Review Article

An Appraisal on Supreme Pharmacological and Minutest Ecological Prospective of *Acacia nilotica* (L.) Del.

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Abstract

Indian gum Arabic tree *Acacia nilotica* is a drought resistant multipurpose legume with wide range of pharmacological potential including antimicrobial, antibiotic, anti-malarial, anti-diarrheal, anti-oxidant, spasmogenic, antispasmodial and molluscicidal activity. The wide range of pharmacological properties are because of the phyto-chemical constituents of the plant parts bark, leaves, pods, roots and seeds. Chemical constituents including amines, alkaloids, cyanogenic glycosides, cyclitols, fatty acids, fluoro-acetate, non-protein amino acids, terpenes, hydrolyzable tannins, flavonoids and condensed tannins which are responsible for the supreme level of the pharmacological application of the plant species. In addition the plants portions provide supplementary ecological benefits including nitrogen fixation, pest control.

***Keywords*:** Legume, *Acacia nilotica,* phytochemicals, nitrogen fixation, pest Control

Introduction

Acacia nilotica (L.) Willd. ex Del commonly known as babul, kikar or Indian gum Arabic tree, has been recognized worldwide as a multipurpose tree (National Academy of Sciences 1983). *Acacia nilotica* grows best on cracking clay soils that have high water holding capacity, but can also grow on sandy soil in areas of higher rainfall. It grows best around waterways and on seasonally inundated floodplains receiving 350–1500 mm of annual rainfall.

Presently about 20% of the total geographical area of India is wasteland. Growing demand for fuel, fodder, wood and food has extensively depleted or eliminated protective plant cover and exposed soils to processes of degradation resulting in partial to complete loss of soil productivity. Since nitrogen is generally deficient in such lands, there is a great need for the identification of suitable nitrogen fixing plants; those can thrive well during the process of stabilization and recovery of degraded sites. In such conditions *A. nilotica* can play an important role. It is a relatively fast growing, drought resistant multipurpose legume with the ability of biological nitrogen fixation. In addition, its strong tap root system (Toky and Bisht, 1992), long growing period of more than 300 days and four peaks of leaf flush (Beniwal et al., 1992), it can intensively exploit soil column for nutrients and moisture. This species has high potential for nitrogen fixation (Toky et al., 1994), and has been considered as one of the fast growing species of the wastelands, and agro forestry systems throughout India providing strong timber, fodder for goats and sheep, and high quality fuel wood apart from enriching the soil with nitrogen.

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Description of *Acacia nilotica*

Acacia nilotica (family Leguminosae, subfamily Mimosoideae) grows to 15-18 m in height and 2-3 m in diameter. The bark is generally slaty green in young trees or nearly black in mature trees with deep longitudinal fissures exposing the inner grey-pinkish slash, exuding a reddish low quality gum. The leaves are bipinnate, pinnae 3-10 pairs, 1.3- 3.8 cm long, leaflets 10-20 pairs, and 2-5mm long. Thin, straight, light grey spines present in axillary pairs, usually 3-12 pairs, 5-7.5 cm long in young trees, and mature trees commonly without thorns. Flowers in globulous heads, 1.2-1.5 cm in diameter of a bright golden yellow colour, born either axillary or whorly on peduncles 2-3 cm long located at the end of branches. Pods 7-15 cm long, green and tomentose when immature and greenish black when mature, indehiscent, deeply constricted between

the seed giving a necklace appearance. Seeds 8-12 per pod, compressed, ovoid, dark brown shining with hard testa. Growth pattern *A. nilotica* germinates following rainfall in the wet season. Although 95% of seed become dead after two years, some seeds may still germinate up to 15 years after seed drop. Germination is aided when seeds are disturbed, e.g. by fire or by passing through the digestive system of animals. Seedlings grow rapidly near water but more slowly in open grasslands. Trees can flower and fruit two to three years after germination, and more quickly after high rainfall years. It flowers between March and June, with pods forming between July and December. Most leaf fall corresponds to this dry period between June and November. Seedpods drop from October to January (Bargali and Bargali, 2009).

Distribution

In its native environment prickly acacia is found in the tropics and subtropics of Africa (Ethiopia, Somalia) through to Pakistan, India and Burma. *A. nilotica* is naturally widespread in the drier areas of Africa, from Senegal to Egypt and down to South Africa, and in Asia from Arabia eastward to India, Burma and Sri Lanka. The largest tracts are found in Sind. It is distributed throughout the greater part of India in forest areas, roadsides, farmlands, tank foreshores, agricultural fields, village grazing lands, wastelands, bunds, along the national highways and railway lines. Mostly it occurs as an isolated tree and rarely found in patches to a limited extent in forests. It has been widely planted on farms throughout the plains of the Indian subcontinent. It is a species of Southern Tropical dry deciduous forests and Southern Tropical thorn forests as distinguished by Champion and Seth (1968). There is some evidence that *A. nilotica* is a weed in its native habitat e.g. South Africa (Holm et al., 1979), but in other areas it is planted for forestry or reclamation of degraded land (Puri and Kybri, 1975, Shetty 1977).

Chemical constituents

Acacia species contains secondary metabolites including amines and alkaloids, cyanogenic glycosides, cyclitols, fatty acids and seed oils, fluoro-acetate, gums, non-protein amino acids, terpenes, hydrolyzable tannins, flavonoids and condensed tannins (Abdulrazak and Orskov, 2000). The plant is richer source of cystine, methionine, threonine, lysine, tryptophan, Potassium, phosphorus, magnesium, iron and manganese (Singh et al., 2008). The plant chemical compounds like diester, pentacosane dioic acid dihexadecyl ester and is alcohol, heptacosane 1, 2, 3-triol (Banso, 2009). The mature seed contains crude protein, crude fibre, crude fat, carbohydrates, potassium, phosphorus, magnesium, iron and manganese occurred in high concentrations and it is richer source of cystine, methionine, threonine, lysine and tryptophan. Fruit also contains mucilage and saponins (Pande, 1981; Siddhuraju et al., 1996). Pods contain gallic acid, Me-este-n-digallic acid and condensed tannins. Leaf contain apigenin, 6-8-bis-D-glucoside, rutin and 8% digestive protein. Bark contains tannin (12-20%), terpenoids, saponins and glycosides, Phlobetannin, gallic acid, protocatechuic acid pyrocatechol, (+) – catechin, (-) epigallocatechin- 5,7-digallate (Chaubal and Tambe, 2006). Root contains octaconsanol, betulin, B-amyrin and B- sitosterol. Gum is composed of galactoaraban which gives on hydrolysis L-arabinose, D-galactose, L- rhamnose, D-glucuronic acid and 4-O-methyl- D- glucuronic acid.

Pharmacological potential

Antimicrobial activity

Solomon-Wisdom et al (2010) has investigated in vitro antimicrobial activity of the crude ethanolic leaf extract of *Acacia nilotica* Linn. against *Campylobacter* coli isolated from goats. The highest zone of inhibition was observed with the 70 mg/ml concentration (Solomon and Shittu, 2010). Banso (2009) has studied the antimicrobial activity of ethanolic extracts of the stem bark against *Streptococcus viridans, Staphylococcus aureus, Escherichia coli, Bacillus subtilis* and *Shigella sonnei* using the agar diffusion method and found the minimum inhibitory concentration of the stem bark extract of the plant ranged between 35 and 50 mg/ml while the minimum bactericidal concentration ranged between 35 and 60 mg/ml.

Khan et al (2009) has explored the antimicrobial activities of the crude ethanolic extracts of five plants against multidrug resistant (MDR) strains of *Escherichia coli, Klebsiella pneumoniae* and *Candida albicans*. Mashram et al (2009) has observed the anti-microbial activity of *Acacia nilotica*, against *S. aureus, B. subtilis* and *E. coli*. The leaf and bark extracts showed zone of inhibition between 7.5-16 and 8-15.5 mm respectively and most active against *E. coli*. Mahesh et al (2008) has observed antibacterial activity study of methanolic extracts of *A. nilotica*, showed highest antibacterial activity against *B. subtilis* and *Staphylococcus aureus* with inhibition zone 15±0.66mm and leaf extract showed highest activity against *Bacillus subtilis* with inhibition zone 20±1.20mm.

Saini et al (2008) examined comparative antimicrobial studies of *Acacia* species and *A. nilotica* exhibited highest activity against three bacterial including *Escherichia coli, Staphylococcus aureus and Salmonella typhi* and two fungal strain including *Candida albicans* and *Aspergillus niger* . Mahesh et al (2008) have showed antifungal activity of methanolic extracts and aqueous extract of *A. nilotica*

with percentage inhibition ranging from 34.27± 1.45 to 93.35±1.99 (Satish et al., 2007). Dried fruits of *Acacia nilotica* are active against *C. albicans* and used to treat oral candidiasis (Candice et al., 2009). Methanolic extract of the plant is active against two animal viruses including Newcastle Disease and Fowl pox Viruses (Mohamed et al., 2010).

Antibiotic activity

The plant extract showed potent antibiotic activity against four bacterial species *Bacillus subtilis, Staphylococcus albus, Streptococcus faecalis* and *Escherichia coli* and two fungal species including *Candida albicans* and *Aspergillus flavus* examine by using paper disc diffusion method (Shanab, 2007).

Antimalarial activity

The root extracts of *A. nilotica* was active against *Plasmodium berghei* and *Plasmodium falciparum* in mice (Ali et al., 2010). He also demonstrated crude methanolic extracts of root of *Acacia nilotica* significant activity against chloroquine sensitive strain of *Plasmodium berghei* in mice.

Anti-diarrhea activity

Acacia nilotica has been reported to be very useful in treating diarrhea and cough in human (Guinko, 1991). Abdulkarim et al (2005) reported anti-diarrhoeal activity of ethyl acetate fraction A. nilotica in castor oil-induced model. It reduces the number of unformed faeces and decreased the intestinal transit of charcoal (Sanni et al., 2010).

Antioxidant activity

Acacia species are rich source of polyphenolic compounds, known to have strong antioxidant properties that help in prevention and therapy of various oxidative stress related diseases including cardiovascular, neurodegenerative and cancer (Singh et al., 2009). Methanolic extract of the plant containing keampherol which is responsible for antioxidant activity of the plant (Singh and Singh, 2008).

Spasmogenic activity and antispasmodial activity

The aqueous extract of seeds of *Acacia nilotica* shows spasmogenic activity on the isolated guinea-pig ileum. The mechanism behind it may be increase in calcium influx that results in muscle spasm (Amos et al., 1999).

Molluscicidal properties

Yousif (2009) has observed that lethal doses of plant that caused 100% mortality (LC100) of the adult *B. truncatus* snails were 112.50 ppm. *Acacia nilotica* have demonstrated the highest Molluscicidal Properties due to tannin activity. Hussein Ayoub (1985) exhibited highest activity using acetone, alcohol and aqueous extracts of the fruits and stem bark of these species are reported against the two snail species which host Schistosomes in the Sudan i.e. *B. truncatus* and *B. pfeifferi*.

Ecological potential

In common *Acacia* sp. are considered as weed, despite the fact some of the ecological potential of *Acacia nilotica* was enumerated by Orwa et al. (2009). He reported the fragrant flowers of *A. nilotica* are popular bee forage. In India, this species is used on degraded saline and alkaline soils. It grows well when irrigated with tannery effluent and colonizes coal mine waste heaps. Over 50 % of the Chambal ravines in India have been revegetated with *A. nilotica* and they acted as soil improver by nitrogen fixing. This subspecies makes an ideal windbreak surrounding fields; its narrow crown shades less than other windbreak species. When intercropped in semi-arid Nigeria, sorghum showed heavily depressed yields. *A. nilotica* coppices very weakly. Orwa et al. (2009) also added that in a survey of phytophagous insects, 43 species of pests were recorded in Pakistan. Of these, 16 appeared stenophagous. Those for which biological control methods might work were *Anarsia acaciae, Pseudosterrha paulula, Azanus ubaldus* and *Ceutholopha isidis*, which feed on flowers; *Bruchidius sahlbergi* and *Sulcobruchus* spp., which damage the seeds; *Ascalenia callynella, Gisilia stereodoxa* and an unidentified gracillariid, which bored into shoots; and *Cydia* spp., which makes stem galls.

Conclusion

In South India, most of the research work has been conducted on the impact of the *Acacia* sp., however the plant species have numerous potential in pharmacology and as well as ecologically. The present review article clearly elucidate the beneficial roles of the plant with various investigation evidences.

Future perspectives

We, authors of the review article have high hope on that the future pharmacological studies in India (especially South India) inevitably promote preservation of the plant species and highlight the wide range of indirect impact of *Acacia nilotica* on its ecosystems. Because, as fuel source, flood controlling agent and with other traditional role the plant has been attached with our South Indian culture as one of the irreplaceable component.

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