

Parkia roxburghii, as an important vegetable and medicinal plant

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Abstract

Parkia roxburghii is a medium-sized erect rainforest tree. It is an underutilized leguminous medicinal plant and also used as an important vegetable in some regions belonging to the family Fabaceae. It is commonly found growing abundantly in the North-eastern regions of India. It is distributed in Southeast Asian countries like Thailand, Bangladesh, Burma and the Malaysian region. It is commonly found growing in every house yard, jhums and forests. *Parkia roxburghii* is an important tree having multidimensional applications, commercial and ecological significance. The flowers, young as well as mature pods, and seeds of this tree are all edible and are all important vegetables. *Parkia roxburghii* is very beneficial for human health. They are a good source of proteins, fats, carbohydrates and minerals and have low fat content with high fiber content. They have antioxidant, antimicrobial, antidiabetic, and anti-proliferative activity, etc. *Parkia roxburghii* has several therapeutic properties and are being utilized for treating various ailments.

Key words: *Parkia roxburghii*, multipurpose tree, nutrition, medicinal property, income.

Introduction

Plants contain several valuable bioactive compounds such as flavors, fragrance, lipids, and phytochemicals, and they have been utilized in pharmaceutical, cosmetics as well as food industries. Due to the presence of these bioactive compounds, the traditional plants are being used in traditional medicines. The bioactive compounds may have great potential of antioxidant, anticancer, antimicrobial, and anti-inflammatory. *Parkia roxburghii* G. Don. (syn. *Parkia javanica* Merr.) syn *Parkia timoriana* of the family Fabaceae/Mimosaceae is an important nutritious leguminous tree. *Parkia roxburghii* is commonly called tree bean. It is an underutilized medicinal plant, a medium-sized unarmed tree. It is found throughout Southeast Asia and North-eastern India (Sahoo, 2013). It is abundantly found in North-eastern region of India which is found growing in wild and cultivated, in jhum land, home gardens and along the marginal land on the road side. *Parkia roxburghii* is popularly consumed in the North-eastern states Manipur and Mizoram of India. It is well known for the high nutritional, ethnomedicinal and ethnobotanical significance. *Parkia roxburghii* has multipurpose importance with great economic significance. It is being used as nutritious vegetables, traditional medicines and firewood. It has great ecological significance also (Rathi et al., 2012). *Parkia roxburghii* is found growing in many conditions varying from cold hilly regions up to foothill regions which are warmer without considering any special care (Thangjam, 2016).

Fruits and bark of *Parkia roxburghii* are being used for treating several ailments. *Parkia roxburghii* is rich source of minerals, protein, essential amino acids, oleic acids, linoleic acids, and fatty acids (Mohan and Janardhanan, 1993). It may also be a source of several other supplements and nutrients. *Parkia roxburghii* has good antioxidant potential. Numerous phytochemical compounds are present that have important role in anti-aging, antibacterial and anticancer activities (Ruthiran and Selvaraj, 2017). Studies on nutrition, ethnomedicinal, pharmacological applications and mass production have been reported (Ralte et al., 2022) investigated the identification of phytochemical compounds of the capitulum, pod, flower and seed methanolic extracts of *Parkia roxburghii* by the application of FTIR and GCMS. Bioactive compounds from *Parkia roxburghii* were isolated and evaluated for their neuroprotective potential against mice where dementia is induced by Scopolamine hydrobromide (Heba et al., 2021).

Plant Distribution and Description

Parkia roxburghii is an underutilized medicinal plant, medium-sized rainforest tree which is also used an important vegetable in some regions. It belongs to the genus 'Parkia' and in the Fabaceae family which is commonly found growing abundantly in the North-eastern regions of India. It is a leguminous tree distributed in Southeast Asian countries like Thailand, Bangladesh, Burma and the Malaysian region (Angami et al., 2017). This tree is distributed in tropical and subtropical zones with an altitudinal variation from 40 to 820 m a.s.l. (Robert et al., 2003). It is abundantly found in North-eastern region of India which is found growing in wild and cultivated, in jhum land, home gardens and along the marginal land on the road side. It is commonly found growing in the Northeast states in India such as Nagaland, Mizoram, Assam, Manipur and Meghalaya (Kanjilal et al., 1938). The tree is well adapted to grow in diverse agro-climatic regions from colder hilly regions to hotter plains without any special care (Thangjam, 2014).

Parkia roxburghii is commonly known as Tree bean. It is known as 'yong-chak' in Manipuri. *Parkia timoriana* have spreading branches with brown or light grey color bark with white spots (Angami et al., 2017). It is an erect tree. Inflorescence type of *Parkia roxburghii* is head or capitulum of racemose type bearing with clusters of numerous yellowish-white tiny flowers. It hangs at the top of long stalk from the branches. The long stalk is with a length 30-45 cm and a width of 2-6 cm and has a leathery texture (Chhikara et al., 2018). Head comes out during June-July and flowering starts by last week of July. The majority of the flowers from the fades and drops off. Afterwards clusters of twisted long pods arise from the heads. The fruit is bright green colour, it is an oblong pod with 35-55 cm length and 3- 5 cm width (Chhikara et al., 2018) which contains 10-18 seeds. There is variation in the size and number of seeds, depending on the pod's shape and size. Seeds are 2-3 cm in length and 1 to 2 cm in width, at maturity the seeds become rounded oval shape (Chhikara et al., 2018). The fruits mature during March - April. Mature pods become black and the pulp turn yellowish dry powder and, in this pulp, black seeds are embedded (Longvah and Deosthale, 1998). *Parkia roxburghii* is commonly propagated by their seeds. They are also propagated by stem cutting and budding. In vitro induction of callus and somatic embryogenesis of *Parkia roxburghii* G. Don. have been achieved (Ahmed et al., 2014; Thangjam and Maibam, 2006).

Importance of *Parkia roxburghii*

Parkia roxburghii is an important tree having multidimensional applications. *Parkia roxburghii* is an important multipurpose leguminous tree having commercial and ecological significance (Angami et al., 2017). The flowers, young as well as mature pods, and seeds of this tree are all edible. They are a good source of proteins, fats carbohydrates and minerals as well (Saha et al., 2007; Seal, 2011). It has low fats content ranging from 1.0 % in tender pod to 33.5 % in matured kernel and high fiber content which shows that *Parkia roxburghii* is very beneficial for health (Roy et al., 2016).

The flowers, young as well as mature pods, and seeds are all vegetable items. And the leaves are used as green vegetable by the Meitei communities in Assam and grown in almost all their home gardens (Devi and Das, 2010). From these vegetable items, different type of dishes is prepared and consumed. In Manipur, flowers, young as well as mature pods, and seeds are taken raw and used in the preparation of "Singju" which is typical salad. Pods and seeds are used in the preparation of different Manipuri dishes such as Kangshu, Eromba, fried and even in other vegetables or meat curry and used in the preparation of pickles as well. Sundried pods and seeds are used during off seasons. The species is also used in different states and various tribes in India and elsewhere. In Manipur, the skin of the fruit of *Parkia roxburghii* is being used for of dyeing cloths and other items (Angami et al., 2017). Fruit skin is used as adhesive for different dye in Mizoram (Akimpou et al., 2005).

Parkia roxburghii is one among the costly vegetable with a premium prize. It is being used in various traditional medicine for treating several. The pods of *Parkia roxburghii* are available in the market from October-November until March-April every year. The consumption of *Parkia roxburghii* starts from flowers, tender and young pods which is light green color until the mature pods is filled with mature seeds. It is consumed raw, fresh, cooked and even sundried in off seasons. *Parkia roxburghii* is a multifunctional crop. It is a valuable tree which can be an income generator both for the users and growers.

Parkia roxburghii has reported to have good nutritional values. The green pods are reported to be a good source of energy and protein (Rocky et al., 2004). The tender pods contain higher minerals namely sodium, calcium, potassium and phosphorous whereas the mature pods are reported with higher amount of manganese, magnesium, iron and copper. The mineral contents of the different parts of pods were reported and found to be

highest in pulp followed by testa and the least in cotyledon (Salam et al., 2009). Protein content of pods ranged from 12.1% in tender to 18.8% in mature pods (Longvah and Deosthale, 1998). Fat content in seeds was found to be more in older pods than the young tender pods (Salam, 2011).

Seeds of *Parkia roxburghii* are reported to contain rich in protein namely globulins and albumins and globulins, minerals such as manganese, potassium, phosphorus, magnesium, iron, and zinc, essential amino acids such as tyrosine, phenylalanine, leucine, and isoleucine) and fatty acids like linoleic and oleic acids (Mohan and Janardhanan, 1993). The protein fractionation of the seeds showed that the seeds have lower globulin to albumin ratio, this showed better protein digestibility and good nutritional value (Salam et al., 2009). *Parkia roxburghii* acts as a good source of ascorbic acid with 26.0 mg 100 per gm, fat with 20.28 %, proteins with 32.82% and minerals reported with 4.45% (Salam et al., 2009).

The quality of the proteins presence in the mature seed is of high quality (Longvah and Deosthale, 1998). Roy et al., (2016) investigated the chemical compositions of mature kernel comparing with young and tender, immature and mature pod. Their result obtained that mature kernel contained the highest moisture percentage with 10 percent, fat with 33.5 percent, and protein with 28.8 percent when compared to young and tender, immature and mature pod. In mature kernel, they obtained the energy value of 505 kcal, 13.3 mg per 100g of iron, 5.6 mg per 100 g of zinc, 2.9 mg per 100 g of manganese and chromium of 7.9 µg per 100 gm when compared to young and tender, immature and mature pod. However, the young and tender pod was observed to contain higher carbohydrates and fiber content (Roy et al., 2016). Crude protein was found to be higher in seed, 22.9% than leaf and pods, whereas pods was found to contain higher total carbohydrate, 23.2% (Devi et al., 2007). Carbohydrate content was found to be ranged from 59.26 to 67.82% in different stages of pods (Salam, 2011). Carbohydrate content increases with the increase in the maturity of pods (Geervani and Devi, 2006). Crude fibre content was observed to be 10.16% in young tender pods, 19.28 % in matured pods and fibre content of seeds was 9.03% (Salam, 2011).

Traditional Medicinal Uses

Parkia roxburghii is being used in treating different ailments. Almost all the parts of *Parkia roxburghii* are being applied in different traditional medicines. The plant parts are being utilized for treating various ailments in the form of paste, decoction and juice. Almost all the plant parts, the bark, peel or skin of pod, leaf, and seeds are used in traditional medicine. Paste of the bark is used as a plaster in the treatment of treat eczema (Rathi et al., 2012). *Parkia roxburghii* has been used to cure different health problems such as gynaecological diseases and hemiplegia (Heba et al., 2021). *Parkia roxburghii* fruits are used by the local people of Ghana for treating hypertension and leprosy (Badu et al., 2012). The leaves and roots are used in Gambia in the preparation of a lotion which is used to curing sore eyes (Ajaiyeoba, 2002) and bark decoction is used in bathing for relieving from fever, used as hot mouthwash to get relief from toothache, bark pulp is consumed orally with lemon for healing wound and ulcer (, 1961). Tribes of Malaysia used pods of *Parkia roxburghii* for treating headache, kidney problems, diabetes, urinary tract problems, and hypertension (Samuel et al., 2010; Ong et al., 2011).

Tribes of Northeast India pods as vegetables, seeds and tender pods are consumed orally to treat stomach and liver disorders, pods pounded in water is used for washing head and face, bark and leaves are used lotion preparation which is utilized for the treatment of skin diseases and ulcer (Bhuyan, 1996; Paul et al., 2016). Local people and ethnic communities of Mizoram, India utilized fruit paste in healing wounds and scabies, fruit and juvenile shoots are taken for treating diarrhoea, dysentery and to get relief from food poisoning (Bhardwaj and Gakhar, 2005).

In Manipur, India pods are used in bleeding piles and bark extract is given in diarrhoea and dysentery. Traditional healers of Manipur used tender pods and bark for intestinal disorders (Khumbongmayum et al., 2005). Meitei communities in Manipur utilized bark decoction for the treatment of diabetes (Devi, 2011). Many reports on the various biological activities on *Parkia roxburghii* have been reported. It has potential as aglucosidase, a-amylase inhibitory, antibacterial, antiproliferative, insecticidal, antidiabetic, and antioxidant candidate (Angami et al., 2017).

Phytochemical Constituents

Plants have valuable bioactive compounds which have great pharmaceutical potential. The study of using bioactive compounds derived from medicinal plants is important. Approximately 80 % of the world's population utilize medicinal plants because of their low cost, non-narcotic origin, high efficacy and have lesser side effects

(Ahmad et al., 2001). *Parkia roxburghii* is one of the important ethnobotanically plants. It has good medicinal and nutritional values. Few reports are available on the isolated phytochemical compounds of *Parkia roxburghii* and their constituents with their pharmacological activities.

Bioactive compounds such as terpenoids, saponins, polyphenols and flavonoids, tannins, alkaloids, steroids, and phytosterol were present in *Parkia roxburghii* (Chhikara et al., 2018). Phytochemical constituents of the pods of *Parkia roxburghii* were studied and good amount of saponins, flavonoids, tannins, anthocyanins and leucoanthocyanins are reported (Salam et al., 2009). Flavonoid compounds showed anti-diabetic, anti-inflammatory, antimicrobial, antihypertensive, antioxidant, antiulcer, antitumor, and antiallergic properties, etc (Zaini and Mustafa, 2017). Presence of anti-nutritional factors, tannins, lectins and total free phenols and L-DOPA (a non-protein amino acid) was also recorded to present at a very low quantity in *Parkia roxburghii* when compared to other leguminous crops like *Mucuna* were reported (Mohan and Janardhanan, 1993). Extermination of the anti-nutritional factors from seeds can be done by the proper processing of seeds which may be by heating or cooking (Angami et al., 2017).

Ralte et al., (2022) studied and reported the phytochemical constituents, antioxidant assay, phosphomolybdate assay for assessing the quantitative total antioxidant capacity, antibacterial activity from the methanolic plant extracts of the edible parts such as capitulum, flower, pod and seed of *Parkia roxburghii*. Phytochemicals like alkaloids, tannins, flavonoids, phenol, and terpenoids were found to present in *Parkia roxburghii*. They reported that pod contains the highest total flavonoid content with the value of 58.38 ± 0.001 mg per g and the least by the flower 28.95 ± 0.002 mg/g. The pod extract contains the highest total phenol content with a value of $38. \pm 0.136$ mg/g and the flower contain the lowest total phenol content 18.7 ± 0.161 mg per g. Methanolic and acetone extracts of pods were reported to contain flavonoid and good amount of total phenolic content (Tapan, 2011).

Capitulum, flower, pod and seed of *Parkia timoriana/ Parkia roxburghii* extracts were used for the analysis of the functional groups and bioactive compounds by using FTIR (Fourier transform infrared spectroscopy) and GC-MS (Gas chromatography-mass spectrometry) (Ralte et al., 2022). The result showed characteristic peaks of carboxylic acids, phenols, glycogen, alkenes, halogen, alkyl halides, aliphatic amines, primary and secondary amines, aromatics, lipids, triglycerides, ether, esters, nitro compounds (Ralte et al., 2022). GC-MS analysis of the *Parkia roxburghii* extracts observed the presence of forty-nine bioactive compounds which are known to have several pharmacological activities and *in silico* molecular docking analysis predicted that the identified compounds may be potential anticancer and anti-inflammatory candidates.

Ethyl acetate fraction of *P. timoriana* pods was taken and two bioactive molecules namely hyperin and epigallocatechin gallate were isolated (Sheikh et al., 2016). Ursolic acid and b-sitosterol, Javanicoside A and Javanicoside B, Javanicoside A pentaacetate and Javanicoside B hexaacetate were obtained from leaf and stem bark methanolic extract of *Parkia timoriana* (Dinda et al. 2009). From the seeds of *Parkia timoriana*, novel mannose/glucose specific lectins were obtained by Kaur et al., (2005). Heba et al., (2021) used reversed phase high performance liquid chromatography (RP-HPLC) an isolated biomolecules namely biochanin A, quercetin, and catechin from the methanol leaf extract *Parkia roxburghii*. *Parkia roxburghii* has pungent smell. This is due to the presence of a cyclic sulphur containing amino acid namely thioproline (Suvachittanoni et al., 1996). Thioproline may be an anticancer agent (Kaur et al., 2005).

Biological Activity

There are several reports available on the biological activities such as antioxidant, antimicrobial, antidiabetic, and anti-proliferative activity, etc. Ralte et al., (2022) studied the antioxidant activity of methanolic extract of *Parkia roxburghii* and they observed significant antioxidant activity as was showed by DPPH and ABTS methods and Phosphomolybdate scavenging activity assay. Methanolic extract of *Parkia roxburghii* showed significant antibacterial activity against *Bacillus pumilus*, *Bacillus subtilis*, *Escherichia coli* and *Pseudomonas aeruginosa* (Ralte et al., 2022). Acetone extract of pods showed high radical scavenging property (Tapan, 2011). *Parkia roxburghii* extract was reported to have good antioxidant activity, 49.39 mg GAE per gram (Tapan, 2011) 36.59 ± 3.80 mg GAE per g (Ruthiran and Selvaraj, 2017). The reducing power assays of the methanolic fruit extracts using DPPH was found to be from 160.44 ± 2.26 to 157.31 ± 1.90 mg per gram (Badu et al., 2012).

Parkia roxburghii extracts were obtained to possess antimicrobial activity. The leaf extract of *Parkia roxburghii* showed significant activity against pathogenic bacteria namely *E. coli*, *Vibrio cholerae*, *Staphylococcus aureus*

and *B. cereus* (Zuhud et al., 2001). *Parkia roxburghii* extracts showed inhibition of the growth of *Streptococcus fecalis* and *Bacillus cereus* (Thongbam et al., 2012). Seed extract showed significant effect against some pathogenic bacteria (Devi et al., 2007). Gold and silver nanoparticles prepared from dried leaves of *Parkia roxburghii* were observed to show significant inhibition against *Staphylococcus aureus* (Paul et al., 2016).

Anti-proliferative activity of the biomolecules isolated from *Parkia roxburghii* was reported.

Lectins were isolated from the seed extracts of *Parkia roxburghii*. The isolated lectins from the seed extracts inhibited the proliferation of cancerous macrophage cell lines, P388DI and J774 (Kaur et al., 2005). Albumins and globulins were reported to be isolated from the raw seeds of *Parkia roxburghii*. The isolated albumins and globulins from the raw seeds were observed to have haemagglutinating activity without any specificity against human ABO system (Mohan and Janardhanan, 1993). Biochanin A, quercetin, and catechin were isolated from the methanol leaf extract *Parkia roxburghii* (Heba et al., 2021). The bioactive compounds isolated were investigated individually and/or in combination for the inhibitory effects on scopolamine-induced memory impairments in mice. They suggested that the biomolecules isolated from *Parkia roxburghii* may be utilized as effective therapeutic candidate for treating Alzheimer's disease (AD) in humans (Heba et al., 2021).

Conclusion

Parkia roxburghii is an important leguminous medicinal plant. *Parkia roxburghii* is one among the costly vegetable with a premium prize. It is being used as nutritious vegetables, traditional medicines and firewood and has great ecological significance also. The proteins presence in the mature seed is of high quality. Valuable bioactive constituents such as polyphenols, flavonoids, tannins, anthocyanins and leuco-anthocyanins are found to be present in *Parkia roxburghii* and they possess antioxidant, antimicrobial, antidiabetic, and anti-proliferative activity, etc. It is an important medicinal plant also and has been used in treating different ailments. Further, many more studies are needed on its phytochemical constituents which may lead to the discovery of many medicinal applications.

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