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Review Article

A Review On Use Of Bacopa Monnieri On Various Diseases

Sanket G. Kadam*, Madhuri D. Game, Vaibhav V. Narwade

Department of Quality Assurance, Vidya Bharti college of Pharmacy, Amravati.

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ABSTRACT

Bacopa monnieri, an herb with a rich history in traditional medicine, has garnered attention for its potential therapeutic effects on various diseases. Extensive research has explored its impact on cognitive function, revealing promising results in enhancing memory and cognitive performance. Additionally, studies suggest that Bacopa monnieri exhibits anxiolytic properties, offering potential relief for individuals dealing with anxiety-related disorders. Furthermore, the herb's neuroprotective and antioxidant properties have been investigated, showcasing its ability to combat oxidative stress and potentially mitigate neurodegenerative diseases. Preliminary findings also hint at Bacopa monnieri's role in reducing symptoms associated with attention deficit hyperactivity disorder (ADHD). While the existing body of research underscores the potential benefits of Bacopa monnieri, it is essential to note the need for further well-designed clinical trials to establish its efficacy and safety across diverse populations. As interest in natural remedies grows, Bacopa monnieri stands out as a promising botanical with a range of potential applications in promoting cognitive health and addressing certain neurological and psychological conditions.

INTRODUCTION

Bacopa monnieri, also known as Brahmi, holds a venerable position in the landscape of traditional medicine, particularly within the realms of Ayurveda, the ancient system of healing originating in India. This herb, characterized by its succulent leaves and delicate flowers, has been revered for centuries for its purported cognitive-enhancing and medicinal properties. In recent years, the interest in Bacopa monnieri has

transcended traditional boundaries, captivating the attention of modern scientific inquiry. The pharmacological potential of Bacopa monnieri lies in its rich composition of bioactive compounds, including bacosides, alkaloids, and flavonoids. This intricate blend has become the focal point of research endeavors seeking to unravel the herb's impact on various diseases. One of the primary areas of exploration is the cognitive domain, where Bacopa monnieri has emerged as a potential ally in

*Corresponding Author: Sanket G. Kadam

Address: Department of Quality Assurance, Vidya Bharti college of Pharmacy, Amravati.

Email ✉: shivsainiksk@gmail.com

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the pursuit of enhanced memory and cognitive function. Numerous studies have delved into the cognitive effects of *Bacopa monnieri*, with promising results suggesting improvements in memory retention, learning capabilities, and overall cognitive performance. The herb's ability to modulate neurotransmitter systems, enhance synaptic communication, and exert neuroprotective effects has positioned it as a compelling candidate for addressing cognitive decline associated with aging and neurodegenerative disorders. Beyond its cognitive effects, *Bacopa monnieri* has been scrutinized for its potential in alleviating anxiety-related disorders. The herb's anxiolytic properties have been demonstrated in preclinical and clinical studies, indicating its ability to modulate stress responses and promote a sense of calm. These findings open avenues for exploring *Bacopa monnieri* as a complementary approach in managing anxiety disorders, offering an alternative or adjunct to conventional pharmaceutical interventions. The neuroprotective attributes of *Bacopa monnieri* further amplify its significance in the realm of holistic health. Research suggests that the herb possesses antioxidant properties, shielding neuronal cells from oxidative stress and potentially mitigating the progression of neurodegenerative diseases. This aspect not only underscores the potential therapeutic relevance of *Bacopa monnieri* but also aligns with the growing interest in natural compounds that contribute to neuroprotection. In the context of mental health, *Bacopa monnieri* has also been investigated for its impact on attention deficit hyperactivity disorder (ADHD). Preliminary studies suggest that the herb may exert beneficial effects in reducing symptoms associated with ADHD, though further research is warranted to establish its efficacy and safety in this specific domain. As the allure of natural remedies continues to gain momentum, *Bacopa monnieri*

stands as a botanical beacon, beckoning researchers, healthcare professionals, and individuals seeking holistic approaches to well-being. This review endeavors to navigate the labyrinth of scientific literature surrounding *Bacopa monnieri*, unraveling its potential applications in various diseases and shedding light on the intricacies that render this herb a subject of fascination and exploration in contemporary medicine.

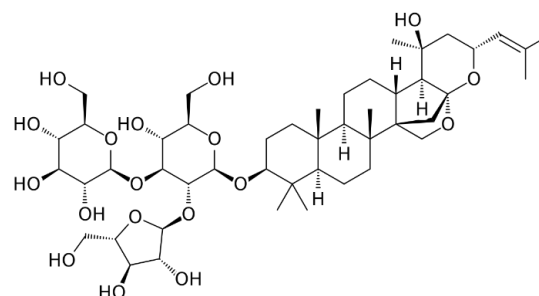


Fig No. 1:- Chemical Structure Of Bacopa Monnieri



Fig no.2:- Plant of Bacopa monnieri

Plant Profile

Taxonomic Classification

Kingdom	Plantae
Division	Tracheophyta
Class	Magnoliopsida
Order	Lamiales
Family	Schrophulariaceae
Genus	Bacopa
Species	monnieri (L.)

Synonyms

Bacopa monniera Hayata & Matsum
Bramia monnieri (L.) Pennel
Gratiola monniera L.
Herpestes monniera (L.) Kunth
Herpestis fauriei H.Lev.
Herpestis monniera

Herpestris monnieri

Lysimachia monnieri L

Moniera cuneifolia Michx.

Therapeutic Importance

It is used in traditional Indian medicine, the Ayurveda, for the treatment of anxiety, memory boosting activity, it is also claimed to be useful in the treatment of cardiac, respiratory and neuropharmacological disorders like insomnia. It was reported to possess anti-inflammatory, analgesic, antipyretic, sedative, free radical scavenging and anti-lipid peroxidative activities also (Kishore and Singh, 2005).

Neuro-Pharmacological Activity

The use of *Bacopa monnieri* has been reported to improve behaviour of many laboratory animal models under broad range of experimental conditions, e.g. mice. *Bacopa monnieri* has been reported for its therapeutic potential in treatment of neurological diseases, improving memory. The principal constituents are dammarane types of triterpenes saponins known as bacosides. They are responsible for cognitive function (Singh and Dhawan, 1997). Two types of saponins jujubogenin and pseudojujubogenin differing in only nature of sugar units in glycosidic chain are found. The major chemical entity responsible for neuropharmacological effects of BM is bacoside A. It is milieu of bacoside A3, bacoside II, bacosaponin C and a jujubogenin isomer of bacosaponin C. A study has confirmed that orally treated BM extract taken by the system shows behavioural improvements. HPLC analysis shows the presence of bioactive compounds bacoside A in serum of *Bacopa monnieri* extract treated rats.

Hepatoprotective Activity

Ethanol extract of *Bacopa monnieri* is rich in saponins and it possess hepatoprotective property too which is attributed to bacoside-A. Extensive research work has been carried out using rat, mice and human model systems. Many studies have shown that carbon tetrachloride (CCl₄) induces

liver cirrhosis. CCl₄ disturbs metabolism of liver cells leading to changes in activities of enzymes. Pre-treatment with methanolic extract against CCl₄ has shown protective effect. It has preserved the liver structure besides congestion of central vein, dilation of sinusoids etc in rats (Muhammad and Fazal, 2014). Chemically induced hepatotoxicity in animals have been widely used for the screening of hepatoprotective herbal compounds.

Antioxidant Activity

Antioxidants help in preventing oxidative damage by free radicals. Oxidative stress happens when free radicals subjugate the homeostatic defence mechanism of cells (Aguiar and Borowski, 2013). evaluated the anti-oxidant role of bacoside-A against chronic cigarette smoking induced oxidative damage in brain of rat. An adult albino rat was exposed to cigarette smoking for 12 weeks and administration of bacoside-A (10mg) was done simultaneously. The measurements of concentration of both enzymatic and non-enzymatic antioxidants as well as trace elements were done. The researchers found that bacoside-A improved anti-oxidant level. Thereby suggesting that smoking exposure enhances oxidative stress and bacoside-A protects the brain through its anti-oxidant capacity. Antioxidant activity of alcoholic and hexane extract of *Bacopa monnieri* on lipid peroxidation by ferrous sulphate and cumene hydroperoxide in rat liver homogenate has been documented by. Another study was done by which assessed the role of *Bacopa monnieri* extract on rat brain-frontal cortex, striatal and hippocampus regions.

Anti-Depressant

Depression is a common life threatening condition. Patients with depression generally reflect decrease in brain neurotransmitters like dopamine, serotonin and norepinephrine (Singh and Dhawan, 1997). Performed an experiment using methanolic extract of *Bacopa monnieri* in



the dose of 20 and 40 mg/Kg orally once daily for 5 days and compared with anti-depressant drug imipramine (15mg/Kg) on rodents which reflected significant anti-depressant activity. Evaluated the anti-depressant activity in rat. The extract was administered in dose of 80 and 120 mg/Kg and compared with anti-depressant drug fluoxetine hydrochloride. The *Bacopa monnieri* extracts reduced escape latency and plasma corticosterone level in rats greatly and showed anti-depressant activity.

Anti-Cancer Activity

Examined the anti-tumour activity of stigmasterol which is isolated from aerial parts of *Bacopa monnieri* against Ehrlich ascites carcinoma in Swiss albino mice. The anti-tumour activity of stigmasterol is thought to be mediated through activation of protein phosphatase 2A. Another study by (Kumar et al, 1998) also examined the anti-tumor activity of ethanolic extract of *Bacopa monnieri*. Oral administration of extract delayed the development of solid tumor. The study was carried out on in vitro short term chemosensitivity and in vivo tumor model test systems. D'Souza et al. (2002) evaluated that ethanolic extracts and saponin rich fraction showed anti-tumour potentiality. Bacoside-A was reported as active constituent responsible for anti-cancerous activity. The extract was tested for brine shrimp lethality also. Elangovan et al. (1995) reported alcoholic extract of *Bacopa monnieri* as anti-cancerous drug. The Ethanolic extract was tested for sarcoma-180 cell culture. The cell growth was inhibited with increasing concentration of the extract.

Anti-Epileptic

Reported the neuroprotective role of BM extract in epileptic rats. The experiment showed the glutamate mediated excitotoxicity occurring during seizures and cognitive damage along with pilocarpine induced epilepsy. The study also involved morris water maze experiment. A clinical study by (Dhanasekaran et al., 2007) reported the

effectiveness of alcoholic extract of *Bacopa monnieri* in decreasing symptoms of epileptic seizures. Mathew et al. (2012) in another experiment investigated temporal lobe epilepsy, a common epileptic syndrome.

Anti-Inflammatory

Inflammation is a type of biological response to stimuli, like pathogens, damaged cells or irritants. It is characterized by redness, swollen joints, joint pain, its stiffness and loss of joint function. evaluated that methanolic extract of *Bacopa monnieri* possess anti-inflammatory activity. The study was carried out through carrageenan and histamine-induced oedema test on rats. 200 and 400 mg/Kg body weight of extract was administered and the dose of 400mg/Kg extract showed significant anti-inflammatory activity compared to drug indomethacin. reported that ethanolic extract of *Bacopa monnieri* showed anti-inflammatory effect against carrageenan-induced paw edema in mice and rats. The extract was treated with chemical mediators like serotonin, histamine and the extract selectively inhibited prostaglandin E2 induced inflammation. There by showing antiinflammatory property.

Anti-Diabetic

Activity Diabetes mellitus is a metabolic disorder affecting carbohydrate, fat and protein metabolism. Approximately 1% of the population suffers from this disease. Diabetes mellitus poses a serious problem. Worked on ethanolic extract of *Bacopa monnieri* and they reported that bacosine, a triterpene is responsible for increase in glycogen content in diabetic rats. The extract also resulted an increase in peripheral glucose utilisation in vitro in the diaphragm of diabetic rats. There by showing insulin like activity in alloxan-induced diabetic rats.

Anti-Microbial

Evaluated the anti-microbial activity of ethanolic, diethyl acetate, ethyl acetate and aqueous extracts of aerial parts of *Bacopa monnieri*. Diethyl ether



extract showed anti-bacterial activity against gram positive while ethyl acetate extract showed activity against gram negative organism. The test was carried out on bacteria like *Staphylococcus aureus*, *Proteus vulgaris*, etc. Ethanolic extract exhibited anti-fungal activity against *Aspergillus niger*, *Candida albican* reported the anti-bacterial activity of ethyl acetate and methanol extracts of *Bacopa monnieri* against 7 gram negative and 11 gram positive bacteria by disk diffusion method. The antifungal activity against *Alternaria alternata* and *Fusarium fusiformis* by phytochemicals isolated from aerial parts of *Bacopa monnieri* like betulinic acid and oroxindin is also reported.

Anti-Ulcerative

The fresh juice from whole plant of *Bacopa monnieri* was examined by using gastric ulcer models induced by ethanol, aspirin. *Bacopa monnieri* juice were given orally twice daily for 5 days at dose of 100 and 300 mg/Kg and sucralfate at 250mg/Kg. The juice showed antiulcer activity in gastric ulcer models except for ethanol induced ulcers. The effect is attributed to mucosal defensive factors like enhanced mucin secretion, mucosal glycoprotein and decreased in mucosal cell exfoliation. Performed an experiment using methanolic extract of *Bacopa monnieri* on susceptibility of NIDDM/ normal rats and found that 50mg/kg body weight extract dose to be effective in healing penetrating ulcers induced by acetic acid and HCl after 5-10 days of treatment. Showed anti-helicobacter pylori activity at 1000µg/ml of *Bacopa monnieri* extract while at the dose of 10µg/ml it showed an increase in prostanooids. This contributed to anti-ulcerogenic activity of *Bacopa monnieri* extract.

Analgesic

Isolated bacosine from aerial parts of *Bacopa monnieri* and found that it possess analgesic effect. The effect was opioidergic in nature. It was also reported that bacosine didn't show any effect on barbiturate narcosis, haloperidol-induced

cataplexy, conditioned avoidance response. Investigated the analgesic effect of ethanol extract of BM. The extract yielded noteworthy writhing inhibition in acetic acid induced writhing in mice at the oral dose (250 and 500 mg/kg) compared to standard drug diclofenac sodium (25mg/Kg).

Cardiovascular

Studied the effect of intravenous *Bacopa monnieri* extract administered in the dose of 20-60 mg/Kg on arterial blood pressure and heart rate of anaesthetized rats. The extract decreased systolic and diastolic pressures without disturbing heart rate. It was concluded that blood pressure reduced partly via releasing nitric oxide from endothelium and partly by actions on vascular smooth muscle Ca²⁺ homeostasis. Reported the broncho-vasodilatory activity of *Bacopa monnieri* extract in anaesthetized rats. The work was done on various fractions derived from *Bacopa monnieri* and the activity was observed because of inhibition of calcium ions.

Neuroprotective activity

The active constituents responsible for *B. monnieri*'s cognitive effects are bacosides A and B, moreover, triterpenoid saponins are responsible to enhance nerve impulse transmission. The bacosides also aid in repair of damaged neurons by enhancing kinase activity, neuronal synthesis, restoration of synaptic activity, and nerve impulse demonstrated that *B. monnieri* suppresses acetylcholinesterase activity resulting in enhanced cholinergic function, which in turn enhances attention and memory processing and increases working memory in elderly people.

Bacopa monnieri IN DIABETES

Oxidative stress is known to cause complications such as neuropathy, nephropathy, and cardiomyopathy in the case of diabetics patients. The protective role of *B. monnieri* on tissue antioxidant defense system and lipid peroxidative status in streptozotocin induced diabetic rats was investigated. The effect of the oral administration



of *B. monnieri* extracts on the enzymatic and non-enzymatic antioxidant levels and lipid peroxidation were observed in the kidney, cerebellum, cerebrum, midbrain of diabetic rats and the results were compared to a reference drug, glibenclamide. The results revealed a significant increase in the antioxidant status and a concomitant decrease in the peroxidative damage. The diabetic rats showed significant improvement of the glycemic index and body weight upon treatment with ethanolic extract of *B. monnieri* compared to untreated rats. The glycemic status of *B. monnieri* extract-treated diabetic rats is comparable to that of the reference drug. Further improvement was observed in rats receiving administration of both the extract and glibenclamide with respect to oxidative stress and hyperglycemic status in the liver of diabetic rats. These results suggest that *B. monnieri* has antidiabetic activity comparable to the existing oral antidiabetic drug and the combinatorial regimen helps in reducing oral antidiabetic drug-induced toxicity.

Bacopa Monnieri IN CANCER

The anticancer potential of *B. monnieri* has been reported earlier by several investigators. Prakash et al., have reported the anticancer activity of bacoside A from whole plant of *B. monnieri* in MCF-7 (human breast cancer), HT-29 (human colon adenocarcinoma), and A-498 (human breast cancer) cell lines. Janani et al. showed that bacoside A exhibits its chemopreventive effects against DEN (diethyl nitrosamine)-induced carcinoma by decreasing the level of lipid peroxidation and enhancing the antioxidant status probably through its free radical scavenging activity. The antioxidant and tumor inhibiting property of *B. monnieri* were also reported in 3-methylcholanthrene-induced fibrosarcoma in rats. *B. monnieri* supplementation enhanced the antioxidant enzyme status, reduced the rate of lipid peroxidation, and down regulated tumor

development markers. Among the five crude samples such as the whole plant of *B. monnieri* and four different fractions (petroleum ether, CHCl₃, EtOAc, and n-BuOH fractions) of the methanol extract, n-BuOH fraction was noted to have the highest anticancer activity as per bioassay-guided methods conducted by Peng et al. The studies showed that dammarane triterpene saponins isolated from n-BuOH fraction, bacoside É and bacoside VII, have potential anticancer effect as revealed from the cytotoxicity studies in various human cancer cell lines MDA-MB-231, SHG-44, HCT-8, A-549, and PC-3M in MTT assay in vitro, and showed 90.52 % and 84.13 % inhibition in mouse implanted with sarcoma S180 in vivo at the concentration of 50 µmol/kg, respectively. Further studies revealed significant inhibition of human breast cancer cell line MDA-MB-231 adhesion, migration, and matrigel invasion in vitro at the concentration of 50 µM.. Studied the effect of bacoside fraction from *B. monnieri* against oxidative stress-induced apoptosis in untransformed (buccal) and transformed (kb oral carcinoma) cells. Interestingly, the results have shown anti-apoptosis in bacoside-treated buccal cells, whereas a steep increase in apoptotic cells was observed in bacoside-treated kb oral carcinoma cells. These observations clearly indicate that bacoside-induced toxicity is specific to cancer cells while sparing normal cells. Their studies suggest combinatorial regimen of bacoside along with established anticancer drugs during chemotherapy for the reduction of undesirable side effects.

Bacopa Monnieri IN PARKINSON'S DISEASE

B. monnieri might be useful in age-related neurodegeneration including PD by maintaining redox homeostasis and mitochondrial activities. Assessed the neuroprotective role of bacoside A against oxidative stress in the brains of rats. The researchers administered 10 mg/ml bacoside A



through oral gavage daily and found the *B. monnieri* significantly increased brain levels of glutathione, vitamin C, vitamin E, and vitamin A in addition to the increased activities of antioxidant enzymes such as SOD, catalase, glutathione peroxidase (GPx) and glutathione reductase (GSR) in rats exposed to cigarette smoke.

Bacopa Monnieri In Alzheimer's Disease

A dose-related reversal of cognitive deficits was observed by treatment with *B. monnieri* in animal models of neurotoxicity induced by colchicine and ibotenic acid. The neuroprotective effect of standardized extracts of *B. monnieri* against acrolein and H₂O₂ was investigated by Singh et al. Acrolein is a highly reactive compound formed as a byproduct of lipid peroxidation. It is not only a marker of lipid peroxidation but also serves as an initiator of oxidative stress by forming adducts of cellular nucleophilic groups. The brains of AD patients showed significantly higher levels of acrolein in vulnerable brain region like hippocampus. Furthermore, it is reported to be more toxic in primary hippocampal culture than 4-hydroxyl-2-nonenal. Actually, hydrogen peroxide (H₂O₂) is the compound which contributes toxicity to the amyloid- β peptide. Neuroprotective effect of *B. monnieri* extract was reported in human neuroblastoma cellline SK-N-SH against H₂O₂- and acrolein-induced toxicity. *B. monnieri* offered cytoprotection through ROS scavenging and maintaining the mitochondrial membrane integrity. *B. monnieri* also modulated expression of several regulatory proteins, such as NF- κ B, Sirt1, ERK1/2, and p66Shc, so as to favor cell survival in response to oxidative stress. Stress also promotes free radical generation. The anti-stress effect of bacosides of *B. monnieri*, dissolved in distilled water, was studied in adult male Sprague Dawley rats. The data indicate that *B. monnieri*'s ability to destress involves the modulation of the

expression/activities of Hsp70, CytP450, and SOD under adverse conditions such as stress.

NEUROPROTECTIVE EFFECT OF Bacopa Monnieri

Chronic administration of *B. monnieri* inhibited the lipid peroxidation particularly in the prefrontal cortex, striatum, and hippocampus regions of the rodent brain, via a mechanism of action similar to vitamin E. In the astrocytes of rodents, bacopa treatment resulted in significant reduction in the damage produced by high concentrations of nitric oxide. Furthermore, various studies suggested that bioactive components from *B. monnieri*, protect the brain against oxidative damage and age-related cognitive decline with several modes of action and also enhance memory. Improved cognitive function is noted with standardized CDR108 extract in both in vivo and in vitro studies. The improved cognitive action of extract of *B. monnieri* was attributed to the increase in the free radical scavenging activity of bacosides. A similar increase was also noted in the case of diabetic rats showing a significant reversal of redox imbalance and peroxidative damage to enhance a defense system against ROS. Heat shock protein 70 (Hsp70), cytochrome P450 (CytP450), and SOD in the rat brain play an important role in the production and scavenging of ROS, and determine stress responses in rats [40]. The binding and detoxification of metal ions, free radical scavenging, or increasing antioxidant activity are some of the mechanisms involved in the neuroprotective and memory enhancing effects of extract of *Bacopa monnieri*. *B. monnieri* was reported to act by reducing divalent metals, scavenging ROS, decreasing lipid peroxides formation, and inhibiting lipoxygenase activity. The results showed *B. monnieri* extract-treated neurons expressed a lower level of ROS, suggesting that brahmi could control intracellular oxidative stress. Clearly reported that bacoside A and *B. monnieri* act as potent neuroprotective



agents in reversing the altered dopamine D1 receptor function, gene expression, and altered Bax expression due to neonatal hypoglycemia. Free radical accumulation in neonatal hypoglycemia results in decreased level of SOD which in turn causes cortical cell death. Bacoside A and B. *monnieri* supplementation helps to maintain the level of SOD by free radical scavenging and thus overcome the stress by prevention of free radical accumulation.

CONCLUSION

The review highlights the therapeutic potential of *Bacopa monnieri* across various diseases. *Bacopa monnieri*, commonly known as Brahmi, has been extensively studied for its cognitive-enhancing properties, including memory retention and cognitive function improvement. Additionally, its anxiolytic properties offer potential relief for anxiety-related disorders. Furthermore, *Bacopa monnieri* exhibits neuroprotective and antioxidant properties, which could be beneficial in combating oxidative stress and addressing neurodegenerative diseases. Preliminary research also suggests its potential in reducing symptoms associated with attention deficit hyperactivity disorder (ADHD). The herb's pharmacological activities extend to hepatoprotective, anti-inflammatory, anti-diabetic, anti-microbial, anti-ulcerative, analgesic, and cardiovascular properties. Additionally, studies indicate its potential in cancer treatment, particularly in inhibiting tumor growth and enhancing chemopreventive effects. Moreover, *Bacopa monnieri* shows promise in age-related neurodegenerative conditions like Parkinson's and Alzheimer's diseases. It has been observed to maintain redox homeostasis, enhance mitochondrial activities, and protect against oxidative stress, contributing to neuroprotection and cognitive enhancement. In summary, *Bacopa monnieri* emerges as a multifaceted botanical with diverse therapeutic applications. However, further well-designed clinical trials are warranted to

establish its efficacy, safety, and optimal dosage across different populations. Nonetheless, its rich pharmacological profile positions *Bacopa monnieri* as a promising natural remedy for promoting cognitive health and addressing various neurological, psychological, and physiological conditions.

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