Review Article

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PHYTOCHEMICAL AND PHARMACOLOGICAL PROPERTIES OF *BABOOL* (*ACACIA ARABICA* WILLD.): A REVIEW

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ABSTRACT

The Ayurvedic drug *Babool*, botanically identified as *Acacia arabica* Willd., is a synonym of *Acacia nilotica* (L.) Delile and *Mimosa arabica* Lam. *Babool* (*Acacia arabica* Willd.) belongs to the family Mimosaceae. Its Habitat is in dry and sandy localities. In Ayurveda, it contains *sthambana* (refrigeration), *shoshana* and *sangrahi* properties and it is applied in *sweta Pradara* (leucorrhoea), *Atisara* (diarrhoea), *Prameha* (diabetes) and many other diseases. It shows astringent, cooling, styptic, expectorant, demulcent, antimicrobial, antibacterial, anthelmintic, anti-inflammatory, antioxidant, anti-diabetics, and a wide range of useful properties for the welfare of mankind. The current study attempts to provide an up-to-date snapshot with full exploitation of all plant parts along with the literature survey of ethnobotany, phytochemistry and pharmacological uses of *Babool* (*Acacia arabica* Willd.).

Keywords: Tannin, Flavonoids, Ayurveda.

INTRODUCTION

Babool (*Acacia arabica* Willd.) is a medicinally precious plant found in the drier parts of India. *Babool* (*Acacia arabica* Willd.) is not found in the classical *Ayurvedic* literature[1]. Its first description is in *Sodhala Nighantu*[1]. *Raj Nighantu* mentioned it as *Barbari*[1]. *Gadanigraha* described *Baboolasava* and the usage of *Babool* leaves in diarrhoea[1]. It is also assured that *Babool* (*Acacia arabica* Willd.) used in India is during Muslim rule (11-12 AD)[1]. *Babool* (*Acacia arabica* Willd.) is an abundantly grown in the plains of Uttar Pradesh, Haryana, Punjab, in the drier parts of Bihar, Maharashtra, Andhra Pradesh, Tamil Nadu, Karnataka[2,3]. It thrives best on shallow alluvial soils overlying hard calcareous pans within the 300-400 mm isohyet[2]. It is drought resistant plant until the sub-soil holds the moisture and doesn't need much care[2]. It can withstand an extreme temperature of up to 50 °C[2,3,] the absolute minimum from -1 to 15 ºC, and the normal rainfall from 7.5 to 125 cm[2].

Babool's bark (2 parts) and myrobalans (1 part) are used in tanning industries to produce leather kips[2]. *Babool*'s gum is used in the making of paper, calico-printing and dyeing, as an adhesive agent, ice-cream stabilizer and also added in sweet meals[2]. This tree consists of tannins, catechin, epicatechin, gallic acid, leucocyanidin gallate, quercetin, sucrose and gum[4]. Medicinally, it is used in ascites, chronic dysentery, diarrhoea, vitiligo, skin diseases, leprosy, burns, haemorrhoids, cough, bronchitis, asthma, oral ulcers and odontopathy[3].

Vernacular Names

1. English – Indian Gum Arabic Tree, Babool, Black Babool.
2. Sanskrit name – *Babool*, *Yugalaksha*, *Kantalu*, *Tikshakantak*, *Goshrunga*, *Deerghakanta*, *Ajabhaksha*, *Sukshmapatra.*
3. Hindi –*Babool*, *Kikar*
4. Punjab and Uttar Pradesh – *Babool*, *Kikar*
5. Marathi – *Babhul*, *Vedibabul*
6. Kannada –*Gobbli*, *Jali*, *Karijali*
7. Bengali – *Babla*, *Babul, Babulgachh*
8. Gujarati – *Babaria*, *Baval*
9. Telugu – *Nallatumma*, *Tumma*
10. Tamil – *Karuvelamaram*,*Karuvelei*
11. Malayalam – *Karuvelam* [5]

Synonyms: Sapitaka, Sadhpadmodini, Yugmakanth, Sukshamapatra, Malaphala, Dridaruha.

Used part: Stembark, Fruit, Gum[6].

Botanical Description

A moderate-sized tree, usually 15m in height and a circumference of 1.2 m[2,3,7], and an altitude of up to 900 m[2] (Figure 1). Bark (Figure 2) is brownish or blackish grey, longitudinally fissured or deeply cracked[2,3,8,9]. Leaves are 2.5-5 cm long, leaflets 10-20 pairs, Bipinnate with spinescent stipules, pinnules narrowly oblong[2]. Flowers (Figure 3) are golden-yellow, having a fragrant odour, in axillary clusters of 2-5 heads, stalked globose heads, 1.5 cm in diam[3,8,10,11]. Legumes (Figure 4) are flat, 7.5-15 cm, 8-12 seeds, persistently grey, constricted between the circular seeds[2,8,10,12,13]. The gum varies in colour from yellow to dark brown, in the form of rounded or ovoid tears (about a centimetre in size)[4,2]. Its gum is denoted as *Gundra* in *Gadanigraha*[1]. Flowering is in the rainy season, and fruiting is during the cold season[3,8,9].

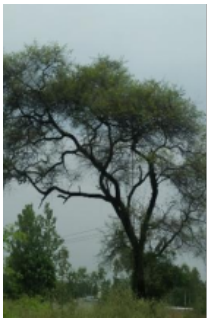

Figure 1: *Babool* (*Acacia arabica* Willd.)

Figure 2: *Babool* (*Acacia arabica* Willd.) Bark

Figure 3: *Babool* (*Acacia arabica* Willd.) Flowers

Figure 4: *Babool* (*Acacia arabica* Willd.) Legumes

Phytochemical Description

***Ayurvedic* properties**	
Rasa	*Kasaya*
Vipaka	*Katu*
Veerya	*Sheeta*
Guna	*Guru*, *Ruksa*
Karma	*Kaphahara*, *Lekhana*, *Grahi* [6]

Chemical constituents

Major- Arabic acid[14]
Others-6-*O*-(*β*-D-Glucopyranosyluronic acid)-D-galactose, 6-*O*-(4-*O*-methyl-*β*-D-Glucopyranosyluronic acid)-D-galactose, 4-*O*-(*α*-D-glucopyranosyluronic acid)-D-galactose, 4-*O*-(4-*O*-methyl-*α*-D-Glucopyranosyluronic acid)-D-galactose[14].

The chemical structures in stems, leaves, and flowers are represented in Tables 1-3.

Table 1: Stem

Class	Class name	References
Tannins	(-) - Epigallocatechin-7-gallate	15
	(-) - Epigallocatechin-5,7-digallate	15
	Dicatechin	16
	Gallic acid	16
Phenolic acids	3,4,5-trihydroxybenzoate	17
	Methyl 3,4,5-trimethoxy benzoate	17
	p- Coumaroyl-glucoside	17
	p- Coumaroyl quinic acid	17
Flavonoids	Quercetin 3-O-(4'-O-acetyl)- rhamnopyranoside	17
	Acacetin	18
	Kaempferol	19
	Kaempferol-7-glucoside	20
	(+)-Catechin-5-gallate	21, 22
	(+)-Catechin-3',5-digallate	22
	(+)-Catechin-4',5-digallate	22
	(+)-Catechin-5,7-digallate	22
Terpenes	Niloticane	23, 21
	Lupenone	23
Fatty acids	Myristic acid	17
	Oleic acid	17
	Palmitic acid	17

Table 2: Leaves

Class	Class Name	References
Flavonoids	3',4',7-trimethyl quercetin	24
	Epicatecine-3-gallate	17
	Quercetin 3-O-(4'-O-acetyl)- rhamnopyranoside	17
	Quercitin-3-galactosyl	27
	Flavone	27
Tannins	Ethyl gallate	28
Terpenes	Lupeol	27
	1,3,4 – Eugenol	24
	3-Oxo-alpha-ionol	24
	4-(1,5-Dihydroxy-2,6,6-trimethylcylohex-2-enyl)but-3-en-2-one	24
Phenolic acids	Caffeic acid phenethyl ester (CAPE)	17
	Cinnamic acid	24
	Ferulic acid	17
	Terephthalic acid ester of neopentyl glycol cyclic dimer	24
	p- Coumaroyl-glucoside	17
	p- Coumaroyl quinic acid	17
Fatty acids	Arachidonic acid	24
	Myristic acid	24
	Oleic acid	17
	Palmitic acid	17
	Stearic acid	24
	Stearic acid ethyl ester	24
	Isopropyl palmitate	24

Table 3: Flowers

Class	Class Names	References
Tannins	Gallic acid	16, 28
Flavonoids	Quercetin	28
	Catechin	28
	Catechin-7-O-gallate	28
	Quercetin	28
	Quercetin-3-O-β-glucopyranoside (Isoquercetin)	28
	Naringenin	25, 26
	Naringenin-7-O-β-glucopyranoside	28

Seed contains palmitic acid (hexadecanoic acid)[31], oleic acid, linoleic acid[32], stearic acid (octadecanoic acid), arachidic acid (ceiocosamic acid)[31]. Pods contain 1-O-galloyl-β-D-glucose, 1,6-di-O-galloyl-β-D-glucose[21], digallic acid[21], ellagic acid[20], epicatechin[20], niloticane[21,9], methyl gallate[33,21]. Melacacidin is present in heartwood[34]. The gum contains D-galactose, L-arabinose, L-rhamnose, 6-O-(β-D-glucopyranosyluronic acid)-D-galactose, 6-O-(4-O-methyl-β-D-glucopyranosyluronic acid)-D-galactose, 4-O-(α-D-glucopyranosyluronic acid)-D-galactose (Anderson and Karamal 1996), 2-O-β-L-arabinofuranosyl-L-arabinose, 3-O-β-L-arabinopyranosyl-L-arabinose[36].

Tannins such as gallic acid, (-)-epigallocatechin-7-gallate, ethyl gallate, (-)-epigallocatechin-5,7-gallate, dicatechins in *Babool* (*Acacia arabica* Willd.) are found. (Figure 5-9) Phenolic acids such as 3,4,5-trihydroxybenzoate, methyl 3,4,5-trimethoxy benzoate, caffeic acid phenethyl ester (cape), p- coumaroyl quinic acid, cinnamic acid, ferulic acid in *Babool* (*Acacia arabica* Willd.) are found. (Figure 10-15) Flavonoids in *Babool* (*Acacia arabica* Willd.) such as acacetin, kaempferol, kaempferol-7-glucoside, catechin, quercetin, isoquercetin, naringenin etc. are present. (Figure 16-22) Terpenes such as niloticane and lupeol in *Babool* (*Acacia arabica* Willd.) are found. (Figure 23 and 24) Fatty acids include oleic acid, myristic acid, palmitic acid, arachidonic acid, stearic acid and linoleic acid in *Babool* (*Acacia arabica* Willd.) are found. (Figures 25 and 30)

Pharmacological Properties

According to *Nighantus*

Chakradata mentioned the application of tender leaves of *Babool* in *Atisar* (diarrhoea) and *Upadansha* (syphilis). *Bhavamishra* mentioned the use of *Babool*'s seed in *Snayuka rog*. *Anjana* (disambiguation) made by its leaves is applied in conjunctivitis. The effectiveness of the stem bark of *Babool* in ascites, on boiling and taking it with *takra* (buttermilk) as *anupana* (adjuvants). *Bhavaprakasha* also mentioned it as *Kapha hara*, *grahi* (digestive and faecal astringents), *Kusthaghna* (skin diseases), *Krimighna* (antimicrobial, antibacterial, anthelmintic etc.), *Visaghna* (anti-poisonous) and treated *Raktapitta* within seven days. *Atraya Samhita* described its ability in the treatment of *Bhagna* (fracture), *Raktatisara* (diarrhoea with bleeding), *Prameha* (diabetes) and *Pradara* (leukorrhea). Babool's gum is used in *Raktatisara*, *Prameha*, and *Pradara* and also has *sheeta*, *Pitta* and *Vata nasaka*, *malarodhaka* (laxatives) and *bhagncka* properties. *Nighantu Ratnakar* mentioned it to alleviate *ama*, *Raktatisara*, *Kasa*, *daha* (burning), and *Prameha*. Its leaves are used for *mala rodhaka*, *ruchikaraka*, *Kasa*, *Parushata* (infertility), and *Arsha* (piles). The pods of *Babool* are *mala sthambaka*, *lekhana* (scraping agents), and *Kapha-Pitta nasaka*. The gum of the *Babool* is also applicable in *malarodhaka*, *Raktatisara*, *Raktapitta*, *Prameha*, and *Pradara* and has the properties of *bhagnasndhankarak*. In *Priya Nighantu, Babool* is considered *kashaya*, *ruksha*, *sheeta virya* and *sthambana* (refrigeration). It is instrumental in *Kasa*, *Kustha* and *Atisara*. *Shodhala Nighatu* also described it in *varna*, *karna*, *ashaya* and *nadivarna nasaka*. Its pod is used as *Kusthgana*, *bedhana* (stimulant purgatives) and

Krimigana. *Raj Nighantu* also applies it in treating *Kasa*, *aama*, *Raktatisar*, *daha* and *Arsha*.

CONCLUSION

Many formulations include *Baboolarista*, *Trayodashang Guggulu*, *Lavangadi vati, Baboolasava, Bhagotar gutika,* and *Kapooradi vati* in which *Babool* has been used as an ingredient for treating diarrhoea, cough and mouth disorders etc. It is a readily available medicinal plant, low in cost and has a natural origin with lesser or no side effects. This current literature is an attempt to highlight the diversity of chemical constituents of each part and various pharmacological effects and other literature information related to the *Babool* (*Acacia arabica* Willd.). Therefore, further laboratory research should be carried out to create more awareness about its phytochemical and physiochemical studies. With the increasing extinction of most herbal medicinal plants, there is a need for further research in laboratories to create more awareness about their phytochemical and physiochemical studies. We hope this article is sufficient to provide complete literature information for researchers to discover its applications in the clinical aspect further.

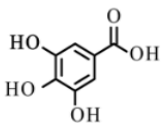

Figure 5: Gallic acid

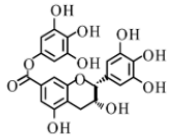

Figure 6: (-) - Epigallocatechin-7-gallate

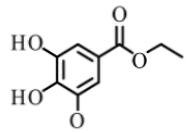

Figure 7: Ethyl gallate

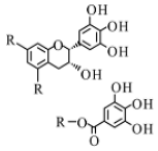

Figure 8: (-)-Epigallocatechin-5,7-digallate

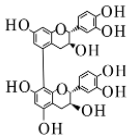

Figure 9: Dicatechins

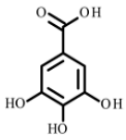

Figure 10: 3,4,5-trihydroxybenzoate

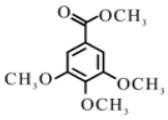

Figure 11: Methyl 3,4,5-trimethoxy benzoate

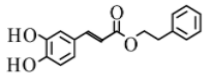

Figure 12: Caffeic acid phenethyl ester

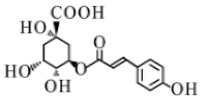

Figure 13: p- Coumaroyl quinic acid

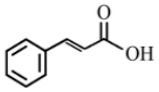

Figure 14: Cinnamic acid

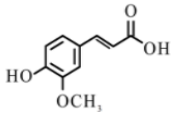

Figure 15: Ferulic acid

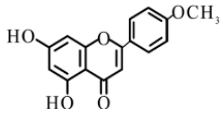

Figure 16: Acacetin

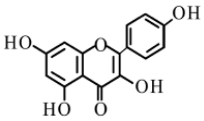

Figure 17: Kaempferol

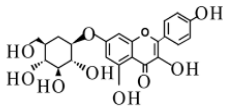

Figure 18: Kaempferol-7-glucoside

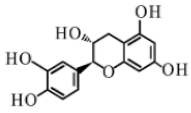

Figure 19: Catechin

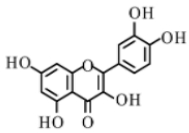

Figure 20: Quercetin

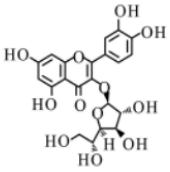

Figure 21: Isoquercetin

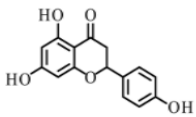

Figure 22: Naringenin

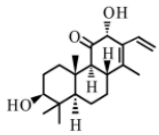

Figure 23: Niloticane

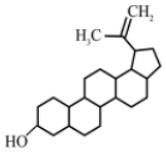

Figure 24: Lupeol

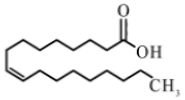

Figure 25: Oleic acid

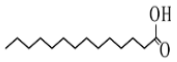

Figure 26: Myristic acid

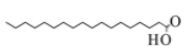

Figure 27: Palmitic acid

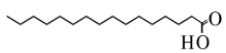

Figure 28: Arachidonic acid

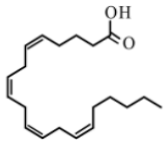

Figure 29: Stearic acid

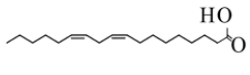

Figure 30: Linoleic acid

Table 4: Pharmacological actions, used part, extracts, Samples or microorganisms taken for the test, results

Actions	Used part	Extracts	Samples or microorganisms taken for the test	Results
Antimicrobial[39]	Bark and pod	Hexane and methanolic extract	Bacterial strains- *Escherichia coli*, *Staphylococcus aureus* and *Salmonella typhi*. Fungal strains- *Candida albicans* and *Aspergillus niger*.	Highest activity in methanolic extract of pods against *Escherichia coli* and *Staphylococcus aureus* while hexane extract against *Salmonella typhi*.
Antimicrobial[40]	Stem bark	Ethanolic extract	*Streptococcus viridans*, *Staphylococcus aureus*, *Escherichia coli*, *Bacillus subtilis* and *Shigella sonnei*	Highest activity against *Bacillus subtilis*.
Antibacterial[41]	Gum, leaf, fruit	Alcoholic, hexane and aqueous extract	*Staphylococcus aureus*, *Escherichia coli*, *Bacillus subtilis*, *Salmonella typhimurium*, *Proteus vulgaris*, *Pseudomonas aeruginosa*.	Positive on alcoholic extract against *Staphylococcus aureus*
Antibacterial[42]	Bark	Hexane, petroleum ether, chloroform, ethyl acetate, acetone, methanol	Gram-positive bacteria (*Bacillus cereus*, *Bacillus subtilis*, *Staphylococcus aureus*, *Streptococcus pyogenes*, *Clostridium perfringens*, *Listeria monocytogenes*) and gram-negative bacteria (*Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Shigella dysenteriae*, *Vibrio cholerae* and *Campylobacter jejuni*)	Acetone extract (except *Campylobacter jejuni*) was followed by methanol, chloroform, ethyl acetate, and hexane, while petroleum ether was less effective.
Antioxidant[43]	Leaves	Ethanolic extract	-	Positive
Antioxidant[44]	Leaf	Crude extract	*Saccharomyces cerevisiae*	Positive
Anti-fungal[45]	Bark, pods, leaves and seeds.	Methanol, di-ethyl ether, acetone, aqueous extract, petroleum ether etc.	*Penicillium italicum*, *Aspergillus niger*	-Among different parts, the extract of bark and pods is more effective. -Among extraction with different solvents, methanol, di-ethyl ether, acetone, and aqueous extract.
Anti-fungal[39]	Bark and pod	Hexane and methanolic extract	Fungal strains- *Candida albicans* and *Aspergillus niger*.	Highest activity in methanolic extract of pods against *Aspergillus niger*.
Anti-inflammatory[46]	Flowers	Alcohol, petroleum ether, di-ethyl ether, ethyl acetate	*Bacillus subtilis*	Ethyl acetate extract showed a positive result.
Anti-inflammatory[9]	Bark	ethyl extract	Indomethacin (positive control)	Positive
Anti-diabetic[47]	Seeds	-	normal and alloxanized rats	A positive result in normal rats, not in alloxanized rats.
Anti-diarrheal[48]	Bark	Methanolic extract	Swiss albino rat against barium chloride, castor oil and magnesium sulphate	Positive
Anti-viral[49]	Leaves	Crude extract	turnip mosaic virus	Positive
Anti-viral[49,50]	Bark	Crude extract	Potato virus	Positive

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