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## Review Article

# Acacia arabica (Babool) - A Review on Ethnobotanical and Unani Traditional Uses as well as Phytochemical and Pharmacological Properties

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### Abstract

In the last few decades there has been an exponential growth in the field of herbal medicine. Herbal medicines have been the basis of treatment and cure for various diseases and physiological conditions in traditional methods of practice such as Unani, Ayurveda and Siddha. A large fraction of the world population, especially in the developing and underdeveloped countries still depends mainly on the traditional system of medicine. Medicinal plants are the valuable and cheap source of unique phytochemicals which are frequently used in the development of drugs against various diseases. The use of plants and plant products in medicines is getting popularized because the herbal medicines are cheap, easily available and have natural origin with higher safety margins and lesser or no side effects. In Unani system of medicine *Babool* (*Acacia Arabica*) is considered as plant having medicinal properties on various system of human body. Different parts of the plant including Bark, root, gum, leaves, pod and seeds have medicinal properties. The present review is an attempt to highlight the various ethnobotanical and Unani traditional uses as well as phytochemical and pharmacological reports on *Acacia arabica* to which commonly known as Babool.

### 1. INTRODUCTION

According to World Health Organization (WHO) more than 80% of the world's population relies on traditional medicine for their primary healthcare needs. Use of herbal medicines in Asia represents a long history of human interactions with the environment. The medicinal value of plants lies in some chemical substances that produce a definite physiological action on the human body.<sup>1</sup>

*Acacia* is the most significant genus of family: Leguminosae, first of all described by Linnaeus in 1773. It is estimated that there are roughly 1380 species of *Acacia* worldwide.<sup>2</sup> *Acacia* species—commonly known as Babool (or babul), Egyptian mimosa, Egyptian thorn, kikar, Indian gum, and red thorn—have long been used for the treatment of various ailments. Dioscorides, the Greek physician considered to be the father of botany, named it kakia, and it is from this word that the modern name, acacia, is derived. The origin of the word, acacia, is “spiny,” which is a typical feature of the species.<sup>3</sup> Ancient Greeks were well known to this tree in 300 BC. This is also clear with this fact that Theophrastus, whose period is 370 BC, mentioned about the gum of this tree by the name ‘kami’. The English word is derived from the same word ‘kami’. Now a day it is known as Gum Arabic, this name was popular during the period, when it was imported in Arab in huge amount.<sup>4</sup> Out of several species, *Acacia Arabica* is one of the species that has been effectively utilized in folk medicine.<sup>5</sup> It has been recognized worldwide as a multipurpose tree (National Academy of Sciences 1980). It 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.<sup>6</sup> It also serves as a source of polyphenols. The

role of these polyphenols to the plant itself is not well implicit, but for the human kind they can be of prime strategies. 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.<sup>7</sup> The bark, root, gum, leaves and flowers have found use for skin diseases, diarrhoea, dysentery, cough, diabetes, eczema, wound healing, burning sensation and as an astringent, demulcent, anti-asthmatic. The tender twigs are used as toothbrushes.<sup>8</sup>

### 2. TAXONOMICAL CLASSIFICATION

Kingdom : Plantae  
Subkingdom : Tracheobionta  
Super division : Spermatophyta  
Division : Magnoliophyta  
Class : Magnoliopsida  
Subclass : Rosidae  
Order : Finales  
Family : Fabaceae  
Genus : *Acacia*  
Species : *nilotica*<sup>9</sup>

**Synonyms**— *Acacia nilotica* (Lam.), *Acacia scorpioides*, *Mimosa Arabica*, *Mimosa nilotica*, *Mimosa scorpioides*<sup>2,10</sup>

### 3. VERNACULARS

**Unani Tibbi Name:** *Aqaqia*, *kikar*, *Mughilan*.<sup>11, 12</sup> **Arabic:** *Ummughilan*.<sup>13,14,15, 16</sup> **Persian:** *Kharemughilan*,<sup>15</sup> *mughilan*.<sup>13,17</sup> **Urdu:** *Babool*, *Kikar*,<sup>15,16,17</sup> **Hindi:** *Kikar*, *Babool*,<sup>18, 19, 20</sup> **Babula**, **Babura**,<sup>21</sup> **English:** Indian gum arabic, Black babool,<sup>18, 19, 22</sup> **Thorn acacia**,<sup>10</sup> **Kannada:** *Jaali*, *Gobbli*.<sup>20, 22, 23</sup> **Tamil:** *Karuvelam*.<sup>18, 19, 20, 22</sup> **Telugu:** *Nallatuma*,<sup>19, 20, 22, 24</sup> *Thumma*.<sup>21</sup> **Sinhala:** *Babbulae*.<sup>11</sup> **Latin:** *Acacia Arabica*,<sup>16, 25</sup> **Assamese:** *Babala*, **Gujrati:** *Baval*, *Kaloabaval*, **Kashmiri:** *Sak*, **Punjabi:** *Kikkar*, **Oriya:** *Babula*, *Babala*, **Marathi:** *Babhul*, *Babhula*, **Bengali:** *Babla*, **Malayalam:** *Velutha Karuvelam*.<sup>21</sup>

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#### 4. MAHIYAT (DESCRIPTION IN UNANI LITERATURE)

There are two type of *babool*, one is black and other one is brown. Black trees have little thorns, more branches, black round big stem. Brown tree has more thorn, becomes old the wood become reddish black. Both trees are up to 50 feet height, stem is 10 – 50 feet, erect with diameter of 5- 12 feet with spreading branches. The bark is thick, scaly, big; branches have thorn of ½ inch– 2 inches in length, shiny, smooth and straight, brownish in colour arranged in pairs. 10- 20 leaves are arranged in pairs on the tip of branches. Flowers are golden yellow in colour, round with pleasant smell; flowering occurs during spring season. The pods of *babool* are 6 inches long, flat divided into 9-21 portions and each portion has one seed and the number of seeds depends upon the length of the pod. Each pod contain 9- 11(usually) or up to 31 seeds. Each seeds separated by white thin fibrous layer. Its seeds are small flat; initially green in colour becomes dark after drying. There is sticky resinous substance present inside the pod. In the month of March and April white and red colour gum is expressed from tree.<sup>13,16,26</sup>

**Parts used :** Bark, root, gum, leaves, pod, seeds.<sup>13, 15, 16, 18, 19</sup>

**Mizaj: (Temperament):** Hot and Dry 2<sup>0</sup> (most),<sup>26</sup> Cold and Dry 2<sup>0</sup><sup>13, 16, 17</sup>

**Af'al (action):** *Qabiz* (Astringent),<sup>13, 14, 17, 26</sup> *Habiskhoon* (Haemostatic),<sup>26</sup> *Mujaffif* (Desiccant), *Mubarrid* (cooling), *Muqawwi* (Tonic),<sup>17</sup> *Mufatteh* (Deobstruent), *Muqai* (emetic), *Mundamile qurooh* (wound healing),<sup>26</sup> *Mumsick* (Aphrodisiac), *Muzeeqe farj* (constricts vagina),<sup>13</sup> *Dafe bulgham* (removes phlegm).<sup>26</sup>

#### **Istemal (uses):**

It prevents leucorrhoea and drives back the uterus and anus when they come out.<sup>16, 17, 26</sup> Decoction of bark (1 part bark 10 part water) boil it until water remains half, use this water after toilet as douche for leucorrhoea and Gonorrhoea, also It tightens the vagina if used locally. Also decoction of bark is used in excessive vaginal bleeding, vaginal and rectal prolapse. Decoction of root bark specially used for abdominal and uterine pain up to 84 gm. Decoction of leaves is used in the form of nutool in prolapse. Decoction and chewing of bark is useful in cough. It is useful in infection of uterus.<sup>26</sup> It prevents slugging of breast: take the jelly matter from unripe fruit and spread over a cloth and let it to air dry when it becomes hard cover the breast and tight around the neck.<sup>16, 26</sup> It is useful as aphrodisiac. Unripe pod should be dried in air, after crushing fried it in ghee and mix with sugar and make powder, 12 gm is used in Gonorrhoea and burning micturition. Tender leaves should be used for (after crushing) gargle and application to mouth ulcer, throat pain, cleaning mouth, prevent gum bleeding and tighten teeth.<sup>26</sup> Small branches used as miswak which are very effective for strengthening of tooth.<sup>17</sup> Juice of leaves prevents diarrhoea and dysentery orally and decoction of bark is use as enema in diarrhoea.<sup>17, 26</sup> Drinking *babool* leaves juice dries away secretion of uterus. Leaves, flowers, pods, bark and wood of *babool* (*panch ang*) 3gm in powder form is used for leucorrhoea. Cloth is soaked in decoction of *babool* pods and then dried; this procedure is repeated 7 times and when necessary use piece of this cloth and put inside vagina; it helps in reducing vaginal secretions. Also douching with decoction of covering of *babool* pods with *alam* reduces white discharge in vagina. *Babool* gum fried with ghee and made *halwa* this is beneficial in vaginal secretion and leucorrhoea. Roasted *babool* gum along with equal quantity of *geru*, 7 gms of powder daily in the morning will help in reducing menorrhagia.<sup>16</sup> Juices of tender leaves or paste applied for redness of eye and eye swelling.<sup>26</sup> Drinking leaves juice in amount of 7gm gives relief in burning micturition. Soak 3 buds in water for overnight and morning after mashing; filtrates it and add 24 gm hot ghee and drink for 2 days and 3rd day drink the mixture without ghee in 4-5 days use, gonorrhoea will go away. Green pods of *babool* are fried in ghee and mix with 12 gm sugar, by eating this will be useful in gonorrhoea and cystitis. Also 24 gm *babool* flower soaked in 250ml of water in clay bowl; in morning after mashing and filtrating drink along with 24 gm *misri* helps in treating gonorrhoea. *Babool* gum dissolved in water is used in the form of douching of genital organs helps in burning micturition. Drinking mucilage of *Babool* gum ends up sugar coming in urine in diabetes mellitus.<sup>16</sup> Take leaves, bark, flower and gum in equal quantity in powder form orally to treat leucorrhoea, premature ejaculation, spermatorrhoea, night fall and decreased viscosity of semen.<sup>13, 14, 17, 26</sup> *Panch ang*, in equal proportion in powder form taking 6gm is beneficial in premature ejaculation and spermatorrhoea.<sup>16</sup>

**Miqdare khurak (dosage):** Stem bark:36gm,<sup>26</sup> Stem bark: 20-30gm for decoction.<sup>11</sup> Gum:1-3 gm or 5-7 gm.<sup>17</sup>

**Muzir (adverse effects):** Chest disease,<sup>26</sup> *Meda* and *Aant*,<sup>13, 17</sup> Constipative.<sup>17</sup>

**Mus'eh (corrective):** *Banafsha*,<sup>26</sup> *Kateera wa shahad*,<sup>13, 17</sup> *Mirch siyah*.<sup>13</sup>

**Mazah (taste):** It has bitter taste.<sup>13</sup> Barks are astringent and mucilaginous.<sup>24</sup> Leaves are astringent.<sup>26</sup>

**Badal (substitute):** *Chal Amrood*,<sup>13, 17</sup> *Palas*.<sup>13, 26</sup>

**Murakkabat (compound formulations):** *Habbe tape balghami*, *Habbe sil*, *Laoq sapistan*,<sup>17</sup> *Halwa-e babool*, *Habbe babool*, *Safoofe babool*, *Khushtae Nuqra*, *Khushtae Qalai*.<sup>16</sup>

#### 5. ETHNO BOTANICAL DESCRIPTION

*Acacia arabica* is a moderate sized, almost evergreen tree<sup>15, 22</sup> with a short trunk, a spreading crown and feathery foliage, found throughout the drier parts of India.<sup>18, 20, 22</sup> Dark brown to almost black longitudinally fissured or deeply cracked bark.<sup>18, 19, 22, 23</sup> The tree generally attains a height of 15m and girth of 1.2m,<sup>18, 19, 22</sup> though tree up to a height of 30m with a girth of 3m have also been recorded. Leaves 2.5-5cm long, bipinnate with spinescent stipules, pinnules narrowly oblong; flowers golden- yellow, fragrant, crowded in long-stalked, globed heads, 1.5cm in diameter, forming axillary clusters of 2-5 head;<sup>18, 19, 22, 27</sup> pods white flat, containing 8-12 seeds, 7.5-15cm, contracted between the circular seeds.<sup>9,12, 18, 22</sup> In this tree flowers blossom during summer and fruits ripen during winter.<sup>18, 19, 28</sup>



Fig.1 Flower and flower buds

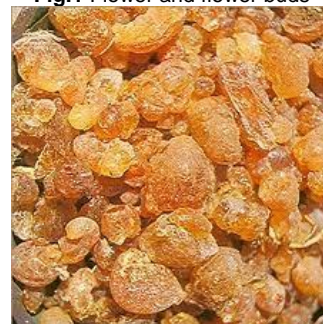


Fig.2 Babool gum



Fig.3 Pods

#### 5.1 Habitat

A moderate-sized, almost evergreen tree with a short trunk, a spreading crown feathery foliage found throughout the drier parts of India, particularly in Andhra Pradesh and Maharashtra.<sup>15, 23, 24</sup> Also distributed in Pakistan, Arab, Africa, Burma, Sri Lanka and Bangladesh.<sup>16, 24</sup> It grows well in dry, hot arid climates with high

mean maximum temperature regimes (upto 50°C) and very low minimum temperature (even below 0 °C) that is, even in deserts.<sup>24</sup> It can be propagated both by seeds and vegetative means.<sup>23</sup>

## 5.2 Actions and uses

**5.2.1 Bark :** The bark is a powerful astringent<sup>11, 24, 29, 30</sup> and bark is used in leucorrhoea, haemorrhages, wounds, ulcers and decoction in diarrhoea and vaginal secretions.<sup>23</sup> The extract is an astringent and injected to allay irritation in acute gonorrhoea and leucorrhoea.<sup>31</sup> Decoction of bark is largely used as an astringent.<sup>32</sup> douche in gonorrhoea, cystitis, vaginitis, leucorrhoea, prolapse of the uterus and piles.<sup>30, 31, 32</sup> It is used as demulcent,<sup>24, 29, 31</sup> aphrodisiac<sup>20, 23, 24</sup> and shows anti-viral properties; an extract of the bark completely inhibited the propagation of potato virus X. It is a powerful tonic.<sup>27</sup> The ground bark mixed with seeds of *Sesamum indicum* Linn. has been used for food.<sup>22</sup> The decoction largely used as a gargle and mouth wash in cancerous and syphilitic affections<sup>31</sup> sore-throat, toothache<sup>18, 19, 22, 28, 33</sup> and dry powder applied externally in ulcers.<sup>18, 19, 28</sup> Decoction of bark is a valuable application in prolapses ani.<sup>30</sup> Stem bark is used in diarrhoea, dysentery, diabetes, astringent, anthelmintic, in skin diseases, cough and bleeding piles; gonorrhoea and as an antiasthmatic,<sup>11, 20, 23</sup> diuretic, leprosy, leucoderma, bronchitis, seminal weakness, utero-vesical disorders etc.<sup>23, 24</sup> The infusion of bark is given in chronic diarrhoea and diabetes mellitus. The juice of bark mixed with milk is dropped into the eye for conjunctivitis. The burnt bark and burnt almond shell both pulverized and mixed with salt to make a good tooth-powder.<sup>31</sup> The powdered bark of the plant with little salt is used for treating acute diarrhoea.<sup>34</sup>

**5.2.2 Leaves:** Infusion of tender leaves used as an astringent and remedy for diarrhoea and dysentery.<sup>18, 19, 20, 28, 32</sup> Also it is used in headaches, eczema, abscess, ophthalmic disorders,<sup>20, 23</sup> in throat infection, urinary problems and gonorrhoea.<sup>23</sup> Bruised tender leaves formed into a poultice and applied to ulcers act as stimulant and astringent.<sup>2</sup> Tender leaves crushed into a pulp are administered in dysentery and diarrhoea; decoction is used as an astringent enemata.<sup>31</sup> Tender leaves crushed into a pulp are used as a gargle in spongy gums, sore throat and as wash in haemorrhagic ulcers and wound.<sup>15</sup>

**5.2.3 Gum:** Fried in ghee and used in the preparation of sweetmeats.<sup>22</sup> It is useful in diarrhoea, dysentery and diabetes mellitus and sore throat,<sup>11, 20, 31</sup> extract of gum is astringent, styptic and tonic.<sup>18, 19, 20, 24, 28</sup> It is used in dry cough, amoebic dysentery, antiasthmatic, tonic, analgesic and in oral cavity lesions.<sup>20</sup> It is also used as demulcent (soothing agent) for inflammatory conditions of the respiratory, digestive and urinary tracts.<sup>11</sup> It is used for burns.<sup>23</sup> It act as cooling, expectorant, constipating, liver tonic, aphrodisiac, homeostatic, antipyretic and tonic. It is useful in cough, asthma, diarrhoea, dysentery, seminal weakness and haemorrhages.<sup>24</sup> Fried in ghee, the gum is useful as a nutritive tonic and aphrodisiac in cases of sexual debility. Powdered gum mixed with quinine is useful in fever cases complicated with diarrhoea and dysentery; mixed with the white of an egg is applied on burns and scalds. Powdered gum is also used to arrest haemorrhages. The gum is administered in the form of mucilage in diarrhoea, dysentery and diabetes mellitus.<sup>31</sup>

**5.2.4 Pods:** Seeds are eaten roasted or raw in times of acute scarcity.<sup>22</sup> Pods when green is used as fodder.<sup>33</sup> Pods decoction is effective in urogenital diseases.<sup>11, 18, 19, 20, 22, 28, 33</sup> Pods are expectorant,<sup>15</sup> used for impotency and dry cough.<sup>20</sup> Seeds are hypoglycaemic in normal rats; no such effect in diabetic rats. Seed oil is antifungal.<sup>11</sup> Pods are used as an astringent in diarrhoea.<sup>32</sup>

**5.2.5 Flowers:** Flowers are useful in reducing the body temperature, ear ache and as a tonic, antidiarrheal, antidyseric.<sup>11, 20, 23</sup>

**5.2.6 Fruits:** It is useful in diarrhoea, dysentery and diabetes.

**5.2.7 Roots:** Used for wound healing and burning sensation.<sup>20</sup>

**5.2.8 Extract:** It is an astringent and injected to allay irritation in acute gonorrhoea and leucorrhoea.<sup>2</sup>

## 6. CHEMICAL CONSTITUENTS

**Bark:** The bark is prosperous in phenolics, condensed tannin and phlobatannin, gallic acid, protocatechuic acid pyrocatechol, (+)-catechin, (-) epigallocatechin-7-gallate, and (-) epigallocatechin-5,7-digallate, (-) epicatechin, (+) dicatechin, quercetin, (+) leucocyanidin gallate, sucrose and (+) catechin-5-gallate.<sup>7, 9, 11, 18, 19,</sup>

<sup>22, 34, 35, 36</sup> It contain 12- 20% of tannin.<sup>7, 11, 22, 33</sup> Bark contain a large quantity of tannin.<sup>15</sup>

**Gum:** Gum contains galactose, L-rhamnose, L-arabinose and four aldobiouronic acids, viz. 6-o-(β-glucopyranosyluronic acid)-D-galactose; 6-o-(4-o-methyl-β-D-glucopyranosyluronic acid)-D-galactose; 4-o-(α-D-glucopyranosyluronic acid)-D-galactose; and 4-o-(4-o-methyl-α-D-glucopyranosyluronic acid)-D-galactose.<sup>11, 18, 19, 22</sup>

**Fruit:** It contains a high percentage of phenolic constituents consisting of m-digallic acid, gallic acid, its methyl and ethyl esters, protocatechuic and ellagic acids, leucocyanidin, m-digallic dimer 3,4,5,7-tetrahydroxy flavan-3-ol, oligomer 3,4,7-trihydroxy flavan 3,4-diol and 3,4,5,7-tetrahydroxy flavan-3-ol and (-) epicatechol. Fruit also contains mucilage and saponins.<sup>36</sup> It contain 32% tannin.<sup>29</sup>

**Flowers and pods:** It contains stearic acid, kaempferol-3-glucoside, isoquercetin, leucocyanidin.<sup>11, 18</sup> Pods contain tannin 22.44%, expressed in terms of oxalic acid; Wood contain chlorides.<sup>32</sup> Whole pods contain 12-19% of tannin and 18-27% after removal of seeds.<sup>11, 22, 33</sup> Seeds contain amino acids, fatty acids, ascorbic acid and tannin as a major constituent,<sup>18, 19</sup> sugar, moisture 14%, ash 3-4% ; pods have got 22-44% tannin.<sup>15</sup>

**Leaves:** It contains apigenin, 6-8-bis-D-glucoside, rutin and 32% tannin.<sup>29, 36</sup>

## 7. ADVANCE RESEARCHES

### Antimicrobial Activity

Banso A (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.<sup>34</sup> One study was done by Rahiman et al (2012) to screen the antimicrobial activity of *Acacia nilotica* and was found to give the most potent antimicrobial extract Noticeably no antimicrobial activity was found in methanolic bark extract of *Acacia nilotica* against the tested bacteria except *Bacillus ciurlans*.<sup>37</sup> Mahesh and Satish (2008) studied methanol leaf and bark extracts of *Acacia nilotica* showed significant antibacterial activity against *Bacillus subtilis*, *Escherichia coli*, *Pseudomonas fluorescens*, *Staphylococcus aureus* and *Xanthomonas axonopodis* pv. *malvacearum* and antifungal activity against *Aspergillus flavus*, *Dreschlera turcica* and *Fusarium verticillioides*.<sup>38</sup> Hassan et al (2009) has tested antimicrobial activity of Ethanolic extract of *Acacia arabica* in vitro against seven bacterial species and two fungal species by well-diffusion method and microdilution methods. The result of this study showed ethanolic extracts of these plants were effective on bacterial strains.<sup>1</sup> Shazia et al (2011) has studied the antimicrobial activity against medicinally important bacterial strains, such as *Pseudomonas aurogenosa*, *Proteus vulgaris*, *Staphylococcus aureus* and *Streptococcus cereviceae*. The anti-microbial activity was determined in methanolic extracts using agar well diffusion method. Result showed anti-bacterial activity against *Staphylococcus aureus*, *Pseudomonas vulgaris*, *Escherichia coli* and anti-fungal activity against *Streptococcus cereviceae*.<sup>39</sup> Antimicrobial activity of the extracts against clinical isolates was performed by agar diffusion method. It exhibited potent activity against all clinical isolates. The minimum inhibitory concentration for ethanol extract was 5 mg/ml while 10 mg/ml for petroleum ether extract. These results may be helpful for rationale use of this plant in the modern system of health care.<sup>40</sup>

### Anti-bacterial activity

The methanol leaf and bark extracts of *Acacia nilotica* showed antibacterial activity against *Bacillus subtilis*, *Escherichia coli*, *Pseudomonas fluorescens*, *Staphylococcus aureus* and *Xanthomonas axonopodis* pv. *Malvacearum*.<sup>38</sup> Amin et al (2013) has studied Methanol, acetone and water extracts of different parts of *Acacia nilotica* (L.) Delile, *Calotropis procera* (Aiton) W.T. Aiton, *Adhatoda vasica* Nees, *Fagoniara abica* L. and *Casuarina equisetifolia* L. to evaluate the anti-bacterial activity against thirty four clinical isolates and two reference strains of *H. pylori*. Minimum inhibitory concentrations (MICs) of the extracts were determined using the agar dilution method and compared with some standard

antibiotics like amoxicillin, clarithromycin, tetracycline and metronidazole, used in the triple therapy for *H. pylori* eradication. Methanol and acetone extracts from *Acacia nilotica* and *Calotropis procera* exhibited stronger anti-*H. pylori* activity than metronidazole, almost comparable activity with tetracycline, but were found to be less potent than amoxicillin and clarithromycin.<sup>41</sup> Mohan Lal Saini et al (2008) examined comparative antimicrobial studies of *Acacia* species and *A. nilotica* exhibited highest activity against three bacterial strains *Escherichia coli*, *Staphylococcus aureus* and *Salmonella typhi*.<sup>42</sup> The antibacterial activity of seed extracts of *A. nilotica*, *P. Juliflora* and *L. Leucocephala* was determined in vitro using disc diffusion method against different bacterial strains viz. *S. aureus*, *E. coli*, *P. aeruginosa*, *K. pneumoniae* *S. typhi*. Dried powder was subjected to successive hot extraction method to obtain various extracts viz. n-hexane, chloroform, acetone, alcohol and water. Assay was performed at a dose of 100mg/ml, compared to standard Amikacin (30mg/ml). Maximum inhibition zone of 10mm was observed by acetone, alcohol and water extracts of *A. nilotica*, against *E. coli*, *S. typhi*, *S. aureus* and *P. aeruginosa* respectively.<sup>43</sup>

#### Anti-fungal activity

The extracts, produced by 80% methanol, from leaf, bark and seed of three medicinal plants namely neem (*Azadirachta indica* A. Juss), kiker (*Acacia nilotica* L.) and jaman (*Eugenia jambolana* L.), were assessed for their antifungal activities against two fungal strains viz. *Aspergillus flavus* and *Aspergillus parasiticus* using disc diffusion method and micro dilution broth susceptible assay. Result showed all the extracts exhibited inhibitory effect against *A. flavus* and *A. parasiticus*.<sup>44</sup> Mohan Lal Saini et al (2008) examined comparative antimicrobial studies of *Acacia* species and *A. nilotica* exhibited highest activity against two fungal strains *Candida albicans* and *Aspergillus niger*.<sup>42</sup> The crude methanolic plant extract of *A. arabica* showed considerable anti-fungal activity against *Streptococcus cereviceae*.<sup>9,39</sup> Dried fruits are active against *C. albicans* and used to treat oral candidiasis.<sup>9</sup> Its fatty oil and unsaponifiable matter were found to possess antibacterial and antifungal properties.<sup>45</sup>

#### Anti-viral activity

Parmar et al (2010) has investigated *Acacia arabica* for preliminary phytochemical analysis and characterization by various instrumental techniques. Methanolic extracts of *Acacia arabica* seeds was very good antibacterial activity and also minimum inhibitory concentration of different virus using HEL cell cultures HeLa cell cultures Vero cell cultures but Minimum inhibitory concentration (MIC) of Herpes simplex - 1 and 2, vaccinia virus, vesicular stomatitis and Herpes simplex-1 (TK ACVI) were observed very good antiviral activity of *Acacia arabica* seeds DMSO extracts.<sup>46</sup> Methanolic extract of the plant is active against two animal viruses; Newcastle Disease and Fowl pox Viruses.<sup>9</sup> The crude extract of the leaves of the plant showed in vitro antiviral activity against the Turnip mosaic virus. There was a decrease in lesions numbers on the hosts *Chenopodium amaranticolor* (93.77 %) and *C. album* (80.2 %). There was also decrease in lesions when the extract was on the host leaves. The bark extract inhibited the potato virus.<sup>2</sup>

#### Antibiotic activity

The plant extract showed potent antibiotic activity against four bacterial species: gram positive; *Bacillus subtilis*, *Staphylococcus albus*, *Streptococcus faecalis*; gram negative, *Escherichia coli* and two fungal species: *Candida albicans* and *Aspergillus flavus* examine by using paper disc diffusion method.<sup>9</sup>

#### Anti-malarial activity

Aqueous root extract of *A. nilotica* was analyzed for antiplasmodial activity in mice. Five groups, of five mice in each group were used. Group 1 or control, was administered with 10ml distilled water/kg body weight; groups 2, 3 and 4 were administered with 100, 200, and 400 mg extract/kg body weight, respectively, while group 5 was administered with 5 mg chloroquine/kg body weight. The results of this study showed that the aqueous root extract of *Acacia nilotica* is safe and has anti plasmodial activity.<sup>47</sup> The root extracts of *A. nilotica* was active against *Plasmodium berghei* and *Plasmodium falciparum* in mice; Ethyl acetate extract of *A. nilotica* have highest antiplasmodial activity in vitro against *Plasmodium falciparum*.<sup>9</sup>

#### Molluscicidal properties

Yousif M. (2009) has observed that lethal doses of plant that caused 100% mortality (LC100) of the adult *B. truncatus* snails were 112.50 ppm (55). Ayoub, S. M. (1982). *Acacia nilotica* have demonstrated the highest Molluscicidal Properties due to tannin activity (18-23%) (56). 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*.<sup>9</sup>

#### Anti-diarrheal activity

The petroleum ether, methanolic and water extracts was evaluated for its antidiarrhoeal activity. Only methanolic extract showed significant antidiarrhoeal activity against castor oil and magnesium sulphate induced diarrhoea and barium chloride induced peristalsis using swiss albino rat.<sup>48</sup> Three experiment (castor oil induced diarrhea, gasterointestinal enteropooling and gasterointestinal movement of charcoal in albino rats) was conducted to ascertain the effect of ethyl acetate fraction of *Acacia nilotica* at a dose rate of 200, 400 and 600mg/kg on diarrhea. Twenty five (25) Wister Albino rats of both sexes weighing between 100-170g were used for each experiment. The results showed that the fraction insignificantly ( $P > 0.05$ ) reduced the number of unformed faeces at all the doses tested.<sup>49</sup>

#### Anti-malarial activity

Aqueous root extract of *A. nilotica* was analyzed for antiplasmodial activity in mice. Five groups, of five mice in each group were used. Group 1 or control, was administered with 10ml distilled water/kg body weight; groups 2, 3 and 4 were administered with 100, 200, and 400 mg extract/kg body weight, respectively, while group 5 was administered with 5 mg chloroquine/kg body weight. The results of this study showed that the aqueous root extract of *Acacia nilotica* is safe and has anti plasmodial activity.<sup>47</sup> The root extracts of *A. nilotica* was active against *Plasmodium berghei* and *Plasmodium falciparum* in mice; Ethyl acetate extract of *A. nilotica* have highest antiplasmodial activity in vitro against *Plasmodium falciparum*.<sup>9</sup>

#### Anti-inflammatory activity

Fresh flowers of *Acacia arabica* willd were extracted with 80% alcohol and the concentrated extract was fractionated in the usual way. The ethyl acetate fraction was found to contain isoquercetin. The structure was characterized by UV, NMR, Paper Chromatographic and Chemical studies. The yellow pigment was found to contain promising results with respect to acute and chronic anti-inflammatory studies. It also showed considerable percentage protection of bacteriostatic effect on *Bacillus subtilis*, a gram positive organism.<sup>50</sup>

#### Immunomodulatory effect

Hot aqueous extract of *A. nilotica* revealed both proliferative and inhibitory effects on the rat splenocytes and IL-10 release depending on the dose.<sup>5</sup>

#### Haemostatic property

In a study the potential of the polymeric component of aqueous extracts of gum acacia (GA) and the seeds of *M. oleifera* (MSP) in wound management was evaluated. The results revealed that both biopolymers were hemostatic and hasten blood coagulation. They showed shortening of activated partial thromboplastin time and prothrombin time and were non-cytotoxic in nature.<sup>51</sup>

#### Anti-thrombotic activity

A study was carried out by Bukhtiar H. Shah et al that the extract of *Acacia nilotica* (*A. nilotica*) have capacity to blocked platelet aggregation mediated by platelet agonists, arachidonic acid (0.75  $\mu$ M), ADP (4.3  $\mu$ M), platelet activating factor (800 nM) and collagen (638 nM) in a dose-dependent manner. The findings revealed that the antiplatelet aggregatory activity of the extract of *A. nilotica* is mainly due to blockade of  $Ca^{2+}$  channels, although evidence also suggests that the involvement of protein kinase.<sup>4, 9, 25</sup>

#### Hypoglycaemic activity

The antidiabetic effects of hydroalcoholic extracts of *Acacia Arabica* investigated in diabetic rats. The Alloxan monohydrate was used to induce the diabetes in normal rats. The tolbutamide 80 mg/kg p.o. was used the standard antidiabetic throughout the study

and the results indicated that 250 and 500 mg/kg body weight of all hydroalcoholic test extracts reversed the altered glucose, cholesterol, triglycerides, LDL and HDL levels in diabetic rats significantly and in dose dependent manner.<sup>52</sup> About 94% seed diet of *Acacia arabica* showed hypoglycemic effect in rats through release of insulin. The plant extract acts as an antidiabetic agent by acting as secretagogue to release insulin. It induces hypoglycemia in control rats but not in alloxanized animals.<sup>53, 54</sup> Powdered seeds of *A. arabica* when administered (2, 3 and 4 g/kg body weight) to normal rabbits, induces hypoglycemic effect by initiating release of insulin from pancreatic beta cells.<sup>53, 54, 55</sup>

#### Anti-oxidant activity

Antioxidant activity of ethyl acetate soluble fraction of *A. arabica* bark by in vitro lipid peroxidation model was carried out by tertiary butyl hydroperoxide induced lipid peroxidation and the most active fraction were identified by TLC and in vivo experiment in most active fraction were carried out with 50, 100 and 150 mg/kg oral dose in carbon tetra chloride induced hepatotoxicity in rats and it is hypothesized that flash chromatographic fraction of ethyl acetate extract exhibited maximum activity with in vitro lipid peroxidation and 150 mg/kg dose of carbon tetra chloride shows marked liver protection in in vitro model.<sup>10</sup> The extracts, produced by 80% methanol, from leaf, bark and seed of three medicinal plants namely neem (*Azadirachta indica* A. Juss), kiker (*Acacia nilotica* L.) and jaman (*Eugenia jambolana* L.), were assessed for their antioxidant activity. The results showed that among the different parts of the investigated plants, neem leaf extract possessed highest activity to scavenge DPPH (71.54%) followed by kiker leaf and jaman leaf with contribution at 66.54% and 54.27%, respectively.<sup>44</sup> *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.<sup>9, 56</sup>

#### Antiproteolytic activity

Inhibition of total proteolytic (caseinolytic), tryptic (by hydrolysis of benzoyl arginine p-nitroanilide) and chymotryptic (by hydrolysis of acetyl tyrosine ethyl ester) activities by ten species of legume seeds on human and bovine pancreatic proteases were studied. *Acacia* seeds extracts displayed more pronounced action on human trypsin and chymotrypsin, it was more effective in inhibiting the total proteolytic activity of the bovine system.<sup>2</sup>

#### Antispasmodial activity

*Acacia nilotica* (methanolic extract) inhibited the spontaneous contraction of rabbit jejunum in a dose-dependent (0.1– 3.0 mg/mL) manner. It also inhibit K<sup>+</sup>-induced contractions, The mechanism behind it is calcium channel blockade that results in lowering of blood pressure effect.<sup>57</sup>

#### Antiulcer activity

In a study by Bansal and goel (2012), different extracts [ethanolic, 50% hydroethanolic (50:50), 70% hydroethanolic (70:30) and aqueous] of young seedless pods were examined in pylorus ligation induced gastric ulcers in rats. Various parameters like, volume of gastric acid secretion, pH, free acidity, total acidity, ulcer index, mucin content and antioxidant studies were determined and were compared between extract treated, standard and vehicle control following ulcer induction. The most active extract was also evaluated in swimming stress induced and NSAID induced gastric ulceration. Results showed significant antiulcer activity in pyloric ligation induced ulceration. Even more the 70% hydroethanolic extract showed better protection as compared to 50% hydroethanolic extract. Further 70% hydroethanolic extract also showed significant mucoprotection.<sup>58</sup>

#### Anti-hypertensive activity and vasoconstriction activity

A methanol extract of *Acacia nilotica* pods (AN) caused a dose-dependent (3–30 mg/kg) fall in arterial blood pressure. Treatment of animals with atropine abolished the vasodilator response of acetylcholine (ACh), whereas the antihypertensive effect of the plant extract remained unaltered. Phentolamine (an  $\alpha$ -adrenergic blocker) abolished the vasoconstrictor effect of norepinephrine (NE), whereas pretreatment of the animal with AN, did not modify the NE response. These results indicate that the antihypertensive

effect of plant extract is independent of muscarinic receptor stimulation or adrenoceptor blockade.<sup>57</sup>

#### Anticancer and Antimutagenic activity

Punar Dutt Meena et al (2006) report the chemopreventive activity of *Acacia nilotica* (Linn.) gum, flower and leaf aqueous extracts, on 7,12-dimethylbenz(a)anthracene (DMBA) induced skin papillomagenesis in male Swiss albino mice. A significant reduction in the values of tumor burden, tumor incidence and cumulative number of papillomas was observed in mice treated by oral gavage with the *Acacia nilotica* gum, flower and leaf extracts as compared with the control group.<sup>8</sup> *Acacia* inhibits tumour cell growth and selectively toxic to tumour cells at very low doses, also shown to have potent cytotoxicity activity against human T-cell leukemia.<sup>25</sup> KM Sakthivel et al(2012) studied the effect of *A. nilotica* extract against Dalton's ascitic lymphoma (DAL) induced solid and ascitic tumors in BALB/c mice. Experimental animals received *A. nilotica* extract (10 mg/kg.bw) intraperitoneally for 10 and 14 consecutive days before induction of solid and ascitic tumors, respectively. Treatment with *A. nilotica* extract significantly decreased the development of tumor.<sup>59</sup>

#### Abortifacient Activity

Nath et al (1992) studied aqueous or 90% ethanol extracts of the plants of interest in rats orally dosed for 10 days after insemination with special reference to see the effect on foetal development. Leaf extracts of *Moringa oleifera* and *Adhatoda vasica* were 100% abortive at doses equivalent to 175 mg/kg of starting dry material. Only the flowers of *Acacia arabica* and *Hibiscus rosa-sinensis* appeared to lack teratologic potential at the doses tested.<sup>60</sup>

#### Anti-helminthic activity

In vitro methanolic extract of *Acacia nilotica* fruit exhibit anthelmintic activity against *Haemonchus contortus* at LC50 = 512.86 and 194.98  $\mu$ g/ml concentration by the adult motility assay, the egg hatch test and the larval development assay.<sup>9</sup>

#### Milk production

Study performed by Z Lompo-Ouedraogo and others (2004) to determine the effect of an aqueous extract of AN on milk production in rats. Female rats that received oral doses of aqueous extract of this plant during their first lactation produced about 59% more milk than controls (P<0.01). The extract of AN was found to stimulate the synthesis and release of prolactin (PRL) significantly (P<0.05). In addition, the mammary glands of oestrogenprimed rats treated with the extract showed clear lobuloalveolar development with milk secretion. This study demonstrates that the aqueous extract of AN can stimulate milk production and PRL release in the female rat.<sup>61</sup>

#### 8. CLINICAL STUDIES

Tangade et al (2012) has studied anti-plaque and anti-gingivitis properties of *Acacia arabica* containing toothpaste. Sixty subjects with gingivitis were randomly assigned to a test group (*Acacia arabica*-containing toothpaste) or control group (regular toothpaste). An analysis of plaque index (PI), gingival index (GI) and bleeding on probing index (BOP%) were carried out at baseline and after 28 days followed by a washout period. Result showed reductions in PI, GI and BOP% in the *Acacia arabica* containing toothpaste compared with regular toothpaste.<sup>62</sup>

A prospective, randomized, placebo and positively controlled clinical trial was designed to evaluate the short-term clinical effects of a commercially available gel containing *Acacia arabica* in the reduction of plaque and gingival inflammation in subjects with gingivitis. Ninety subjects diagnosed with chronic generalized gingivitis were selected and randomly divided into three groups: Group I – placebo gel, Group II – gumtone gel and Group III – 1% chlorhexidine gel. Gumtone gel showed significant clinical improvement in gingival and plaque index scores as compared to a placebo gel. This improvement was comparable to 1% chlorhexidine gel. Unlike chlorhexidine gel, gumtone gel was not associated with any discolouration of teeth or unpleasant taste.<sup>63</sup>

Double-blind, randomized control trial sought to evaluate the clinical effects of 3 mouthrinses against salivary mutans streptococci (MS). Ninety high-caries risk volunteers were randomly assigned to 3 groups, each group using a selected mouthrinse BID for 30 days. Subjects in Group 1 rinsed with 10 ml of 50% *Acacia nilotica*, Group 2 subjects rinsed with 10 ml of 0.2% chlorhexidine (active

control), and subjects in Group 3 rinsed with saline water (passive control). Unstimulated saliva samples were collected at baseline, 30, and 60 days. MS were cultured on mitis salivarius bacitracin agar, and colony counts were obtained. There were significant decreases in the MS colony count in the A. nilotica and chlorhexidine groups at 30 days (85% and 83%, respectively) and at 60 days (65% and 63%, respectively) ( $P < 0.0001$ ). The antibacterial action of A. nilotica against MS was similar to that of chlorhexidine.<sup>3</sup>

One study was conducted to assess the effect of Indian Gum Arabic pods powder on blood glucose and lipid levels of type 2 diabetic subjects. Forty five subjects with type 2 diabetes: age 45-65 years, male or female, not on insulin therapy, not taking medicine for other health conditions and fasting blood glucose levels between (110–300 mg/dl) were divided randomly in three groups. Group I, II and III consumed 2, 3 and 4 g of pods powder daily, respectively for four weeks. After 28 days the pods powder reduced the fasting blood glucose (10–19%), post prandial (7-35%), triglyceride (6-18%), LDL (7–10%), total cholesterol (5-11%), VLDL (7-15%), HDL cholesterol (5-10%) and blood pressure (8-13%) of the subjects. Changes were significant in the post prandial glucose level, triglyceride and VLDL cholesterol and blood pressure levels of the third group of subjects who were taking 4 g of pods powder daily.<sup>64</sup>

A prospective, single blind, standard controlled randomized clinical trial on 45 patients (30 patients in test group and 15 in control group) with complaint of abnormal vaginal discharge or vulvovaginal pruritus. Married patients aged 18- 45 years with regular cycles and diagnosed as having BV were included in this study. Decoction of Chal babool was given orally (30gms twice daily) for one month and standard drug Tab. Metronidazole (400mg twice daily) for 7 days was given in test and control group respectively. For diagnosis and cure rate of bacterial vaginosis, Amsel's criteria were used. Results: There was a significant improvement in the subjective and objective parameters; test drug was found to have similar effective as in control drug in the management of Bacterial Vaginosis ( $P = 1.000$ ) statistically.<sup>65</sup>

Single blind, plain controlled randomized study was conducted to evaluate the efficacy of Aqaqia (Acacia arabica) in improving Woman's Quality of Life in Nutue Rehm (Uterine Prolapse) with well validated Prolapse-Quality of Life (P-QOL) Questionnaire. Thirty subjects diagnosed with uterine prolapsed were selected and randomly divided into two groups: Group I – test group (Acacia arabica powder orally as well as pessary with pelvic floor muscle exercise) I, Group II-control group (Vitamin B complex with pelvic floor muscle exercise). Clinical evaluation was undertaken using the P-QOL questionnaire. The test group shows a significant improvement in quality of life in uterine prolapse patient as compared to a control group.<sup>47</sup>

## 9. CONCLUSION

As the pharmacologists are looking forward to develop new drugs from natural sources, development of modern drugs from Acacia arabica can be emphasized for the control of various diseases. It contains a number of phytoconstituents, which are the key factors in the medicinal value of this plant. It is quite evident from this review that Acacia arabica is an important medicinal herb and extensively all types of medicinal systems. It elicits on all aspects of herb and throws the attention to set the mind of the researchers to carry out the work for developing the new formulations which can ultimately beneficial for the human being.

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