



# SYSTEMATIC REVIEW ON CULTIVATION, PHYTOCHEMICAL & PHARMACOLOGICAL ACTION OF BACOPA MONNIERI

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**Abstract:** Bacopa monnieri (Family: Scrophulariaceae) also known as Bramhi is an important medicinal food plant in the Indian subcontinent. Bramhi is used for enhancement of memory, intelligence and to treat neurodegenerative disorders. Pharmacological activities of Bacopa monnieri include anti-epileptic, anticancer, anti-ulcer and anti-inflammatory etc. This review attempts to encompass the available literature on Bacopa monnieri with respect to its pharmacognostic characters, cultivation, chemical constituents and summary of its various pharmacological activities and clinical uses.

**Keywords -** Bacopa monnieri , pharmacology, cultivation, phytochemistry.

## I. INTRODUCTION:

Bacopa monnieri is widely used in the Indian Ayurvedic system of medicine and is considered beneficial as a health supplement and for boosting the immune system. This article discusses the important phytochemistry, medicinal value and clinical evaluation of Bacopa monnieri (BM). Brahmi herb plays an important role in the treatment of minor and chronic diseases, Brahmi herb has been used for thousands of years and now India is an important country in Ayurveda, Siddha and Unani medicine. In India, the plant is sold commercially under the name Brahmi, a word derived from Brahma, the legendary creator of the Hindu pantheon. Brahmi has uses such as brain healing, intelligence enhancement, anti-epileptic, wound healing, anti-cancer, anti-anxiety.<sup>(3)</sup> Consuming Brahmi daily for two months can reduce stress, anxiety, and depression and improve patients' energy and mood. Bacopa monnieri is grown in southern and eastern India, Australia, Europe, Africa, Asia, North and South America and Sri Lanka. Brahmi synonyms such as hyssop, brahmi, thyme-leafed gracile, herb of grace, and Indian pennyworth. Most of the trials on Bacopa Monnieri are used for treatment of defining healthy and unhealthy cases from different diagnostic and symptom groups using assessment tools which were not necessarily comparable. Bacopa Monnieri is a medicinal plant used in the Ayurvedic system to improve memory and brain development. In brahmi extract, five different compounds are found in each extract, namely bacopaside A, bacopaside B, bacopaside C isomer, and bacopasaponin C. and Bacopa saponin-I were determined using the HPLC method. In preclinical studies, various extracts of Bacopa monnieri have shown positive cognitive effects when administered to animals. In animal behavior studies, animals given Bacopa monnieri have been shown to improve their motor skills<sup>(30)</sup>.

**PLANT PROFILE:****Fig 1. Bacopa Monnieri**

1. **Name:** Brahmi
2. **Synonym:** Nir Brahmi, Indian pennywort, Jalanevari, Jalbrahmi.
3. **Source:** It consist of fresh leaves and stem of plant known as Bacopa Monniera Linn.
4. **Family:** Scrophulariaceae
5. **Chemical Constituents:** Brahmi contain Bacoside-A and Bacoside-B.
6. **Genus:** Bacopa
7. **Species:** B. Monniera
8. **Zoological Name:** Bacopa Monnieri
9. **Class:** Mangoliopsida
10. **Subclass:** Asteranae

**GEOGRAPHICAL SOURCE:-**

Geographical source of Bacopa Monnieri was found to be Asia, Australia, and North & South America, Thailand, and Indian Region Such as Maharashtra at maa saraswati herbal farm of rakesh y. bhute at umari, post-mangali, tah-pauni, dist-bhandara (MH), Madhya-Pradesh, Kolkata, Utter Pradesh. Bacopa Monniera also found to be india, Nepal, Sri-lanka, China, Taiwan, Vietnam, Florida Hawaii, and other Southern state of USA .

**II. CULTIVATION PARAMETERS OF BACOPA MONNIERI:** (2, 20, 30,32,34,35,38)**Table 1.- Cultivation Parameters of Bacopa Monnieri**

Sr. No.	Parameters	Descriptions
1.	<b>Atmosphere</b>	Temperature at 20-42°C may be suitable for Bacopa Monnieri and PH of soil between 5-8.
2.	<b>Soil</b>	It grows in variety of soils. It can even tolerate poor drainage system.
3.	<b>Popular Varieties &amp; its bacoside contains</b>	<b>Pragyashakti:</b> Developed by CIMAP, Lucknow. The variety contains 1.8-2% Bacoside. <b>Subodhak:</b> Also developed by CIMAP, Lucknow. The variety contains 1.6 % Bacoside. <b>CIM-jagriti:</b> This variety contains 1.8 -2.2 % Bacoside.
4.	<b>Land Preparation</b>	For Brahmi plantation, it required well pulverize and levelled soil. To bring soil to fine tilth, ploughing and harrowing is to be done. Application of FYM @20q/acre is mixed with soil at the time of ploughing.
5.	<b>Sowing</b>	<b>Time of Sowing:</b> The planting should be done in the month of mid-June or early July. <b>Spacing:</b> Seedlings are transplanted at the distance of 10 x 10cm <b>Method of sowing:</b> Seedlings are transplanted in main field.
6.	<b>Seed</b>	<b>Seed Rate:-</b> About 40000 numbers of cuttings are required for planting in one acre area.
7.	<b>Nursery Management And Transplanting</b>	Sow rooted plants on prepared beds. Transplanting is done when the seedlings are 4-5 cm long and are sow at the distance of 10 x 10cm. Irrigation is given immediately after transplanting.

8.	<b>Weed Control</b>	Hand weeding is to be done to keep the field weed free. First weeding is done in 15-20 days after transplanting.
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Sr. No.	Parameters	Descriptions
9.	<b>Irrigation</b>	It is a rainy season crop therefore it requires water immediately after end of rainy season. In winter season, apply irrigation with the interval of 20 days and in summer season irrigation should be done at the interval of 15 days.
10.	<b>Harvesting</b>	Plant starts yielding by 5-6 months after transplantation. The upper portion from the base i.e. 4-5 cm from the base is cut for harvesting. 2-3 harvestings are done in one year.
11.	<b>Post-Harvesting</b>	After harvesting, drying of fresh material is done in shade. Then packing is done in airtight bags or long distance transportation.
12.	<b>Storage</b>	Bacopa monnieri were store in polythene bag for 6 months. If it was stored more than 6 month may be main constituent of Bacopa Monnieri (Bacoside) will be degrade .



**Fig. 2. Cultivation Practices & Management of Bacopa Monnieri**

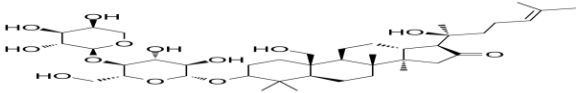
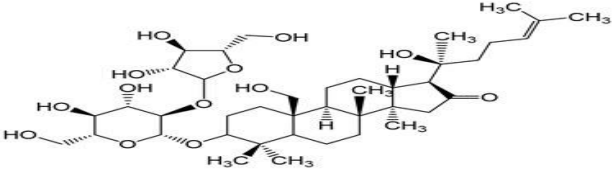
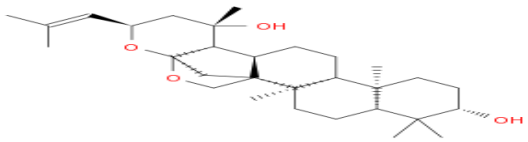
### III. PHYTOCONSTITUENTS:

Pharmacologically bioactive compounds in *Bacopa monnieri* include saponins, steroids and alkaloids. Preliminary research confirmed that the alkaloid "brahmin" was isolated from *Bacopa monnieri*. Other alkaloids such as herpesin and nicotine were also reported in the same year. D-mannitol and saponin, hersaponin and potassium salt are then isolated. Bacopaside A is the main compound found to be responsible for the neuropharmacological and nootropic or anti-amnesic effects of *Bacopa*. Bacoside A often occurs together with Bacoside B; The last difference is only in optical rotation, perhaps an artifact during separation of bacoside A. The main chemical components isolated and characterized by different spectroscopic, chemical and 2D NMR studies performed by various research groups from alcoholic extracts of medicinal herbs are jujubogenin saponin and pseudojujubogenin saponin as aglycones and dammarane



type triterpenoid saponins. Bacoside forms a mixture of aglycones, bacogenin A1, A2, A3, upon acid hydrolysis. Three major types of triterpenoid saponins have been isolated: Bacopa saponins A, B and C and Bacopa saponin. Pseudojubilogenin were isolated and a new dammarane type pseudojubilogenin glycoside, bacopasaponin-D, was identified using chemical transformation and spectroscopic methods. Two new sapogenic glycosides of Bacopa were isolated from the glycoside moiety of methanol fraction, named Bacopaside I and II. Later, three new saponins were isolated, called Bacopasides III, IV and V. In addition, three new phenylethanoid glycosides (monnierasides I to III) were identified from the glycoside moiety of Bacopa monnieri as well as from the known plantainoside-B analogue.<sup>(39,42)</sup>

**Table 2: Phytoconstituents of Bacopa Monnieri**

Sr. No.	Chemical Constituents	Structures
1.	Bacoside-A	
2.	Bacoside-B	
3.	Jujubogenin	

#### IV. MECHANISM ACTION OF BRAHMI (BACOPA MONNIERI)

The neuropharmacological effects of Brahmi (*Bacopa monnieri*) extract have been extensively studied. Brahmi contains elements such as saponin and its bacosides, which are responsible for improving the conduction of nerves. *Bacopa monnieri* helps repair damaged neurons by improving kinase activity, neuronal synthesis and restoration of synaptic function and ultimately nerve conduction. In animals, *Bacopa monnieri* has a relaxing effect on pulmonary artery, aorta, trachea, ileum and bronchial tissue, which can be treated by blocking the flow of calcium ions into cell membranes. Many clinical studies and studies have been conducted by different researchers to examine the nootropic effects of *Bacopa monnieri*.<sup>(41)</sup>

#### V. PHARMACOLOGICAL ACTIVITY :-

##### a) Memory Booster in Alzheimer's Disease and Schizophrenia

Brahmi (*Bacopa monnieri*) has been used as a memory enhancer for many years. The verification of the traditional claims of Brahmi began with the study of the effect of alcoholic extract of this herb on its acquisition, accumulation and retention in mice over different periods of time. These include shock driven brightness-discrimination response, continuous avoidance reactions, and positive defensive reactions. It was found that motor skills, acquisition and consolidation were improved and newly acquired behavior was retained for a long period of time in all the three learning responses by the introduction of the CDRI-08 (Keen Mind; 40 mg/kg, po. × 3d) in mice.<sup>(18,29)</sup>

**b) Anti-Alzheimer's Properties**

Alzheimer's disease (AD) is a neurodegenerative brain disease that deteriorates the brain, ultimately leading to impairments in thinking, planning, language, and thinking. In addition to the two main classes of medications, there are currently acetylcholinesterase inhibitors (AChEI), which are used to treat mild to moderate Alzheimer's disease, and acetylcholinesterase inhibitors (AChEI), which are used only for mild Alzheimer's disease.<sup>(31, 33)</sup> Drugs or treatments other than glutamate modulators that have solutions for the treatment of Alzheimer's disease. One of the most important ways to treat Alzheimer's disease is to use AChEI inhibitors to increase acetylcholine levels in the brain.<sup>(36)</sup> Ethanol extract of *Bacopa monnieri* contains bacopaside-A, which can be used to improve memory and intelligence. Clinical trials show that oral administration of 300 mg of standard *Bacopa monnieri* extract twice daily for six months improves cognitive performance in Alzheimer's patients.<sup>(37,39)</sup>

**c) Anti-Cancer/Cytotoxic Properties:**

Ethanol extract of *Bacopa monnieri* contains bacopasides A and B, betulinic acid, brahmin and cucurbitacin. Cucurbitacin has potent anti-inflammatory properties by inducing cell cycle arrest in the G2/M phase and the formation of proliferating cells.<sup>(4)</sup> reported the cytotoxic activity of the ethanolic extract of the dichloromethane (DCM) fraction of *Bacopa monnieri* against two different cell lines, namely MCF-7 and MDA-MB 231, due to the presence of cucurbitacins and betulinic acid in the DCM fraction. *Bacopa monnieri* extract induces cell death via apoptosis in murine sarcoma 180 cell culture.<sup>(5)</sup> Two new dammarane glycosides, 20-deoxy derivatives of pseudojubenin, and eight new compounds were isolated and tested for their cytotoxic, anti-leishmanial, anti-inflammatory, and antimalarial activities. Some of these compounds demonstrated mild to moderate activity against non-cancerous kidney cell lines.<sup>(6)</sup> Additionally, the activity of Bacopaside A fraction and its derivatives was found to be higher than Bacopaside B fraction. *Bacopa monnieri* improves mucosal activity in the brine shrimp lethality test (a test predicting the ability to prevent cancer) and thus exhibits therapeutic and anti-inflammatory properties.<sup>(7,40)</sup>

**d) Antianxiety and antidepressant activity:**

Studies using mouse models for clinical anxiety show that *Bacopa monnieri* extract contains 25% Bacopaside-A an anti-anxiety benzodiazepine anti-anxiety lorazepam, and it is worth noting that *Bacopa monnieri* extract does not cause amnesia, side effects. It is related to lorazepam, but has memory-enhancing effects.<sup>(8,10)</sup> Brahmi supplementation normalized acute and chronic pain-induced abnormalities in the corticosterone hormone in rats. Levels of 5-HT, norepinephrine (NA), and dopamine also normalized in the rat cortex and hippocampus in animals exposed to stress and chronic pain.<sup>(13,14)</sup>

**e) Antimicrobial effect:**

Methanol, ethanol, chloroform and petroleum ether were used to study the antibacterial activity of *Bacopa monnieri* against different species. Phytochemical screenings were performed to understand the details of these activities. Methanol, ethanol and chloroform extracts tested against *Bacillus amyloliquefaciens* (MTCC 1270), *Streptococcus pyogenes* (MTCC 1923), *Bacillus vulgaris*, *Bacillus megaterium* (MTCC 3353), *Kojima niger* (MTCC 281milus *Bacillus*, *Bacillus vulgaris*, *Bacillus vulgaris*) was done.<sup>(15)</sup> luteum resistance. Depending on the growth inhibition zone of bacteria, the sensitivity to crude extracts will vary depending on the bacteria and extraction intensity. In most of the plants mentioned above, the methanol extract did the highest job. According to the results obtained, it can be concluded that methanol can be used in the extraction of antimicrobials compounds from leaves.<sup>(16)</sup>

**f) Antioxidant Effects :**

Oxidative stress and the subsequent formation of free radicals are associated with the development of many diseases. Brahmi is a well-known herb that is reported to have antioxidant activity. There are many factors that create oxidative stress mediated by free radicals in the body.<sup>(1)</sup> Smoke from crackers increases the risk of various lung diseases and ultimately leads to the development of oxidative stress. Pandarish M. Anand investigated whether Brahmi could ameliorate brain damage and physiological changes in mice exposed to tobacco smoke. Antioxidants have been documented to prevent oxidative damage from free radicals that cause many human diseases, including atherosclerosis, diabetes, high blood pressure, arthritis, Alzheimer's disease, ischemic gastritis, and AIDS. The antioxidant properties of *Bacopa monnieri* may protect against free radical damage resulting from heart disease and some types of cancer.<sup>(13)</sup> *Bacopa monnieri* has been reported to eliminate free radicals such as superoxide, peroxide, and hydroxyl radicals. Alcoholic and hexane extracts of *Bacopa monnieri* were reported to have antioxidant effects on lipid

peroxidation via cumene hydroperoxide and ferrous sulfate in rat homogenized liver. According to animal studies, Bacoside has been shown to have antioxidant activity in the hippocampus, frontal cortex, and striatum and to regulate the expression of certain enzymes involved in the production and elimination of reactive oxygen species in the brain, finding Bacoside-A3 to be effective. It has a blocking effect. Effect of nitro blue tetrazolium on the release of superoxide from polymorphonuclear cells in the hydroalcoholic extract of the whole system. <sup>(21)</sup>

### **g) Hair growth promoting activity**

Herbal hair oil formulated with extracts of *Emblica officinalis*, *bacopa monnieri* and *Cyperus rotundus* or as a holistic medicine. Hair oil is prepared by using coconut oil as a base, separately and by mixing three herbs in different quantities and fixed proportions. The physical, chemical and hair growth effects of the formulated oil were evaluated by topical application of various concentrations to the shaved skin of albino mice. Healthy albino mice were used to perform the first skin irritation test and hair growth test, comparing hair growth with standard minoxidil 2% ethanol solution. The hair oil formulation was found to give the best results among other formulations evaluated, showing an increase in hair follicle size and anagen prolongation. <sup>(17, 25)</sup>

### **h) Management of diabetes nephropathy-<sup>(25,26)</sup>**

Diabetes Mellitus (DM) is a life-threatening metabolic disease characterized by hyperglycemia, hyperlipidemia, hyperaminoacidemia and hyperinsulinemia. According to the seventh edition of the World Diabetes Atlas published by the International Diabetes Federation (IDF), as of 2015, approximately 415 million people worldwide have diabetes. By 2040, this number may rise to 642 million. There are medications available to monitor and treat people with diabetes, but there are no reports of complete resolution of diabetes. As an alternative to these drugs, plants have the ability to prevent diabetes and are frequently used in many medications to prevent diabetes. In a study by Gosh et al., the antioxidant and antihyperglycemic activities of the ethanol extract of *Bacopa monnieri* were evaluated in the Wistar rat model and showed that *Bacopa monnieri* extract inhibited glucose in vitro with increased IC<sub>50</sub> of sylated heme. Value of 11.25 µg/ml, which is comparable to the drug α-tocopherol. When treated with Bacosine (triterpene of *Bacopa monnieri*) alone, the IC<sub>50</sub> value reached 7.44µg/mL. <sup>(25,26)</sup>

### **h) Gastrointestinal and Hepatoprotective Effects: <sup>27,28)</sup>**

Brahmi has been shown to cure many stomach ailments. CDRI-08 (KeenMind) at a dose of 500 mg/kg orally prevented the development of diarrhea in mice. Brahmi has the ability to reduce bowel movements more frequently than loperamide (50 mg/kg), indicating its role as an anti-inflammatory agent in the body. <sup>(13)</sup> It has also been shown that the fresh juice of this plant prevents bacterial growth. In this study, the research team evaluated the preventive and therapeutic role of CDRI-08 (KeenMind) in five different types of gastrointestinal diseases. The results showed that the extract (20 mg/kg for 10 consecutive days) reduced the rate of lipid peroxidation in the gastric mucosa of mice, alleviated penetrating ulcers caused by acetic acid, improved the mucosal barrier, and reduced mucosal exfoliation. The extract has also been reported to be anti-*H. pylori*. A randomized, double-blind, placebo-controlled study was conducted on 169 patients suffering from indigestion to evaluate the therapeutic potential of Ayurvedic preparations containing Brahman herbs and *Aeglemarmelos*. This medication was given orally to patients three times a day for 6 weeks. The effects of Ayurvedic treatment are effective in the treatment of this disease. However, since patients were given both drugs simultaneously, it is not possible to predict the effectiveness of Brahmi. <sup>(27,28)</sup>

## **VI. SOME BRAHMI INGREDIENTS WORK WELL IN FOOD PRODUCTS:**

Nutritious foods support public health, but strong scientific evidence is needed. It is also suitable for using Brahmi or other Ayurvedic herbs. There is also confusion about claims made on food and nutritional products. Claims must be communicated effectively to consumers to reduce confusion about the product. Consumers should be careful to distinguish between health practices and scientific study models. In recent years, the use of herbal products has increased in the western world and developing countries due to their great health benefits. *Bacopa monnieri*, a well-known nootropic, is a very important medicinal herb widely used in many foods for healing purposes. There are many food products in the Indian market that contain brahmi as a nutritional ingredient. The table lists descriptions of various products, including ingredients, product origin, and different claims. <sup>(9, 11)</sup>

**Table 3: Description of various products available worldwide with Brahmi as ingredient <sup>[12]</sup>**

Sr. No	Products	Country of Origin	Ingredients	Product Claims
1.	B-Natural Brahmi Ready to Serve Fruit Beverage	India	Water (69.4%), Brahmi leaf extract (16%), deionised apple concentrate (14.5%), citric acid (1%)	Brahmi is proven to improve the mental acuity and support the physiological process involved in relaxation. Its active constituents help calm the mind and reduce stress
2.	Baidyanath Junior Chyawanprash	India	Chyawanprash Avaleha Baelchhal Ganiyari Cleodendym Parul Chhal Mugdaparni Prishniparni Gokhru Mashparni Pipal Shalparni Gangeticum Chhoti Kateri Bari Kateri dalchini tejpatha nagkesar chhoti elaichi madhu, Brahmi.	It provides energy, immunity and strength. The complete brain and body nourishment product is specially formulated for growing children and contains 50 vital herbs and minerals to help all-round growth of the child
3.	Amrita Drugs Brahmi Powder	India	Brahmi, sankhapushpi, ashwagandha, shatavari, jatamansi, gokshur, sugar	Amrita Drugs Brahmi Powder is described as a memory booster. The ayurvedic product is said to improve memory and concentration levels, relieve the problems associated with excessive stress among professions, intellectuals, students and elderly people, and is also an excellent tonic
4.	Dabur Chyawanprash	India	Dashmool, bala, mudgaparni, mashaparni, karkatshring, tamalaki, draksha, jivanti, pushkara, haritaki, guduchi, karchura, musta, punarnava, utpala, vasa, yashti, kakrasika, varahi, ashwagandha,	The product ensures immunity, mental and physical fitness in growing children it keeps youth fit by protecting from day to day ailments like common cold and cough, provides active elders with antioxidants and strengthens their immune system
5.	Basic Ayurveda Muslified Energetic Drink	India	Safed musali (asparagus adscendens), shatawar (asparagus racemosus ), Brahmi, samel musli (bombax malabaricum), gond katira (astragalus gummifer ), ashwagandha (withania somnifera ), swarn varka (pure gold foil ), kesar/ saffron (crocus sativus)	Basic Ayurveda Muslified Energetic Drink is described as a powered energy booster and is a routine health support for men, women, children, teens and seniors
6.	Patanjali Brahmi sharbat	India	Brahmi Extract Baccopa monnieri, Sugar, Jala Nimbu Sat, Preservative, Sugandhit, Dravya Colour,	



7.	Panchwati Health Prash	India	Brahmi, shankpushpi, arjuna, pipali, amla, ashwagandha, honey	It is recommended for students and is also claimed to be ideal for adults. The product is available in a 1kg jar
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**Fig.3: Various products available worldwide with Brahmi as ingredient**

## VII. CONCLUSION:

The present review shows that *Bacopa monnieri* Cultivation practices and contains several different phytochemicals like alkaloids, saponins, glycosides, flavonoids, etc. Out of these phytochemicals saponins, i.e., Bacoside A and B are the most important one which are responsible for the different pharmacological activity. It was found that Bacoside A is the main phytochemical which helps in the memory enhancement. *Bacopa monnieri* also helps in the improvement of neurodegenerative disorder as it improves the memory. So it can be utilize as a drugs for the treatment of neurodegenerative disorders.

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