add harmful agrochemicals to the environment.
- It evergreens the gray soil surface, harnesses abundantly available solar energy and converts it into biochemical energy all round the year.
- Simarouba checks overheating of the soil surface all through the year and particularly during summer.
- Large scale planting of simarouba in the marginal/wastelands utilizes harmful green house gases, checks their accumulation in the environment and helps enormously in reducing global warming ^[16].

Conclusion

While many scientific research groups attempts to synthesize one or more of simarouba's potent quassinoids for pharmaceutical use, the plant remains an important natural remedy in the herbal pharmacopeias of many tropical countries and in the rainforest potent plant remedies.

For a long-term strategy, cultivation of versatile tree Simarouba, Lakshmi taru is advocated in the abundantly available marginal/wastelands in arid and semi-arid tropics and its implementation shall be economically viable and ecologically sustainable.

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