Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
https://www.phytojournal.com
JPP 2023; 12(6): 345-348
Received: 12-11-2023
Accepted: 18-12-2023

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A review on a medicinal tree *Acacia nilotica* Linn

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DOI: https://doi.org/10.22271/phyto.2023.v12.i6d.14802

Abstract
Acacia nilotica Linn. (Mimosaceae) indigenously known as 'Babul' or 'Kikar' is a proverbial, medium-sized tree and is broadly scattered in tropical and subtropical countries. Almost all its parts such as leaves, bark, roots, flowers, pods, gum, etc. are used in medication. This plant contributes several groups among which are alkaloids, volatile essential oils, phenols and phenolic glycosides, resins, oleosins, steroids, tannins and terpenes. *Acacia nilotica* is a medicinal plant acknowledged to be rich in phenolics, consisting of condensed tannin and phlobatannin, gallic acid, protocatechuic acid, pyrocatechol, (+) - catechin, (-) epi- gallocatechin-7-gallate and (-) epigallocatechin-5, 7-digallate. Different parts of this plant such as the leaves, roots, seeds, bark, fruits, flowers, gum and immature pods act as anti-cancer, antimutagenic, spasmogenic, vasoconstrictor, antipyretic, anti-asthmatic, cytotoxic, anti-diabetic, anti-platelet, anti-plasmodial, anti-fungal, antioxidant activities, anti-bacterial, antihypertensive and anti-spasmodic activities. They are also engaged for the treatment of different ailments in the indigenous system of medicine. This review summarizes the information concerning the phytochemistry, biological activity and pharmacological properties of the *Acacia nilotica* Linn.

Keywords: *Acacia nilotica*, phytomedicine, pharmacological properties, medicinal uses, diseases

Introduction
Acacia nilotica (Linn.) Willd. ex. Del. belonging to the Leguminosae family and sub-family Mimosaceae consists of dried mature stem bark having moderate-sized, spiny, evergreen trees found throughout India. Acacia is one of about 135 thorny African Acacia species. Variation is considerable with nine subspecies presently recognized, three occurring in the Indian subcontinent and six throughout Africa. The common name of this tree is Babul tree, an Indian gum Arabic tree. The species is naturally widespread in the drier areas of Africa, from Senegal to Egypt and down to South Africa, and in Asia from Arabia eastwards to India, Burma and Sri Lanka. It has also been cultivated elsewhere, including Australia, Cape Verde islands, Indonesia, Iran, Iraq, Nepal, Vietnam, and the West Indies. It is indigenous to the plains of Andhra Pradesh and Maharashtra in India.

More than 30% of the entire plant species at one time or other was used for medicinal purposes. The Ayurveda system of medicine uses about 700 species, Unani 700, Siddha 600, Amchi 600 and modern medicine around 30 species. Plants are used medicinally in different countries and are a source of many potent drugs. A wide range of medicinal plant parts is used for extract as raw drugs and they possess varied medicinal properties. The different parts used include root, stem, flower, fruit, twig exudates and modified plant organs. While some of these raw drugs are collected in smaller quantities by the communities and folk healers for local use, many other raw drugs are collected in larger quantities and traded in the market as the raw material for many herbal industries. *Acacia nilotica* occurs from sea level to over 2000 m. It withstands extremes of temperature (-1 to 50 °C) but is frost-tender when young. Annual rainfall varies from 250 - 1500 mm. Trees are generally deciduous during the dry season, though riverine species can be almost evergreen. It is a moderate-sized, almost evergreen tree with a short trunk and a spreading crown. The bark is dark brown to almost black, longitudinally fissured or deeply cracked. Leaves are 2-pinnate and the main rachis has glands. Stipular spines are variable. Leaflets are subsessile and glabrous. Flowers golden-yellow, fragrant, crowded in long-stalked globose heads, forming auxiliary clusters of 2-5 heads. Pods are stalked, flat, compressed 7.5-15.0 cm in length and contracted between the circular seeds.

Traditionally the bark, leaves, pods and flowers are used against cancer, cold, congestion, cough, diarrhoea, dysentery, fever, gall bladder, haemorrhoid, ophthalmia, sclerosis, tuberculosis smallpox, leprosy, bleeding piles, leucoderma and menstrual problems. They have spasmogenic, vasoconstrictor, antihypertensive, -mutagenic, carcinogenic, -spasmodic, -inflammatory, -oxidant and -platelet aggregatory properties (Singh *et al*., 2009) [21].

Acacia nilotica has antplasmodial, anti-fungal, and anti-microbial activity (Sultana *et al*., 2007) [25]. The bark of the plant is used as astringent, acrid, cooling, styptic, emollient, anthelmintic, aphrodisiac, diuretic, expectorant, emetic and nutritive, in haemorrhage, wound ulcers, leprosy, leucoderma, skin diseases and seminal weakness. Gum is used as an astringent, emollient, liver tonic, antipyretic and antiasthmatic (Baravkar *et al*., 2008) [6]. The bark is used extensively for colds, bronchitis, biliousness, diarrhoea, dysentery, bleeding piles and leucoderma (Del, 2009) [8]. It is used by traditional healers of different regions of Chhattisgarh in the treatment of various cancer types of mouth, bone and skin. In West Africa, the bark and gum are used against cancers and tumors (of ear, eye, or testicles) and indurations of the liver and spleen, the root for tuberculosis, the wood for smallpox and the leaves for ulcers (Kalaivani and Methew, 2010) [14].

Fig 1: *Acacia nilotica* (Picture courtesy by Author)

Chemical constituents

Plant compounds have interest as a source of safer or more valuable substitutes than synthetically created antimicrobial agents. Phytochemical progress has been aided extremely by the development of rapid and accurate methods of screening plants for particular chemicals. These procedures have shown that many substances originally thought to be rather rare in occurrence are of almost universal distribution in the plant kingdom. The phytochemicals are divided chemically into several groups among which are alkaloids, volatile essential oils, phenols and phenolic glycosides, resins, oleosins, steroids, tannins and terpenes (Banso, 2009) [5]. Phytochemistry confirmed that all the tested extracts contain phytosterols, fixed oils, fats, phenolic compounds, flavonoids and saponins (Kalaivani *et al*., 2010) [14]. The phytochemicals alkaloids and glycosides detected in the crude extracts of *Acacia nilotica* roots are indicated (Jigam *et al*., 2010) [13] below. Phytochemical screening of the stem bark of *Acacia nilotica* revealed that the plant contains terpenoids, alkaloids, saponins and glycosides. Negative results were recorded for steroids and flavonoids which authenticate the absence of these phytochemicals (Banso, 2009) [5]. This plant recommends a variety of phytochemicals such as gallic acid, ellagic acid, isoquercitin, leucocyanadin, kaempferol-7-diglucoside, glucopyranoside, rutin, derivatives of (+)-catechin-5-gallate, apigenin-6, 8-bis-Cglucopyranoside, m-catechol and their derivatives. *Acacia nilotica* contains gallic acid, m-digallic acid, (+)-catechin, chlorogenic acid, gallolyated flavan-3, 4-diol, robidandiol (7, 3, 4, 5-tetrahydroxyflavan-3-4-diol), androstene steroid, D-pinitol carbohydrate and catechin-5-galloyl ester (Singh *et al*., 2009) [21]. The bark is prosperous in phenolics *viz*. condensed tannin and phlobatannin, gallic acid, protocatechuic acid pyrocatechol, (+)- catechin, (-) epigallocatechin-7-gallate, and (-) epigallocatechin-5,7- digallate (Singh *et al*., 2009) [21]. The bark is also reported to contain (-) epicatechin, (+) dicatechin, quercetin, gallic acid, (+) leucocyanidin gallate, sucrose and (+) catechin5-gallate (Mitra and Sundaram, 2007) [19]. *Acacia nilotica* is a medicinal plant from which the polyphenolic compound kaempferol has been reported for the first time. Another compound umbelliferone has been reported from *Acacia nilotica* (Singh *et al*., 2010) [23].

Medicinal uses and pharmacological effects

Acacia nilotica is a multipurpose tree species. It is used as green fertilizer, timber tree, and fodder tree in agroforestry systems across the world. The medicinal traits and pharmacological activities endorsed to various parts of *Acacia nilotica* are detailed as follows.

Anti-hypertensive and anti-spasmodic activities

A decrease in arterial blood pressure is reported by the use of methanolic extract of *Acacia nilotica* pods and provides evidence of anti-hypertensive activities independent of muscarinic receptor stimulation. In the *in vitro* studies, *Acacia nilotica* has an inhibitory effect on force and rate of spontaneous contractions in guinea-pig paired atria and rabbit jejunum. *Acacia nilotica* also inhibits K + induced contractions in rabbit jejunum advocating the antispasmodic action of *Acacia nilotica* which is mediated through calcium channel blockade and this may also be responsible for the blood pressure lowering effect of *Acacia nilotica* observed in the *in vivo* studies (Gilani *et al*., 1999) [10]. An aqueous extract of the seed of *Acacia nilotica* is also investigated on the isolated guinea-pig ileum which exposed the sustained dose-related contractile activity. A dose-related significant elevation of blood pressure is produced by intravenous administration of the extract (Amos *et al*., 1999) [2].

Antibacterial and antifungal activities

The assays of the stem bark extracts confirm the antimicrobial activity against Streptococcus viridans, *Staphylococcus aureus*, *Escherichia coli*, *Bacillus subtilis* and *Shigella sonnei* using the agar diffusion method. *Acacia nilotica* could be a potential source of antimicrobial agents (Banso, 2009) [5]. *Acacia nilotica* demonstrates the highest activity against three bacterial (*E. coli*, *S. aureus* and *Salmonella typhi*) and two fungal strains (*Candida albicans* and *Aspergillus niger*) (Kalaivani and Methew, 2010) [14].

Antiplasmodial activities

The ethyl acetate extract holds the highest activity on Plasmodium falciparum. Phytochemical analysis indicated that the most active phase contained terpenoids and tannins and was devoid of alkaloids and saponins (El-Tahir *et al*., 1999) [9]. Crude methanolic root extracts of *Acacia nilotica* reveal significant activity against the chloroquine-sensitive strain of Plasmodium berghei in mice (Jigam, 2010) [13].

Anthelmintic activity

In vitro anthelmintic activity of crude methanolic extract (CME) of the plants was determined against Haemonchus contortus by the adult motility assay, the egg hatch test and the larval development assay. *In vivo* anthelmintic activity was evaluated in sheep naturally infected with gastrointestinal nematodes by administering increasing doses of crude powder (CP) and CME (1.0-3.0 g/kg). The plants exhibited dose- and

time-dependent anthelmintic effects by causing mortality of worms, and inhibiting egg hatching and larval development.

Antioxidant activity

Water extract/fractions of *Acacia nilotica* in lipid peroxidation assay possess the peroxyl radical scavenging capacity and results prove the anti-oxidant activity of plant. The bark powder of the plant extracts with different solvents found scavenging activity using maceration extraction (Del, 2009) [8]. Another study reveals that *Acacia nilotica* is an easily accessible source of natural antioxidants, which can be used as a supplement to aid the therapy of free radical-mediated diseases such as cancer, diabetes, inflammation, etc (Amos *et al*., 1999) [2]. Furthermore, the high scavenging property of *Acacia nilotica* may be due to hydroxyl groups existing in the phenolic compounds that can scavenge the free radicals (Kalaivani and Mathew, 2010) [14].

Acetylcholinesterase inhibitory activities

Acetylcholinesterase is a basic aim in the treatment of Alzheimer's disease. It has been found that *Acacia nilotica* affects central nervous system activities due to potent Acetylcholinesterase inhibitory activities. More investigations are required in the treatment of Alzheimer's (Crowch and Okello, 2009) [7].

Antibacterial Activity

The methanol leaf extracts of *Acacia nilotica* showed significant activity against *E. coli*, *S. aureus* and X. a. pv. malvacearum around 15 mm. The highest antibacterial activity of 20 mm in *B. subtilis* and least activity recorded in *E. coli* measured 14 mm. Bark extract of *Acacia nilotica* Linn. exhibits the highest activity against *B. subtilis* and *S. aureus* (15 mm) and lowest in P. fluorescens.

Chemo-preventive, cytotoxic and anti-mutagenic activities

It has been reported, that the antimutagenic and cytotoxic activities exhibited by acetone extract may be due to the presence of gallic acid and other polyphenols (Kaur *et al*., 2005) [16]. It is reported that the leaf extract of *Acacia nilotica* had significant chemopreventive and anti-mutagenic activity than the other parts (Kalaivani and Mathew, 2010a) [14]. The chemopreventive activity of *Acacia nilotica* gum, flower and leaf aqueous extracts, on 7,12– dimethylbenz (a) anthracene (DMBA) induced skin papillomagenesis in male swiss albino mice has been found. The chemopreventive and anti-mutagenic activity of the leaf extract of *Acacia nilotica* was the most significant, followed by the flower extract and then by gum (Meena *et al*., 2006) [18].

Future Prospects

Based on the different studies on different parts of *Acacia nilotica* there is a grim need to isolate and identify new compounds from different parts of the tree, which have possible antimutagenic and cytotoxic activities. Therefore, the spreadability of naturally occurring polyphenolic compounds having the ability to protect against certain types of mutagens and carcinogens is of great importance. The *Acacia nilotica* extract was also studied for its possible interaction with serotonin (5-HT) receptors which is associated with hypertension. Furthermore, it contains additional serotonin-blocking compounds, which may be further studied for detailed interaction with serotonin receptor subtypes (Gilani *et al*., 1999) [10]. The high scavenging property of *Acacia nilotica* exhibits high scavenging activity due to the presence of phenolic compounds. However, further research is required to identify individual components forming antioxidative systems and develop their application for the pharmaceutical and food industries (Kalaivani and Mathew, 2010) [14]. Umbelliferon, a potent antioxidant isolated from *Acacia nilotica* plant and food-derived antioxidants are implicated in the prevention of cancer and aging by destroying oxidative species that initiate carcinogenesis through oxidative damage of deoxyribonucleic acid (DNA) The supplementation of functional food with antioxidants, which inhibit the formation of free radicals, can lead to prevention of some diseases As most of the antimutagenic compounds act via scavenging of free radicals, There is an intense need to investigate the antioxidant activity of the functional components present in the extract from *Acacia nilotica* (Singh *et al*., 2009) [21]. Literature is however scarce in respect of the efficacy of gallotannins as antiplasmodial agents so more investigation is required (Jigam *et al*., 2010) [13]. Having potential uses of this plant, it is highly recommended to cultivate widely to get maximum production for the welfare of mankind.

Conclusion

Acacia nilotica is a multipurpose tree species, which is widely distributed and used in many therapeutic and pharmacological actions. The global scenario is now changing towards the use of non-toxic plant products. The present article would help create awareness among people for taking control measures based on, herbal plants against infectious diseases. Further more detailed clinical researches are needed to explore its medicinal value to establish it as a standard drug.

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