International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 3 May-June 2025, pp: 2206-2212 www.ijprajournal.com ISSN: 2456-4494

An Overview on Ethanopharmacological Profile of Bacopa Monniera

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Date of Submission: 28-06-2025 Date of Acceptance: 08-07-2025

ABSTRACT
Plants have long been used as medicines due to their therapeutic properties. They keep receiving a lot of attention due to their ability to cure both acute and long-term pathological conditions. Plant research has gained global attention in recent years. A substantial amount of data has been amassed to show the enormous potential of medicinal plants in a variety of medical systems. Bacopa monniera is one of the most beneficial medicinal herbs in Ayurvedic medicine. Bacopa monniera was found worldwide in marshes and warmer climates. In traditional medicine, it was commonly used to treat a variety of illnesses. Brahminic acid, D-mannitol, β-sitosterol, nicotinine, herpestine, bacosides A, triterpenoid saponins, saponins A, B, and C, and pseudojujubogenin glycoside were among the alkaloids found in Bacopa monniera. Pharmacological studies revealed that Bacopa monniera had a wide range of pharmacoogical effects, including antioxidant, gastrointestinal, endocrine, anti-inflammatory, analgesic, hair growth promoting effect, and effects on the central nervous system like memory enhancement, antidepressant, anxiolytic, anticonvulsant, and antiparkinsonian activity.

Key Words: Bacopa monniera, Brahmi, Brahminic acid and Bacopasides

I. INTRODUCTION

Bacopa monniera, a member of the Scrophulariaceae family, is also referred to as Brahmi. (1) There are 56 species in the genus that live in tropical and subtropical areas.(2) It originates from Indochina, Sri Lanka, and India that grows along lakes and rivers. The Andaman and Nicobar Islands are home to it. It is present in every district in Kerala, the southernmost state of India. (3)It is an essential component of several medicines and traditionallyused in India. It has numerous branches, tiny elliptical leaves, violet blooms, and it is a creeping herb.(4)

The first mention of Bacopa monniera dates back to the sixth century A.D. In writings like the Sushruta Samhita, Athar-Ved, and Charaka Samhita as a medhyarasayana - class plant used to lessen mental impairments and hone intelligence. Bacopa monniera is a common ingredient in several Ayurvedic medicines recommended for cognitive impairment. In contrast to the potentially strong and addictive effects of commonly used psychostimulants, moderate and long-term treatment of Bacopa monniera seems to support rather than deplete neurons a finding consistent with 1400 years of Ayurvedic research.

It is used to treat a variety of nerve problems, as a brain tonic to improve learning, memory, and focus, and to relieve anxiety in patients; it is also used to treat skin disorders, digestive issues, and as an antiepileptic, analgesic, and antipyretic (5).Alkaloid brahmine, nicotinine, herpestine, bacosides A[3-(α-L-arabinopyranosyl)-O-β-Dglucopyranoside-10,20-dihydroxy-16-keto-dammar-24-ene], triterpenoid saponins, saponins A, B, and C, betulinic acid, D-mannitol, stigmastanol, β-sitosterol, and pseudojujubogenin glycoside were all present in Bacopa monniera. Pharmacological studies revealed that Bacopa monnierahad a wide range of pharmacological effects, including antioxidant, gastrointestinal, endocrine, antimicrobial, anti-inflammatory, analgesic, cardiovascular, and smooth muscle relaxant effects. It also had effects on the central nervous system, including memory enhancement, antidepressant, anxiolytic, anticonvulsant, and antiparkinsonian effects(6-14).

BOTANICAL DESCRIPTION

1. **Synonyms**

i.	English	: water hyssanth, etc
ii.	Sanskrit	: Brahmi, Tiktalonika
iii.	Tamil	: Nir-P-Pirami, Piramiyam
iv.	Telugu	: Sambrani Oku
v.	Hindi	: Jalbuti, baam, jalnim, Nir Brahmi
vi.	Kanada	: Jala Brahmi, Niru Brahmi
vii.	Manipuri	: Brahmi Sak

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viii. Marathi : Brahmi, Jala Brahmi, Nir Brahmi
ix. Oriya : Brahmi, prusnipar

2. **Taxonomy**

i. Kingdom :plantae
ii. Division :Magnoliophyta
iii. Class : Magnoliopsida
iv. Order :Lamiales
v. Family : Scrophulariaceae
vi. Genus : bacopa
vii. Species : bacopa monniera

Fig 1: Bacopa Monniera

Morphological characters of Bacopa Monniera plant parts:

Root: White in colour, cylindrical, 5 mm in diameter, longitudinally.

Stem: Glanton, branches are growing vertically, and nodes and internodes are present. They are about 1-1.5 cm long and 3-4mm in diameter, pale yellowish-green.

Leaf: Simple, opposite, and decussate, sessile, spatulate in shape, 0.6-2.5cm in length and3-8 in width, entire.

Flower: Pale blue or pinkish-white, solitary, axillary 0.6-3 cmin length., Corolla gamopetalous, stamens 4,didynamous, anthers two-celled, syncarpous ovary, two-chambered with many ovules, stigma bilobed.

Fruit: Glabrous capsule, 5 mm long, persistent calyx, ped1-3 CM long,purplish when fresh.

Seed: Numerous, minute, <1cm wide, elliptical or regular.

Ethnobotanical uses of Bacopa monniera (Brahmi):

a. Brahmi leaf juice enhances the neurological system and increases blood flow (15).
b. One effective antioxidant for treating oxidative damage is Brahmi. Epilepsy, mental illnesses, and irritation are all alleviated (16).
c. Gonorrhoea and other STDs are treated with a powdered Brahmi leaf and milk mixture.
d. Elephantiasis is treated with ointment made from Brahmi root.
e. Brahmi leaf extract is a neurological tonic with neuroprotective properties that relieves fever and jaundice.
f. It is used to treat skin issues, spleen problems, anaemia, dyspepsia, and leprosy.
g. It provides nutrients to hair and promotes the growth of longer, thicker hair (17).
h. It's also applied to the treatment of tumours, dementia, and ulcers.
i. When coupled with Tulsi, neem, and amla, Brahmi promotes the growth of nails, hair, and skin.

CHEMICAL CONSTITUENTS:

The beneficial chemical components which are present in bacopa monnieraare alkaloids, saponins, glycosides, flavonoids, nicotine, herpestine, and important chemicals like bacosides and bacopa saponins. In addition to them bacopasides X, II, A3, and C as well as bacopa saponins are also present.(18,19)It also contains serine, pseudojujubogen, betulinic acid, brahmine, herpestone, nicotine, alanine, aspartic acid, glutamic saponins A, B, and C, bacosides A and B, triterpenoid, saponins, stigmastanol, D-mannitol, and stigmasterol (20). One of the isolated bacoside combinations from Bacopa monnieri is called bacoside A. Among its most significant components are bacopasides A3, II, and C, as well as the isomer of bacopasappnin C called jujubogenin (21).

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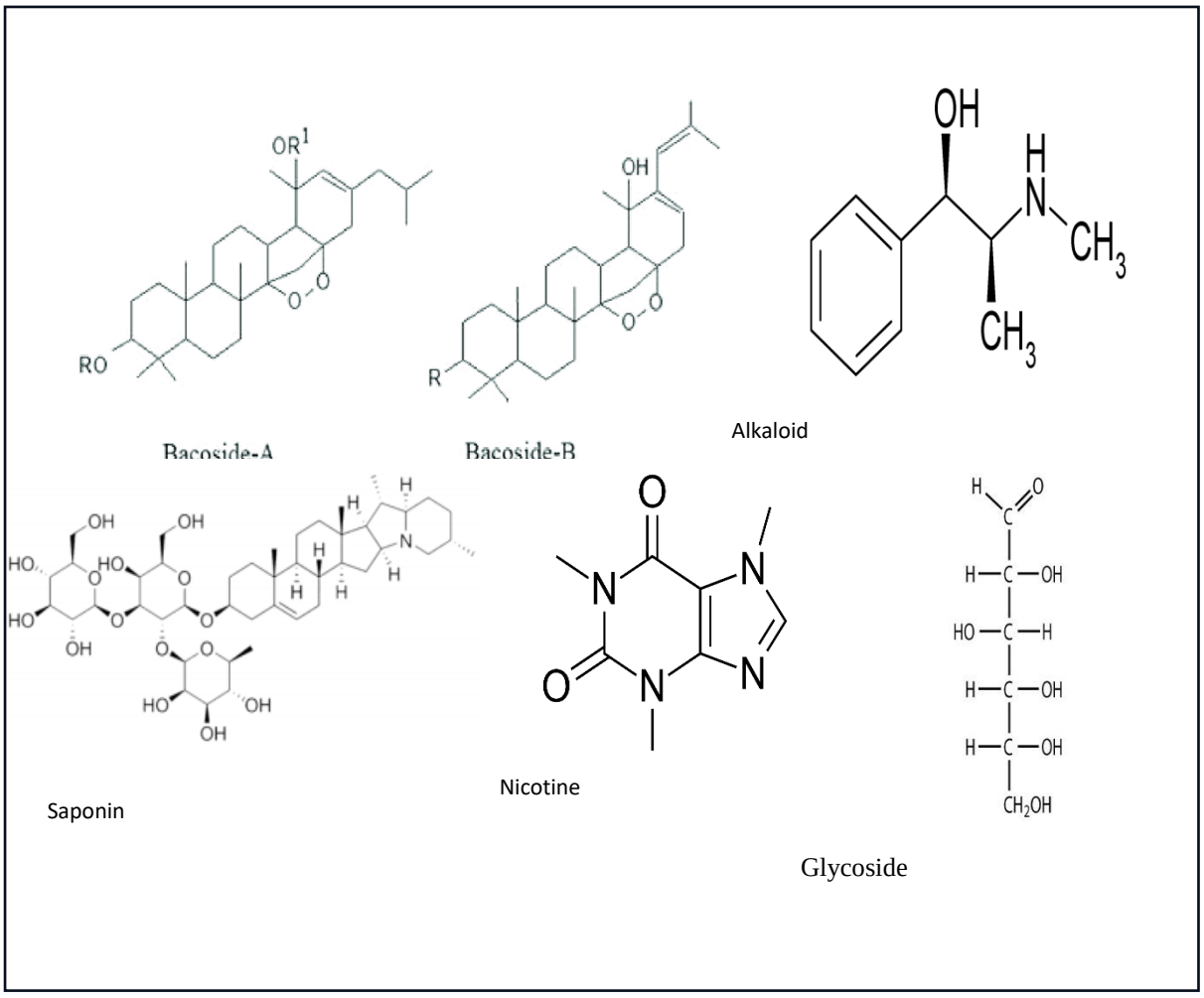

Fig:2 Structures of the chemical constituents of Bacopa monnieraplant

PHARMACOLOGICAL ACTIONS:

Central nervous effects:

1. Memory enhancement:

Animal behavioural research has demonstrated that Bacopa enhances motor learning, acquisition, and retention while delaying the extinction of recently learned behaviours (22). Using the forced swimming test (FST) and tail suspension test (TST) on mice, the antidepressant efficacy of B. monniera methanol extract and various fractions was assessed. However, it was shown that bacosides improve the level of acetylcholine and the hypoxic environment, which may help anterograde memory and reduce anterograde experimental amnesia caused by scopolamine and sodium nitrite, respectively. Furthermore, bacosides prevented retrograde amnesia caused by BN52021, a platelet-activating factor receptor antagonist. This effect is likely the result of bacosides increasing platelet activating factor production by raising the level of glutamate in the brain (23).

Bacopa seems to work in the brain through a variety of ways, all of which could help slow down the aging process related to cognitive loss. These comprise the following: (i) direct action that promotes cholinergic function; (ii) activity related to antioxidants (flavonoids); (iii) metal chelation; (iv) actions that reduce inflammation; (v) enhanced blood circulation; (vi) adaptogenic activity; and (vii) elimination of b-amyloid deposits. (24).

2. Anti-Depressant Activity:

Depression is a common, often fatal illness that affects a large number of people. It has reduced concentrations of norepinephrine, serotonin, and dopamine (25). Both the stress hormone and the hormonal balance of the body are

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influenced by substances. It's leaf increases the brain's serotonin levels, which lower anxiety and uneasiness and promote relaxation (26,27). In the forced swim and learned helplessness tests, two of the most often used behavioral paradigms in animal models of depression, it was discovered to have strong antidepressant effects. In rodents, it was shown to have antidepressant efficacy equivalent to that of imipramine, a common antidepressant medication. Because of its antidepressant and anxiolytic properties, serotonin and gamma-aminobutyric acid (GABA) are thought to be involved in the mechanism of action.(31)

When evaluated on forced swimming and tail-suspension models in experimental animals, bacopasides A and B, bacopasides I and II, bacopasaponin C, and the extract of Bacopa monniera showed antidepressant action, but bacopaside VII showed no antidepressant activity at all (28-30).

3. Anxiolytic:

Additional studies have demonstrated the anxiolytic, depressive, anticonvulsive, and antioxidant properties of crude plant extract of Bacopamonnieri, or bacosides(32). As an adaptogen, bacopa monniera proved very successful in restoring rats' corticosterone levels after both acute and chronic stress. Moreover, it restored noradrenalin (NA), 5-HT, and DA to normal in the rat brain and hippocampal regions under both acute and long-term unpredictable stress (33). Bacopa monniera increased 5-hydroxytryptamine levels in the cerebral cortex, hypothalamus, and hippocampal regions while decreasing norepinephrine levels. Comparing the higher doses of Bacopa monniera extracts to lorazepam, a common anxiolytic medication from benzodiazepine group, revealed noticeably more anxiolytic effects (34).

4. Anti parkinsonism:

Bacopa monnierahas demonstrated potential as an anti-Parkinsonian drug by reducingalpha synuclein aggregation, preventing dopaminergic neurodegeneration, and restoring lipid content in nematodes in pharmacological Caenorhabditis elegans models of Parkinson's disease(35).

5. Anticonvulsant:

Additionally, bacosides or crude plant extract of Bacopa monniera have demonstrated anticonvulsive activity (38). It had neuroprotective properties against glutamate-mediated excitotoxicity during seizures and against cognitive impairment linked to epilepsy brought on by pilocarpine.(36)Several convulsive models, including strychnine- and maximal electroshock-induced convulsions in rats, hypoxic stress-induced convulsions in mice, and lithium-pilocarpine-induced status epilepticus, were used to assess the anticonvulsant activity of the ethanolic extract of Bacopa monniera. For every model examined, the ethanolic leaf extract demonstrated strong anticonvulsant efficacy with a mechanism of action like that of benzodiazepines (GABA agonist)(37).

6. Endocrine Effects:

Bacopa monniera increased T4 by 41% in mice. It is not activated, suggesting that the extract acts only on the epithelial level to promote T4 production and release, not on the conversion of T4 to T3. BMEs caused a reversible suppression of fertility and spermatogenesis. The treatment altered the somniferous tubules in mice and decreased sperm motility and viability as well as the quantity of spermatozoa in the cauda, epididymis, and testis (39).

7. Anti-Microbial Activity:

The antibacterial effectiveness of Bacopa monniera was tested against a variety of bacterial strains using ethanol, methanol, and chloroform. Chloroform, methanol, and ethanol extracts were used to analyse Streptococcus pyrogens, Bacillus pumilus, Bacillus amayloliquefaciens, Salmonella typhi, Vulgarica, Micrococusluteus, Aspergillus Niger, Bacillus megaterium, and Bacillus subtilis. The bacteria's reaction to crude extracts varied based on the growth inhibition zone, the microorganisms, and the solvent (40,41).

8. Hair Growth-Promoting Activity:

Alcoholic extracts of Emblica officinalis, Bacopa monniera, Cyperus rotundus, or the full medication are used to make herbal hair oil. Using coconut oil as the base, each of the three herbs was produced separately and added to the hair oil in different amounts.Using hair length testing and healthy albino rats, the hair growth was compared to a standard minoxidil 2 percent ethanolic solution in a main skin irritation test. In terms of follicular size expansion and anagen phase prolongation, hair oil formulations fared better than the others (42-44).

9. Gastrointestinal Effects:

Both people and animals have had in vitro studies conducted on the effects of Bacopa

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monniera on the gastrointestinal tract. Irritable bowel syndrome and other conditions causing spasms in the intestines may be beneficial for BME (45,46).The results indicate that calcium influx inhibition, which affects both receptor- and electrical impulse-mediated calcium channels in the cell membrane, is principally responsible for BME's spasmolytic impact on smooth muscles. Research on animals and in vitro has shown that BM might have a protective impact. It affects stomach ulcers both preventively and therapeutically (47,48).

10. Antioxidant activity:

Bacosides have the ability to control the activities of SOD (superoxide dismutase), P450, and Hsp70, enabling the brain to be ready to respond in stressful or other unfavourable situations (49).The alcoholic extract of Bacopa monniera demonstrated hepatoprotective properties against the morphine-induced drop in GSH levels and inhibition of antioxidantenzymes in rats. (50)With an IC.50 value of 0.739 mg/ml, the methanolic extract of Bacopa monniericallus demonstrated scavenging activity (5). The administration of bacoside-A preserved the levels of trace elements and enhanced the antioxidant status. In rats with fibrosarcoma, bacopa Monnier extract increased antioxidant status, decreased lipid peroxidation rate, and decreased tumour development indicators (51).

11. Anti-inflammatory activity:

The triterpenoid and bacoside found in Bacopa monnieri are responsible for the plant's anti-inflammatory properties. By regulating the release of pro-inflammatory mediators, it can reduce inflammation. Tumour necrosis factor-alpha and interleukin-6, two pro-inflammatory cytokines, were not produced in the fractions containing bacosides and triterpenoids (52).

II. DISCUSSION & CONCLUSION:

Bacopa monniera is a medicinal plant used to treat various kinds of diseases and it is mainly used to treat neurodegenerative disorders. It is widely used in ayurvedic medicine. The health benefits and nutritional contents of Bacopacontributes to the medicinal world. This plant has high medicinal and food applications and it also contributes to the Sustainable Development Goal of promoting good health and well-being.It grows alongside of lakes and rivers and found in many places in India. The main chemical components, it contains are alkaloids, saponins, glycosides, flavonoids, nicotine, herpestine, and important chemicals like bacosides and bacopa saponins it is used to treat variety of diseases. Due to its high availability and important chemicals present in it, bacopa monniera becomes the important source to treat various kinds of diseases.

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