



Brahmi (*Bacopa monnieri*): Up-to-date of memory boosting medicinal plant: A review

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ABSTRACT

Bacopa monnieri, Family: Plantaginaceae, known as water hyssop, herb of grace or Indian penny wort, is one of the traditional medicinal plants in Ayurveda medicine, where it is also called Brahmi, a name derived from Brahma, the creator God of the Hindu Pantheon. It is now being widely promoted to enhance memory, learning and concentration and also to treat anxiety, depression, and systemic disorders like cardiovascular, gastrointestinal, hepatic, neurological and also respiratory problems. Further, Brahmi has been shown to possess anticancer, antidiabetic, anti-inflammatory, antimicrobial and antioxidant properties. Its phytochemical substances are alkaloids, flavonoids, glycosides, saponins, and the important constituents such as bacosides, bacopasides, and bacopasaponins, which all of these contribute to its remedial properties. This article provides a brief overview of the memory boosting activity of brahmi, (*B. monnieri*), to further provide an up-to-date review showing its importance especially, memory boosting.

Key words: Bacoside, *Bacopa monnieri*, Brahmi, Memory boosting, Neurological protective.

Neurodegenerative diseases are a group of chronic, progressive disorders of the central nervous system, characterized by the gradual loss of neurons in the brain and spinal cord, affecting mental abilities or motor abilities like Alzheimer's disease, Parkinson's diseases, and related disorders (Ramanan and Saykin, 2013; Brettschneider *et al.*, 2015; Medina and Evans, 2015). It was estimated that by 2020, neurodegenerative diseases will be the eighth leading cause of death in developed countries, and by mid-century neurodegenerative diseases will be the world's second leading cause of death overtaking cancer (Menken *et al.*, 2000). National estimates, one-third or 32 % of people age 85 and older in the United States has Alzheimer's disease (Hebert *et al.*, 2013). Currently available drug treatments decelerate the progression of the disease, provide symptomatic relief, but fail to achieve a definite cure (Connolly and Lang, 2014; Kumar and Ekavali, 2015). There are a number of foods (plants, herbs, fruits, and vegetables) and supplements that are known to enhance the brain activity as "Memory Boosting Foods or Supplements" (Othman *et al.*, 2015; Venkatesan *et al.*, 2015) for the example Indian traditional memory enhancing herbs (Bhowmik *et al.*, 2010; Jatwa *et al.*, 2014), Chinese traditional memory enhancing herbs (Ho *et al.*, 2005), Korean East Asian traditional cognitive impairment herbs (Kumar *et al.*, 2013), Japanese traditional memory and learning-enhancing herbs medicine (Nakamura *et al.*, 2006), Europe traditional cognitive

impairment herbs (Eckert, 2010). According to the National Medicinal Plants Board report, the annual market demand for Brahmi, *Bacopa monnieri* is around 1,000 tones in year 2000, which increased many fold due to its potential uses in Ayurvedic medicine to treat variety of diseases (Tripathi *et al.*, 2012). In recent years, *B. monnieri* has received much attention worldwide due to its wide spectrum of pharmacological activities. The numbers of scientific literature during 2000-2015 showed 529; 330; and 8,930 hits on "Bacopa" according to the ScienceDirect, PubMed, and Google Scholar database, respectively, search on October 18, 2015. Among them are book, classical article, clinical trials, journal article, patent application and reviews.

Taxonomical classification: The taxonomy of *B. monnieri* is in the Kingdom (Plantae); Subkingdom (Viridiplantae); Infrakingdom (Streptophyta); Superdivision (Embryophyta); Division (Tracheophyta); Subdivision (Spermatophytina); Class (Magnoliopsida); Subclass (Asteridae); Superorder (Asteranae); Order (Lamiales); Family (Plantaginaceae); Genus (Bacopa); Species (*B. monnieri*) (ITIS, 2015).

Nomenclature: *B. monnieri* is native in India, Bangladesh and Southern Asia, and also grows in Australia, Europe, and Africa. The vernacular name of *B. monnieri* is also known as Indian pennywort, water hyssop (English), farfakh (Arabic), brahmi (Assamese), aaghabini (Bengali), jia ma chi xian (Chinese), petite bacopa (French), kleine fettblatt

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(German), baam (Gujrati), psheta srva (Hebrew), adha birni (Hindi), bakopa (Japanese), jala brahmi (Kannada), barna (Malayalam), ghola (Marathi), medha giree (Nepalese), bakopa drobnolistna (Polish), brahmibuti (Punjabi), adha birni (Sanskrit), ahaznda poozndu (Tamil), neeri sambraani mokka (Telugu), phrommi (Thai), and rau dang bien (Vietnamese) (PMP, 2014).

Plant description: *B. monnieri* is the small smooth creeping fleshy plant with the numerous branches. It grows to a height of 60-90 cm and its branches are 5-35 cm long (Fig. 1). Roots are thin, wiry, small, branched creamish-yellow. Stem is thin, green or purplish green, about 1-2 mm thick, soft, nodes and internodes prominent, glabrous; taste, slightly bitter. Leaves are stalkless, simple, opposite, decussate, green, sessile, 8-15 mm long and 4 mm wide, ovate-oblong, taste slightly bitter. Flowers are small, axillary and solitary, five petaled white, purple, pink or pale violet in color, pedicels 6-30 mm long, bracteoles shorter than pedicels. Fruits are capsules up to 5 mm long, ovoid, glabrous and sharp at apex (Trivedi Manisha *et al.*, 2011).

Phytochemical substances: The extract of *B. monnieri* was revealed the presence of tannins, flavonoids (Singh, 2012;

Pant *et al.*, 2015), glycosides (Sivaramakrishna *et al.*, 2005; Tothiam *et al.*, 2011), terpenoids, saponins (Zhou *et al.*, 2007; Phrompittayarat *et al.*, 2007; 2008), bacosides, bacopasides (Agrawal *et al.*, 2006), bacopasaponins (Mahato *et al.*, 2000), and steroids. The major chemical constituents isolated and characterized from *B. monnieri* are dammaranes of triterpenoid saponins with pseudojubilogenin glycosides or jubilogenin glycosides (Chakravarty *et al.*, 2001, 2003; Hou *et al.*, 2002; Kamonwannasit *et al.*, 2008).

Traditional uses: From review literatures that regarding the traditional uses or phytochemical properties of *B. monnieri* are shown in Table 1.

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 (Mahato *et al.*, 2000; Hou *et al.*, 2002; Chakravarty *et al.*, 2001; 2003). The bacosides also aid in repair of damaged neurons by enhancing kinase activity, neuronal synthesis, restoration of synaptic activity, and nerve impulse transmission (Singh and Dhawan, 1997). Peth-Nui *et al.* (2012) demonstrated that *B. monnieri* suppresses acetylcholinesterase activity resulting in enhanced

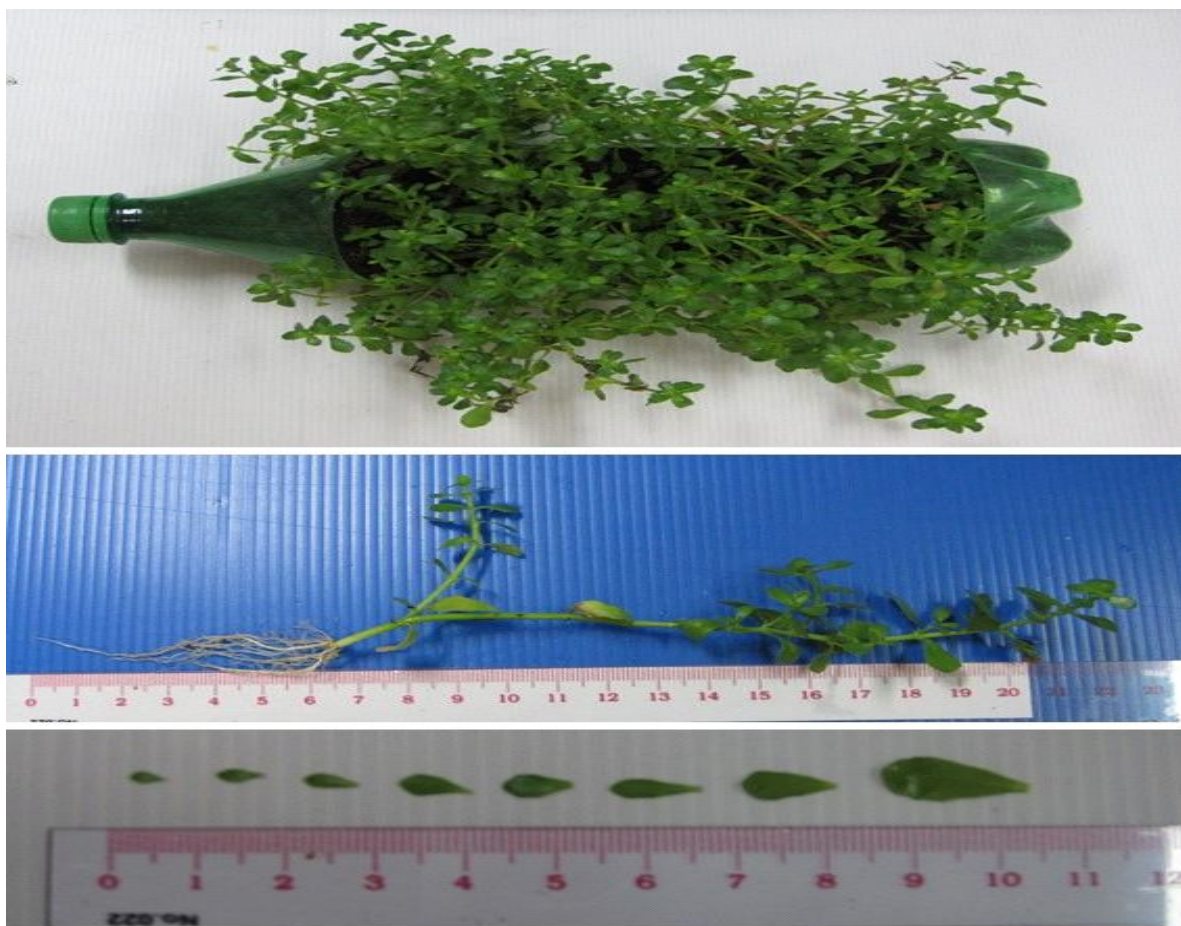


FIG 1: *Bacopa monnieri* (Top) smooth creeping fleshy plant with the numerous branches; (Middle) showing roots, stems and leaves (Bottom) various size of leaves.

TABLE 1: The traditional uses or phytochemical properties of *B. monnieri*

Phytochemical properties	References
Antianxiety activity	Chatterjee <i>et al.</i> , 2010
Anticancer activity	Peng <i>et al.</i> , 2010; Ghosh <i>et al.</i> , 2011a; Patil <i>et al.</i> , 2014
Antidepressant activity	Shen <i>et al.</i> , 2009; Hazra <i>et al.</i> , 2012; Sindhu <i>et al.</i> , 2014; Ramana Murty Kadali <i>et al.</i> , 2014; Mannan <i>et al.</i> , 2015
Antidiabetic activity	Ghosh <i>et al.</i> , 2008; Ghosh <i>et al.</i> , 2011b; Prasenjit <i>et al.</i> , 2014
Antihypertensive activity	Kamkaew <i>et al.</i> , 2011; Onsa-ard <i>et al.</i> , 2012
Anti-lipidemia activity	Kamesh <i>et al.</i> , 2012; Mitra, 2014
Anti-inflammatory activity	Channa <i>et al.</i> , 2006; Joshi <i>et al.</i> , 2014
Antimicrobial activity	Rajashekarappa <i>et al.</i> , 2008; Udgire and Pathade, 2012; Joshi <i>et al.</i> , 2013
Antioxidant activity	Mohan <i>et al.</i> , 2011; Meena <i>et al.</i> , 2012; Nandagaon <i>et al.</i> , 2013; Subashri and Pillai, 2014
Hepatoprotective activity	Gudipati <i>et al.</i> , 2012; Shahid and Subhan, 2014
Gastrointestinal protective activity	Subhan <i>et al.</i> , 2010; Afjalus <i>et al.</i> , 2012
Neuroprotective activity	Uabundit <i>et al.</i> , 2010; Aguiar and Borowski, 2013

cholinergic function, which in turn enhances attention and memory processing and increases working memory in elderly people.

Alzheimer's disease: Goswami *et al.* (2011) evaluated the effect of 300 mg *B. monnieri* (Bacognize®) orally twice a day for 6 month in the newly diagnosed patients of Alzheimer's disease in the Psychiatry Outdoor Patient Department in India. Mean age of 39 patients who completed the study was 65.23 years. Study patients showed statistically significant improvements in various components of Mini Mental State Examination Scale including orientation of time, place and person, attention and in their language component in terms of reading, writing and comprehension. The patients involved in this trial also reported improvement in their quality of life, and decrease in the irritability and insomnia. In 2013, Kunte and Kuna studied the neuroprotective properties of 100 mg *B. monnieri* per kg body weight for 180 days on memory deficits and biochemical changes in ATPase system of Alzheimer's disease induced mice. Their results revealed that *B. monnieri* showed positive effects on body weight, learning skills, memory and concentration, moreover, *B. monnieri* could revert all the constituents of ATPase system to normal levels in Alzheimer's disease induced mice. So, Kunte and Kuna concluded that *B. monnieri* had potential compounds which can prevent the learning and memory deficits effectively; and to maintain ion gradients across biological membranes, thus confer significant neuroprotection against Alzheimer's disease by stabilizing the structural and functional integrity of the membrane.

Parkinson's disease: Jadya *et al.* (2011) studied the effect of *B. monnieri* on two different strains of *Caenorhabditis elegans*, a transgenic model expressing "Human" Parkinson's disease. The results showed that *B. monnieri* reduced alpha synuclein aggregation, prevented dopaminergic neurodegeneration and restored the lipid content in nematodes, thereby proving its potential as a possible anti-Parkinsonian agent. Swathi *et al.* (2012) examined the

neuroprotective effect of *B. monnieri* in rotenone induced Parkinson's disease with particular reference to glutamate metabolism in different regions of rat brain. Glutamine content and activity levels of glutamate dehydrogenase, glutamine synthetase were significantly depleted and elevated glutaminase activity was found in different brain regions of rat during rotenone induced Parkinson's disease when compared to control rats. Treatment with *B. monnieri* caused significant elevation in glutamine content and the activity levels of glutamate dehydrogenase, glutamine synthetase and depletion in glutaminase activity in different brain regions of rats when compared to induced Parkinson's disease rats. So the results of Swathi *et al.* (2012) suggest the ability of *B. monnieri* extract to modulate glutamate metabolism in different brain regions of induced rodent model of Parkinson's disease.

Clinical Trial: A number of human clinical studies have examined the effects of Brahmi, most of which have focused on its cognitive enhancing activity. Roodenrys *et al.* (2002) reported that 76 adults aged between 40-65 years took part in a double-blind randomized, placebo control study in which various memory functions were tested and levels of anxiety measured. The results show a significant effect of the Brahmi on a test for the retention of new information. Follow-up tests showed that the rate of learning was unaffected, suggesting that Brahmi decreased the rate of forgetting of newly acquired information. Tasks assessing attention, verbal and visual short-term memory and the retrieval of pre-experimental knowledge were unaffected. Questionnaire measures of everyday memory function and anxiety levels were also unaffected. Barbhuiya *et al.* (2008) evaluate the efficacy and tolerability of *B. monnieri* (BacoMind®) in 65 adults aged between 50-75 years with a single oral dose of 450 mg daily for the duration of 12 weeks. The neuropsychological tests revealed that BacoMind improved performance in tests associated with attention and verbal memory such as digit span backward test, list learning delayed recall test, paired associates dissimilar delayed recall test and in visual retention-I test.

In conclusion, Brahmi, *Bacopa monnieri*, may serve as the memory boosting alternative source for the development of new neurological agent due to its biological activities. Recent researches were found that Brahmi as a viable medicine for improving mental health and the prevention and treatment of age related cognitive decline. Because of the source of various chemical constituents which are used for the treatment of many fatal or life threatening diseases, Brahmi is quite help the body in numerous ways.

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