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Review

Acacia nilotica: A plant of multipurpose medicinal uses

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Acacia nilotica **Lam (Mimosaceae) indigenously known as 'Babul' or 'Kikar' is a proverbial, medium sized tree and is broadly scattered in tropical and subtropical countries. It has an inspiring range of medicinal uses with potential anti-oxidant activity. This plant contributes a number of groups among which are alkaloids, volatile essential oils, phenols and phenolic glycosides, resins, oleosins, steroids, tannins and terpenes.** ***A. 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, anti-pyretic, anti-asthamatic, cytotoxic, anti-diabetic, anti-platelet agregatory, anti-plasmodial, molluscicidal, anti-fungal, inhibitory activity against Hepatitis C virus (HCV) and human immunodeficiency virus (HIV)-I and antioxidant activities, anti-bacterial, anti-hypertensive and anti-spasmodic activities, and are also engaged for the treatment of different ailments in the indigenous system of medicine. This review spotlights on the detailed phytochemical composition, medicinal uses, along with pharmacological properties of different parts of this multipurpose plant.**

Key words: *Acacia nilotica,* phytomedicine, multipurpose plant, different parts, medicinal uses, pharmacological properties.

INTRODUCTION

Acacia nilotica (L.) Del. syn. *Acacia arabica* (Lam.) Willd. (Mimosaceae) is an imperative multipurpose plant (Kaur et al., 2005). *A. nilotica* is a plant 5 to 20 m high with a thick spherical crown, stems and branches usually sinister to black colored, grey-pinkish slash, fissured bark, exuding a reddish low quality gum. The plant has straight, light, thin, grey spines in axillary pairs, usually in 3 to 12 pairs, 5 to 7.5 cm long in young trees, mature trees commonly without thorns. The leaves are bipinnate, with 3 to 6 pairs of pinnulae and 10 to 30 pairs of leaflets each, rachis with a gland at the bottom of the last pair of pinnulae. Flowers in globulous heads 1.2 to 1.5 cm in diameter of a bright golden-yellow color set up either axillary or whorly on peduncles 2 to 3 cm long located at the end of the branches. Pods are strongly constricted, white-grey, hairy and thick (baravker et al., 2008). *A. nilotica* is a pantropical and subtropical genus with species abundant throughout Asia, Australia, Africa and America. *A.nilotica* occurs naturally and is imperative in traditional rural and agro-pastoral systems (Shittu, 2010). *A. nilotica* is recognized by the following names: Acacia, Acacia Arabica, Babhul - Hindi and Napalese, Babla - Bengali, Babool - Unani, Babool Baum - German, Babhoola - Sanskrit, Babul, Babul Tree, Huanlong Kyain - Burmese, Kikar, Mughilan - Arabian Indogom - Japenese and Ummughiion – Persian (Steve, 2004). *A. nilotica* is an imperative multipurpose plant that has been used broadly for the treatment of various diseases (Singh et al., 2009b).

Natural medicinal plants promote self healing, good health and durability in ayurvedic medicine practices and have acknowledged that *A. nilotica* can provide the nutrients and therapeutic ingredients to prevent, mitigate or treat many diseases or conditions). It also serves as a

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Abbreviations: HIV, Human immunodeficiency virus; **DMBA,** 7,12– dimethylbenz(a)anthracene; **HCV,** hepatitis C virus; **PR,** protease; **DNA,** deoxyribonucleic acid.

Table 1. Some common medicinal uses of different parts of *A. nilotica.*

Part used	Uses	References
Root	The roots are used against cancers and/or tumors (of ear, eye, or testicles), tuberculosis and indurations of liver and spleen.	(Kalaivani and Mathew, 2010)
Leaf	Chemoprventive, anitmutagenic, anti bacterial, anticancer, astringent, anti microbial activity Tender leaves are used to treat diarrhea, Aphrodisiac, dressing of ulcers,anti-inflammatory and Alzheimer's diseases.	(Kalaivani and Mathew, 2010; Shittu, 2010; Kalaivani et al., 2010)
Gum	Astringent, emollient, liver tonic, antipyretic and antiasthmatic.	(Baravkar et al., 2008)
Stem bark	Anti bacterial, antioxidant, anti-mutagenic, cytotoxic bark is used as astringent, acrid cooling, styptic, emollient, anthelmintic, aphrodisiac, diuretic, expectorant, emetic, nutritive, in hemorrhage, wound ulcers, leprosy, leucoderma, small pox, skin diseases, biliousness, burning sensation, toothache, leucoderma, dysentery and seminal weakness. The trunk bark is used for cold, bronchitis, diarrhoea, dysentery, biliousness, bleeding piles and leucoderma.	(Agrawal et al., 2010; Del, 2009; Kalaivani and Mathew, 2010; Kaur et al., 2005; Singh et al., 2009; Singh et al., 2008a)
Seeds	Spasmogenic activity and antiplasmodial activity.	(El-Tahir et al.,1999; Amos et al., 1999)
Pods	Anti hypertensive and antispasmodic, anti-diarrhoerial, astringent,anti-fertility and against HIV-1 PR, Inhibited HIV-1 induced cythopathogenicity, antiplatelet aggregatory activity and anti oxidant.	(Gilani et al., 1999; Asres et al., 2005; Shah et al., 1997; Singh et al., 2009)

source of polyphenols (Singh et al., 2009a). The role of these polyphenols to the plant itself is not well implicit, but for the human kind they can be of prime strategies (Singh et al., 2009a). The phytochemicals contribute chemically to a number of groups among which are alkaloids, volatile essential oils, phenols and phenolic glycosides, resins, oleosins, steroids, tannins and terpenes (Banso, 2009). This plant contain a profile of a variety of bioactive components such as gallic acid, ellagic acid, isoquercitin, leucocyanadin, kaempferol-7-diglucoside, glucopyranoside, rutin, derivatives of (+)-catechin-5-gallate, apigenin-6,8-bis-C-glucopyranoside, m-catechol and their derivatives (Singh et al., 2009a). It has been reported that different parts of the plant are prosperous in tannins (ellagic acid, gallic acid and tannic acid), stearic acid, vitamin-C (ascorbic acid), carotene, crude protein, crude fiber, arabin, calcium, magnesium and selenium (Meena et al., 2006). A number of medicinal properties have been ascribed to various parts of this highly esteemed plant (Table 1). Traditionally the bark, leaves, pods and flowers are used against cancer, cold, congestion, cough, diarrhea, dysentery, fever, gall bladder, hemorrhoid, ophthalmia, sclerosis, tuberculosis and small pox, leprosy, bleeding piles, leucoderma and menstrual problems.

They have spasmogenic, vasoconstrictor, anti/-hypertensive, -mutagenic, -carcinogenic, -spasmodic, -inflammatory, -oxidant and -platelet aggregatory properties (Singh et al., 2009b). *A. nilotica* has anti-plasmodial, molluscicidal, anti-fungal, anti-microbial activity, inhibitory activity against HCV and HIV-I (Sultana et al., 2007). The bark of the plant is used as astringent, acrid, cooling, styptic, emollient, anthelmintic, aphrodisiac, diuretic, expectorant, emetic and nutritive, in hemorrhage, wound ulcers, leprosy, leucoderma, skin diseases and seminal weakness. Gum is used as astringent, emollient, liver tonic, antipyretic and antiasthmatic (baravkar et al., 2008). The bark is used extensively for colds, bronchitis, biliousness, diarrhoea, dysentery, bleeding piles and leucoderma (Del, 2009). It is used by traditional healers of different regions of Chattisgarh in treatment of various cancer types of mouth, bone and skin. In West Africa, the bark and gum are used against cancers and/or tumors (of ear, eye, or testicles) and indurations of liver and spleen, the root for tuberculosis, the wood for smallpox and the leaves for ulcers (Kalaivani and Methew, 2010a). Pods and tender leaves are given to treat diarrhoea and are also considered very useful in folk medicine to treat diabetes mellitus (Gilani et al., 1999). The tender twings are used as toothbrushes (Meena et al., 2006). So far no comprehensive review has been compiled encircling the efficacy of this plant in all proportions from the literature. Its stretchy utility as a medicine forced us to bridge the information gap in this area and to write a comprehensive review on the medicinal, phytochemical and pharmacological traits of this plant of high economic value.

PHYTOCHEMISTRY

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 a number of groups among which are alkaloids, volatile essential oils, phenols and phenolic glycosides, resins, oleosins, steroids, tannins and terpenes (Banso, 2009). Phytochemistry confirmed that all the tested extracts contain phyterols, fixed oils, fats, phenolic compounds, flavanoids and saponins (Kalaivani et al., 2010b). The phytochemicals alkaloids and glycosides detected in the crude extracts of *A. nilotica* roots are indicated (Jigam et al., 2010) below. Phytochemical screening of the stem bark of *A. nilotica* exposed that the plant contain terpenoids, alkaloids, saponins and glycosides. Negative results were recorded for steroids and flavonoids which authenticate the absence of these phytochemicals (Banso, 2009). This plant recommends a variety of phytochemical such as gallic acid, ellagic acid, isoquercitin, leucocyanadin, kaempferol-7-diglucoside, glucopyranoside, rutin, derivatives of (+)-catechin-5-gallate, apigenin-6,8-bis-C-glucopyranoside, m-catechol and their derivatives. *A. 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., 2009a). 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., 2009a). The bark is also reported to contain (-) epicatechin, (+) dicatechin, quercetin, gallic acid, (+) leucocyanidin gallate, sucrose and (+) catechin-5-gallate (Mitra and Sundaram, 2007). *A.nilotica* is a medicinal plant from which the polyphenolic compounds kaempferol has been reported for the first time[]. Another compound umbelliferone has been reported from *A. nilotica* (Singh et al., 2010b).

MEDICINAL USES AND PHARMACOLOGICAL EFFECTS

A. nilotica also has numerous medicinal uses. The medicinal traits and pharmacological activities endorsed to various parts of *A. nilotica* are detailed as follows.

Anti-hypertensive and anti-spasmodic activities

A decrease in arterial blood pressure is reported by use of methanolic extract of *A. nilotica* pods and provides evidence of anti hypertensive activities independent of muscarinic receptor stimulation. In the *in vitro* studies, *A. nilotica* has inhibitory effect on force and rate of spontaneous contractions in guinea-pig paired atria and rabbit jejunum. *A. nilotica* also inhibits K^+ induced contractions in rabbit jejunum advocating the antispasmodic action of *A. nilotica* which is mediated through calcium channel blockade and this may also be responsible for the blood pressure lowering effect of *A. nilotica*, observed in the *in vivo* studies (Gilani et al., 1999).

An aqueous extract of the seed of *A. 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).

Antibacterial and antifungal activities

The assays of the stem bark extracts confirms the antimicrobial activity against *Streptococcus viridans*, *Staphylococcus aureus*, *Escherichia coli*, *Bacillus subtilis* and *Shigella sonnei* using the agar diffusion method. *A. nilotica* could be a potential source of antimicrobial agents (Banso, 2009).

A. nilotica demonstrates highest activity against three bacterial (*E. coli, S. aureus* and *Salmonella typhi*) and two fungal strain (*Candida albicans* and *Aspergillus niger*) (Kalaivani and Methew, 2010a).

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). Crude methanolic root extracts of *A. nilotica* reveals significant activity against chloroquine sensitive strain of *Plasmodium berghei* in mice (Jigam, 2010).

Antioxidant activity

Water extract/fractions of *A. nilotica* (L.) 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 the scavenging activity using maceration extraction (Del, 2009). Another study reveals that *A. nilotica* is easily accessible source of natural antioxidants, which can be used as supplement to aid the therapy of free radical mediated diseases such as cancer, diabetes, inflammation, etc (Amos et al., 1999). Furthermore, the high scavenging property of *A. nilotica* may be due to hydroxyl groups existing in the phenolic compounds that can scavenge the free radicals (Kalaivani and Mathew, 2010).

Acetylcholinesterase inhibitory activities

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

Anti-diabetic activities

Studies have confirmed anti-diabetic activities. However, pods and tender leaves are considered very beneficial in folk medicine to treat diabetes mellitus (Gilani et al., 1999).

Chemopreventive, 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). It is reported that the leaf extract of *A. nilotica* had significant chemopreventive and anti-mutagenic activity than the other parts (Kalaivani and Mathew, 2010a). The chemopreventive activity of *A. 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 *A. nilotica* was the most significant, followed by the flower extract and then by gum (Meena et al., 2006).

OTHER MULTIPLICITIES

The extract of *A.nilotica* is found to stimulate the synthesis and release of prolactin in the female rate and may be give a better result for lactating women (Lompo et al., 2004). *A. nilotica* are used for tanning, dyeing of leather, for gastrointestinal disorders, syphilitic ulcers and toothache (Amos et al., 1999). *A. nilotica* pods have reported inhibited HIV-1 induced cythopathogenicity (Asres et al., 2005). Fresh roots extract used as narcotic, known as Desi sharab (local bear), gum is used as aphrodisiac with water; branches are used for cleaning teeth (Badshah and Hussain, 2011). Methanolic bark extract of bark has significant inhibitory effects of sudanese medicinal plant extracts on HCV protease (Hussein et al., 1999b). In the end, methanol extracts of bark and pods have considerable inhibitory effects against HIV-1 PR (protease) (Hussein et al., 2000a).

FUTURE PROSPECTS

Based on the different studies on different parts of *A.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 spreadilbility of naturally occurring polyphenolic compounds having ability to provide protection against certain types of mutagens and carcinogens is of great importance. The *A. 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). The high scavenging property of *A. nilotica* exhibits high scavenging activity due to presence of phenolic compounds. However, further research is required to identify individual components forming anti-oxidative system and develop their application for pharmaceutical and food industries (Kalaivani and Mathew, 2010a). Umbelliferone, a potent antioxidant isolated from *A. 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 antimu- tagenic compounds act via scavenging of free radicals, There is intense need to investigate the antioxidant activity of the functional components present in the extract from *A. nilotica* (Singh et al., 2009b).

Literature is however scarce in respect of the efficacy of gallotannins as antiplasmodial agents so more investigation is required (Jigam et al., 2010). Having potential uses of this plant, it is highly recommended to cultivate widely to get maximum production for welfare of mankind.

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