Karanj (*Pongamia pinnata* Linn pierre) a promising plant of Jharkhand

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Abstract

Pongamia pinnata exhibits many pharmacological attributes. In traditional system of medicine various plant parts like leaves, stems, seeds and even whole parts are used for treatment. Traditionally the leaves, seeds and entire plant are used in the treatment of many diseases. Its uses includes Anti-ulcer, Ant-diarrheal, Anti-plasmodia, Anti-inflammatory, Anti-viral, Anti-bacterial, Anti-lice. This review encompasses the available literature *on Pongamia pinnata* with respect to its pharmacognostic characters, physicochemical parameters, synopsis of pharmacological activities and traditional uses. . Added to the problems of climate change leading to increasing temperatures, the world is facing the problems of soil deterioration due to pollution and mining activities. It is therefore necessary to come up with appropriate technologies involving tree species that are efficient in not only cutting down global warming and bring about perceptible levels of C sequestration; but also ameliorate the problem soils. *Pongamia pinnata* is one such species that is capable of carrying out the soil amelioration as well as enhancement of upper environment this attempt provides a direction towards further research.

Key words: *Pongamia pinnata* ,pharmacological C-sequestration

Introduction

Plants have been the basis for life, medicines and ecological balance through much of human history. Majority of world population relies on traditional medicines for primary healthcare, most of which involves use of locally available plants. In India all most 95% of the prescription are plant based in the traditional systems of Unani, Ayurveda, Homeopathy and Siddha [1].Modern medicine recognizes herbalism as a form of alternative medicine, as the practice of herbalism is not strictly based on evidence gathered using the scientific method. Modern medicine, does, however, make use of many plant-derived compounds as the basis for evidence-tested pharmaceutical drugs, and phytotherapy works to apply modern standards of effectiveness testing to herbs and medicines that are derived from natural sources. Ancient ethnic communities around the world have learnt to utilize their neighborhood herbal wealth for curative as well as offensive purposes [2]. Due to lake of literacy, their knowledge on plants developed often at the cost of their dear life through centuries old experience could be perfectly documented and it had rather descend from one generation to another as a domestic culture heritage [3]

Modern medicine facilities are now making a rapid penetration into the areas which have been centers of herbal use as medicines for ages as their tradition. Such activites may result in disappearance of traditional use and knowledge herbal wealth. It is therefore important (as bioethical mater) that the valuable knowledge from locally folklore, in particular, of the medicinal uses of locally available plants to treat different diseases be recorded [4].Many attempts have been made on inventarisation of medicinal plants currently being used for treatment of ailments in different parts of India such as Nayar [5] reported medicinal plants of Eastern Ghats, Nagaraju and Rao [6] enlisted medicinal plants of Tirumala Hills and the plants crude drug of Rayalaseema (A.P.). Similarly Jain et el. from Raipur [7], Kumar et al., from Bikaner [8], Bondya et al., and Chandra et al. from Ranchi [9,10] have studied on medicinal plants and their traditional uses. Jharkhand is a treasure of medicinal plants. People of Jharkhand literally (bushland) and symbolically are associated with forests. Various ethnic groups like Munda, Oraon, Ho, Santhal, Paharia etc. have symbiotic relations with forests. Topchanchi Wild Life Sanctuary is very rich in flora and fauna. It is situated on Parasnath hill at 18,625.99 hectare. The area is covered by forest and is 8,135.19 hectare. This area is very interior and naxal affected. Local people still thrives on local vaidyas as their primary treatment or ailments.

Koroch (*P. pinnata*) is the member of Leguminosae family and Papilionoideae, more specifically the Millettieae tribe [12]. It is an oil seed tree known for its versatile applications but still remain unexploited. It is medium-sized, drought resistant, fast-growing, nitrogen fixing leguminous tree or glabrous shrub (15–25 m tall). It has been delineated as briefly deciduous or evergreen with a broad canopy of drooping or spreading branching behavior [13]*Pongamia pinnata* Linn Pierre (Fabaceae) is a fast growing medium sized tree commonly called as kanuga in Telugu. This plant is native in tropical and temperature regions of Asia. All parts of the plant have been used as a crude drug for the treatment of tumours, piles, skin diseases, itches, abscess, wounds, ulcers, cleaning teeth, dermetopathi, vagainopathi, painful rheumatic joints.(14) Besides the meal can be used as animal fodder or composted, green manure, timber and fish poison. It has also been recognised to possess applications in the field of environment and agricultural management. The seed powder of the plant is given as expectorant in the treatment of bronchitis. An infusion of Pongamia leaves is used to relieve rheumatism. In the treatment of dyspepsia the *Pongamia* seed oil is given as stomachic and cholagogue.(15) By the process of trans-esterification the seed oil of Pongamia pinnata can be converted to biodiesel. The activities such as antidiarrhoeal, anti- plasmodium, anti-inflamatory, anti-ulcer, wound healing properties were reported . The literature survey on an elite medicinal plant *P. pinnata* showed that it is a potential medicinal plant. the isolation of two new β-hydroxy chalcones named ponganones I and II from the root bark of Pongamia pinnata; and the structures were characterized as 7-hydroxy-2',5'-dimethoxy-[6",6"-dimethyl pyrano(2",3": 4',3')] chalcone for ponganone I, and 7-hydroxy-2',5'-dimethoxy-3, 4-methylene dioxy-[6",6"-dimethyl pyrano (2",3": 4',3')] chalcone for ponganone II, respectively by means of spectroscopic analysis(16). Six compounds (two sterols, three sterol derivatives and one disaccharide) together with eight fatty acids (three saturated and five unsaturated) from the

seeds of Pongamia pinnata. heir structures were elucidated with the help of physico- chemical methods and spectroscopic techniques. (17) characterization of two new flavones glycosides from the seeds of Pongamia pinnata on the basis of chemical and spectral evidence. (18) Four compounds, karanjin, pongachromene, pongapin and demethoxykanugin, were characterized from the methanolic extract of its roots19 three new furanoflavonoid glycosides, pongamosides A- C, and new flavonoid glycoside, pongamoside D from fruits of Pongamia pinnata20. The structures of these compounds were established from the spectral data. isolated Karanjachromene21, C21H18O4, from the seed oil of Pongamia pinnata. Karanjachromene is a fluorescent pyranoflavonoid. Such compounds are reported to have many interesting pharmacological and industrial applications. They reported on its isolation in significant yield and X-ray crystal structure.(**22)** reported Biochemical characterization of primary metabolites such as sugar, starch, protein, lipid, phenol, ascorbic acid and amino acid which are present in different plant parts of Pongamia pinnata.(**23)**investigated on the production of biodiesel through transesterification of Karanja (Pongamia pinnata) oil was studied. The Karanja oil was treated with a lower alcohol (methanol) in the presence of a base catalyst (KOH) to yield methyl esters of fatty acids (biodiesel) and glycerin. The influences of reaction temperature, molar ratio of alcohol to oil, amount of catalyst and reaction time on the product yield were studied. The optimal combination of operating parameters for maximum yield was found out using Taguchi's method. The performance and emission tests were carried out in a four stroke single cylinder, Kirloskar AV1 D.I.Engine. Different blends of biodiesel with conventional diesel were tested. The results show an appreciable reduction in emission level and marginal increase in performance when compared with sole fuel. The results concluded that the biodiesel from Karanja oil can be used as an effective alternate in existing diesel engines without any engine hardware modifications. Traditionally, Koroch has been utilized in Indian sub-continent and neighboring countries as folk medicines, green manure, animal fodder, wood, and poison for fish and fuel [24,25]. It is also used in agriculture and management of environment as fungicide, insecticide, nematicide [26], and soil improver as it fixes atmospheric nitrogen [27]. *Pongamia* has bio-ameliorative capacity which adds nitrogen, phosphorous, potassium, and organic carbon to soil. It also improves the rural economic condition by engendering employment opportunities during different phases of cultivation and further processing.

Ecology Morphology and taxonomy

Jharkhand state is immensely rich in biological diversity and traditional knowledge with about 23,605 sq. km forest area, which is 29% of the total geographic area. It is also rich in ethno medicine and about 80%people live in rural are [10]. The population compromising various ethnic groups and indigenous mass making it hub of horopaths, Pahans, Vidhya and other having traditional knowledge about medicinal uses of various plants found in ambience. The current trend of life style is resulting in gradual loss of valuable indigenous therapeutic knowledge (Homeopathy) associated with ethnic culture in the area in particular 28].

Origin and geographical distribution

It was naturally distributed in Asia, now this is found in Australia, Florida, Hawaii, India, Malaysia, Oceania, Philippines and Seychelles. It was commonly grown in coastal forests over India and near the streams and rivers.

Ecology

The best growth is found in well drained sandy loams with assured moisture. It does not grow well on dry sands even though it tolerates salinity conditions, alkalinity and water locked soils. It will also grow on heavy swelling clay soils. These species have PH higher than7.5 They become nutrient deficient PropagationIn-situ germination is preferred for this seeds and time limit is within 1-5 weeks of sowing. Planting to the field should occur at the beginning of the next rainy season, when the seedlings are about 60 cms in height. As young plants tolerate shade well a spacing of 7.5x15cms is recommended. Natural reproduction is profuse by seed and commonly by root suckers. Spontaneous seedlings and root suckers may cause critical weed problems. This plant is ready to grow in the temperature of maximum 27-38°C to minimum of 1-16°C. The withstanding temperature of this plant is slightly below 0°C (32°F) and up to about 50°C.

Morphological characteristics

Millettia pinnata is a legume plant that grows to about 15-25 meters in height with large canopy. It has straight or curved trunk and its diameter is about 50-80 cms. Stem is light green in color with some irritating odor. It is herbaceous and slightly hard to break. It has smooth texture on its surface. The plant has a long, thick taproot and widely spreading lateral roots. The spread of roots on this species, about 9 meters in 18 years, is greater than most other species; moreover it produces root suckers profusely. Because of these characteristics, panama is unsuitable for agro-forestry and has the potential to become a weed if not managed carefully. Leaves are soft shiny reddish-purple when young and mature to a glossy. They are deep green as the season progresses with prominent veins underneath. Imparipinnate leaves of the tree alternate and are short stalked, rounded or cuneate at the base, ovate or oblong along the length.

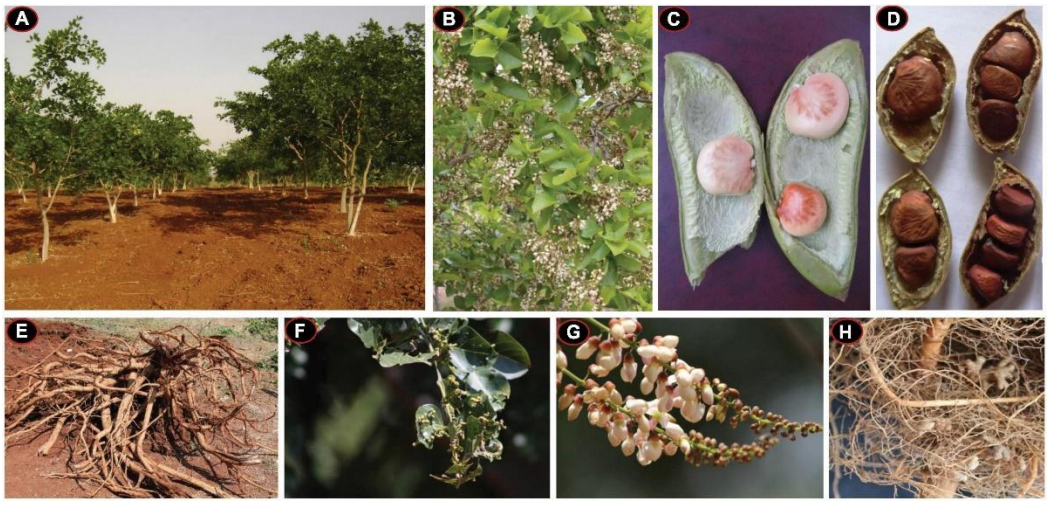

FIGURE 1. Morphological and phenological characteristics of a typical pongamia plant. **(A)** *Pongamia pinnata* plantation in an experimental farm. **(B)** Pongamia at a full-bloom stage. **(C)** An immature pod with a typical seed-arrangement pattern. **(D)** Mature pods bearing varied number of seeds. **(E)** Root biomass harvested. **(F)** Characteristic leaf buds of pongamia. **(G)** The Racemose type of inflorescence in pongamia. **(H)** Root nodules of pongamia. Flowers are generally with small clusters of white, purple and pink flowers blossoming throughout the year. The raceme like inflorescence bears 2 to 4 flowers which are strongly fragrant and grow to be 15 -18 mm long. Flowering generally starts after 3- Calyx

These are bell shaped and truncate. Corolla is rounded ovate shape with basal auricles with a central spot of green colour.Seeds are about 1.5-2.5 centimeters long with a brittle, oily coat and are unpalatable to herbivores. Brown seed pods appear immediately after flowering and mature in 10-11 months. The pods are thick-walled, smooth, somewhat flattened and elliptical, but slightly curved with a short, curved point. Pod production commences when seedlings are 5-7 years old. The pods generally do not open naturally, and must decay before the seeds can germinate.29

Taxonomy and classificatio Kingdom : Plantae

Order : Fabales Family : Fabaceae

Genus : Pongamia (Millettia Species : Pinnata

Binomial name : *Pongamia pinnata* Linn pierre

Pongamia pinnata (L.) Pierre was transferred to the genus *Millettia* in 1989 based on morphological traits (Geesink, 1984), and supported later by a genetic study (Acharya et al., 2004). However, molecular phylogenetic studies have since shown that *Pongamia* is monophyletic and *Millettia* polyphyletic (Hu et al., 2000)

Potentials' of the *Pongamia pinnata*

Medicinal Value

Used to treat bleeding hemorrhoids, or pilesExtracts used to lower or relieve fever and to sedate the central nervous systemAid treatment of abdominal tumors, female genital tract infections, ulcers, and hemorrhoids Extracts can be used to heal scar tissue tumors, treat high blood pressure, and treat anemia Powder reduces fever and helps in treating bronchitis and whooping cough.30 Used as an astringent and to kill parasitic worms .Helpful in treating whooping cough, piles, liver pain, chronic fever, ulcers, and leprosy Relieves sore joints and muscles and arthritis Used to treat eczema and other skin irritations when mixed with zinc oxide Whole leaves used as a digestive and laxative and to treat inflammation and wounds Leaf juice aids in treatment of leprosy, gonorrhea, diarrhea, flatulence, coughs, and colds Leaf infusions and extracts alleviate rheumatism and itches, respectively. Relieves coughs and colds, reduces spleen inflammation, and mental disorder Useful for treatment of bleeding piles(26)

Anti-oxidant property

The antioxidant property may be due to the presence of flavonoids and polyphenol in the extract. Antioxidant property have been observed that effect of Pongamia leaf extract on circulatory lipid peroxidation, antioxidant status was evaluated in ammonium chloride – induced hyperammonium rats enhanced lipid peroxidation in the circulatory ammonium chloride –treated rats was accounted by a significant decrease in the levels of vitamin-C, vitamin-E reduced glutathione peroxidase, superoxide dismutacatalase. It showed that PPEt modulates by reversing the oxidant – anti oxidant imbalance during chloride-induced hyperammonemia and this could be due to its anti hyperammonemia effect by means of detoxifying excess ammonia, urea and creatinine and antioxidant property(31,15.)

Antiviral activity

The crude aqueous seed extract showed antiviral activity. It completely inhibited growth of herpes simplex virus type1(HSV-1) and (HSV-2) at the concentration of 1 and 20 mg /ml (w/v) respectively and showed complete absence of cytopathic effect. The crude dried leaves extract showed no activity against rota virus.(12)

Antidiarrhoeal Activity

This activity was determined by evaluating antimicrobial effect of crude decoction of dried leaves of *Pongamia pinnata*. It also evaluated for its effect on production and action of Enterococcus (cholera toxin, Escherichia coli labile toxin, stable toxin) and adherence of enteropathogenic *E.coli* and invasion of enteroinvasive *E.coli* and *Shigella flex* epithelial cells. This study concludes that decoction of *Pongamia pinnata* had selective anti-diarrhoeal action with against cholera and entero invasive bacterial causing bloody diarrhoeal episode (10)

Anti-Inflammatory activity

It has been reported that the 70% ethanolic leaf extract of *P. pinnata* possess potent anti-inflammatory activity against different phases (acute, sub-acute and chronic) of inflammation without side effect on gastric mucosa. It also showed significant anti pyretic action of the extract against brewer's yeast-induced pyrexia.(15)

Anti-Ulcer activity

The methanolic extract of roots of *P. pinnata* reported for significant protection against mucosal damage induced by aspirin and has a tendency to decrease acetic- acid induced ulcer after 10-days treatment. The extract showed ulcer protective effect with cessation of mucosal defensive factors like mucin secretion, life span of mucosal cells, mucosal cell glycoproteins, cell proliferation and prevention of lipid peroxidatioPhytochemistry of P. pinnata(25)

Phytochemicals of Pongamia

The chemical composition including major fatty acids of P. pinnata oil such as palmitic acid, stearic acid, linoleic acid, and eicosenoic acid indicate this oil could be good source for

biodiesel feedstock (34)Some alkaloids such as demethoxy, gamaty, glabin, glabro saponin, kaempferol, kanjone, kanugin, karangin, neuroglobin, pinnatin, pongamol, pongapin, quercetin, saponin, b-sitosterol, and tannin were reported to found in P. pinnata. 31.0% charcoal, 36.69% pyroligneous acid, 4.3% acid, 3.4% ester, 1.9% acetone, 1.1% methanol, 9.0% tar, 4.4% pitches and losses, and 0.12m3/kg gas were found by destructive distillation of the wood (dry weight basis).

Ecological importance

Pongamia pinnata (Karanj) is one such species that is capable of carrying out the soil amelioration as well as enhancement of upper environment.

Pongamia (Karanj) as Carbon Sequestrator: The Carbon sequestration potential of Pongamia pinnata (Karanj) during the 10 to 15 years of its growth was found to be many folds higher than that of several other tree species. Pongamia was found to sequester around 45 to 50 kg of C per tree per annum as against 28 to 35 kg of Neem (Azadirachta indica), 23 to 26kg of Mahua (Madhuca latifolia) and 11 to 15 kg in respect of Tendu (Diospyros)(32)

Phytoremediation

Pongamia (Karanj) based phytoremediation is nondestructive, in-situ technology, which employs establishment of elite Pongamia saplings (known to be hyper accumulators) forming a vegetative cover to bring about soil amelioration through the inherent mechanisms of Phyto-stabilization & Phyto-extraction for toxic or mine spoils.(32)

Nitrogen fixation and nodulation

P. pinnata has the quality to fix atmospheric nitrogen. The nodulation of most legumes occurs effectively with one or few specific species of Rhizobia. However, nodulation process of Pongamia has been found to be quite promiscuous, which make symbiosis with different species of both Bradyrhizobium and Rhizobium (31) (33)

Bio-pesticide

Oil extracted from seeds of Pongamia used in agriculture as it functions against the insect pests. The main active ingredient of Pongamia oil is Karanjin which used as acaricide and insecticide. Karanjin also possess nitrification inhibitory properties. Application of the insecticide based on Pongamia oil causes high larval mortality of Plutella xylostella and significantly reduces the damage caused by feeding to crops. The product formulation based on the combination of P. pinnata and Thymus vulgaris or Foeniculum vulgare essential oils can be recommended against Plutella xylostella larvae for protection of cabbage crops [34]. Mechanical extraction of Pongamia seeds produces oil seeds cakes as byproducts.(35)

Besides above discussed uses different part or as whole Pongamia also be used for shade and shelter, controlling soil erosion, soil reclamation, fish poison, apiculture, fiber, tannin or dyestuff, and ornamentals.

Current status and future prospects and challenges

Pongamia is versatile plant, and it is more valued for its biodiesel properties but its production is not satisfactory level. In Jharkhand commercial cultivation and production of biodiesel and bio-ethanol from P. pinnata has not started yet [16]. Pongamia and other fuel crops are not planted commercially, and no mass plantation program has been taken yet. Pongamia is planted in dumped coal mining areas of Dhanbad ,Ramgharh,Hazaribagh district of Jharkhand for soil reclamation and to control soil erosion. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Andhra Prdesh, India is supporting innovative research on the Pongamia "journey from Forest to Micro-enterprise" to ameliorate rural Leflore and empowerment. The purpose of this organization is to exonerate the degraded lands and conserve the environments, to assess and elevate sustainable crop management practices and to assess the enhancement of income of self-helped groups by planting Pongamia. There is also another target to value addition of its byproducts after extraction of oil. There is about 28 institution in India, and they are working for undertaking joint research on some issues such as marking of prime planting materials, seed resource assessment, collection and storage, phonological and chemical analysis for characterization, improvement of trees to get quality and reliable seed source, multi-location trials of superior planting materials, and agro-forestry models for evolving good intercropping system f tree borne oilseeds

Conclusion

In traditional system of Ayurvedic medicine *Pongamia pinnata* has been widely used as curative agents for variety of ailments. In the traditional systems of medicines, such as Ayurveda and Unani, the plant is used for anti-inflammatory, anti-plasmodial, anti-nociceptive, anti-hyperglycaemic, antilipidperoxidative, anti- diarrhoeal, anti-ulcer, antihyperammonic, anti- oxidant and antibacterial. The extensive literature survey revealed that *Pongamia Pinnata* L. is an important versatile medicinal plant with diverse pharmacological spectrum. *Pongamia* is an underutilized species but it has great potential for use in production of biodiesel and in pharmaceuticals. Furthermore, wasteland can be effectively used for cultivation and subsequent agronomic or silvicultural practices and also helps in bucolic development and poverty alleviation through development of employment opportunities. To increase the production of *Pongamia* standardization of the vegetative propagation techniques, large-scale production of genetically superior saplings throughout the year, appropriate planting models for different agro-ecological zones and land uses and post planting care are of prime importance. The plant shows the presence of many chemical constituents which are responsible for varied pharmacological and medicinal properties. However, evaluation needs to be carried out on *Pongamia Pinnata* L. in order to explore the concealed areas and their practical clinical applications, which can be used for the welfare of the mankind.

Thus, the future success of *Pongamia* as a sustainable source of feedstock for the biofuel industry is dependent on an extensive knowledge of the genetics, physiology, and propagation of this legume. Moreover, research activities should be targeted to ameliorate the physic-chemical properties and plant growth as it relates to oil biosynthesis

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