



**BIOPROSEPECTING AND GENETIC TRANSFORMATION OF *BACOPA MONNIERI* L.
THE SOURCE OF TRADITIONAL INDIAN AYURVEDIC MEDICINE: A REVIEW**

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DOI: 10.7897/2277-4572.036205

Received on: 19/10/14 Revised on: 28/11/14 Accepted on: 13/12/14

ABSTRACT

Bacopa monnieri (L.) Wettst. a member of the family Scrophulariaceae has been used in traditional Ayurvedic Indian medicine for over 3000 years. This herbal remedy is also known as, Brahmi. The name Brahmi is derived from the word "Brama" the mythical "creator" in the Hindu pantheon. It was used as a brain tonic to enhance memory developed, learning, and concentration, and to provide relief to patients with anxiety or epileptic disorders. The plant has also been used as a cardiac tonic, digestive aid and to improve respiratory function in cases of bronchoconstriction.

Keywords: *Bacopa monnieri*, Brahmi, Scrophulariaceae, Ayurvedic, Wetland.

INTRODUCTION

Bacopa monnieri (L.) Wettst. (Scrophulariaceae), commonly known, as "Brahmi" is a medicinal herb. The name 'Brahmi' is applied to *Bacopa monnieri* (L.) Penn. syn. *Herpertis monnieri* (Scrophulariaceae) and to *Centella asiatica* (L.) Urban syn. *Hydrocotyle asiatica* Linn (Apiaceae) (Chopra *et al.*, 1994).! However, according to some 'Brahmi' of Bengal is *Bacopa monnieri*, whereas, the Gujarati 'Brahmi' is actually 'Mandukparni', identified as *Centella asiatica*. It is found throughout the Indian subcontinent in wet and marshy places (Kapoor, 1990). *Bacopa monnieri* is used in the Ayurvedic and traditional medicines.

Habit and Habitat

Bacopa monnieri begins as a creeping marshland vine which grows naturally in wetland type environments on almost every continent. Perennial ground cover to 10 cm high, with sprawling stems that put down roots as they trail along the soil; fleshy, oval shaped leaves up to 2 cm long, form opposite along the stems. Small, tubular, five-petalled, white flowers develop in leaf terminals and can blossom over many months of the year, small, dark seeds set in a flat, oval capsule. The edible leaves and stems have a strong bitter taste; originally cultivated in areas like Nepal, Vietnam, Sri Lanka, and India.

Morphology

Brahmi in an annual creeping herb, with numerous branches, succulent, rooting at the node, numerous prostrate branches, each 10-30 cm long; leaves petiolate, oblong, sessile and flowers solitary axillary, purple in color. Flowers and Fruits appear in summer and used medicinally. In India and the tropics it grows naturally soil, shallow water and marshes. The herb can be found at elevations from sea level to altitudes of and is easily cultivated it adequate water is available.

General uses

Bacopa monnieri's role is primarily to enhance memory and learning, in both adults and children. The plant is used in the Ayurvedic system of medicine as a brain tonic, memory enhancer, improvement of intellect and revitalize of sensory

organs (Garai *et al.*, 1996). It is also used as an anti-inflammatory. It works well to ease chronic joint and muscle pain. It has also been used as a successful treatment for epilepsy, tumors, and leprosy. Besides it is also claimed to be useful in the treatment of cardiac, respiratory (Nadkarni, 1988) and neuropharmacological disorders like insomnia, insanity, depression, psychosis, epilepsy and stress. It is reported to possess anti inflammatory, analgesic, antipyretic, sedative (Russo and Borrelli, 2005; Kishore and Singh, 2005), free radical scavenging and lipid per oxidative activities (Anbarasi *et al.*, 2005).

Chemical constituents

The plant is rich in saponins. The name 'saponin' is derived from the Latin word sapo, which means 'soap', because saponin molecules form soap-like foams when shaken with water. They are structurally diverse molecules that are chemically referred to as triterpene and steroid glycosides. Saponins are generally known as non-volatile, surface-active compounds that are widely distributed in nature. They consist of non-polar aglycones coupled with one or more monosaccharide moieties. This combination of polar and non-polar structural elements in their molecules explains their soap-like behavior in aqueous solutions.

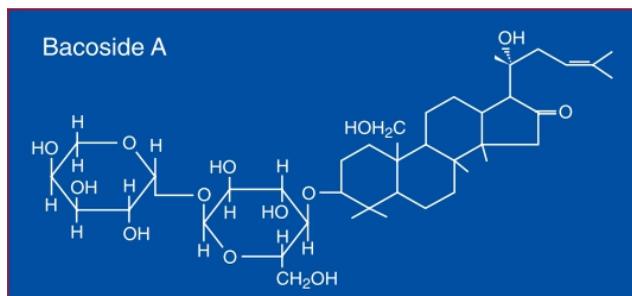
Nutraceuticals

Several pharmacological (Singh *et al.*, 1988, 1997) and clinical studies (Nathan *et al.*, 2001 and Stough *et al.*, 2001) on the extracts of *B. monnieri* standardized to the bacosides A and B have been published. *B. monnieri* extracts are widely available with label claims on the content of bacosides A and B in the international nutraceutical market. Bacopa also provides neural nutrients. Bacopa affects the release of serotonin and dopamine, two neurochemicals responsible for mental calm and clarity, in addition to elevated mood.

Bioactive compounds

The major chemical constituents isolated and characterized from *B. monnieri* are dammarane type triterpenoidsaponins with jujubogenin or psuedojujubogenin moieties as aglycones. The pharmacological effects of *B. monnieri* are mainly attributed to these saponins especially Bacoside A and Bacoside B, which are therefore, considered as bio- active

marker compounds for this species (Deepak and Amit, 2004). The composition of Bacoside A and Bacoside B have been established very recently as a mixture of four triglycosidic and four diglycosidic saponins, respectively (Bacoside A is a mixture of Bacoside A3, Bacopaside II, jujubogenin and Bacopa-saponin C and bacoside B is a mixture of bacoside: N1, bacoside N2, bacoside-IV and bacoside-V) (Chakravarty *et al.*, 2001; Deepak *et al.*, 2004, 2005; Sivaramakrishna *et al.*, 2005).



Other compounds include phenylethanoid glycosides, flavonoids and alkaloids such as brahmine and herpestine (Russo and Borrelli, 2005; Bhandari 2007).

Curcubitacins

Bhandari *et al.*, (2007) reported new cucurbitacins together with known phenylethanoid glycosides from *B. monnieri* possess inhibitory effects on the growth of human colon, breast, lung and central nervous system cancer cell lines (Jayaprakasam *et al.*, 2003). Cucurbitacin E has recently been reported to possess inhibitory effects on the growth of human colon, breast, lung and central nervous system cancer cell lines (Jayaprakasam *et al.*, 2003).

Pharmacological studies

Recent pharmacological studies indeed confirmed the activity of brahmi as described in Ayurvedic medicines (Singh *et al.*, 1988). It was also confirmed that the activity was due to the saponins present in the alcoholic extract of the plant (Chakravarty *et al.*, 2001).

Genetic transformation

Majumdar *et al.*, (2011) have developed an efficient transformation system for *Bacopa monnieri*, an important Indian medicinal plant, using *Agrobacterium rhizogenes*. Transformed calli showed the presence of rol AB or rol A, TR and *ags* genes and showed morphological features typically seen in transgenic plants produced by *A. rhizogenes*. In pRi A4-transformed plants, the content of bacopasaponin D, bacopasaponin F, bacopaside II and bacoside V was enhanced significantly as compared to Wild Type (WT) plants of similar age while bacoside A3 and bacopasaponin C content was comparable with that of WT plants. Genetic transformation of the Indian medicinal plant, *Bacopa monnieri*, using a gene encoding cryptogein, a proteinaceous elicitor, via Ri and Ti plasmids, were established and induced bio production of bacopasaponins in crypt-transgenic plants were obtained (Majumdar *et al.*, 2012).

DISCUSSION

Brahmi has been used in traditional Indian medicine for over 3000 years. *Bacopa monnieri*, has been used as neurotonic in the Ayurvedic system of medicine for centuries. Bacopa is a

great neurotonic, immuno-modulator, adaptogen, tranquilizing, memory and learning enhancing, cerebral activator, anti-ulcer, antispasmodic, anti-asthmatic Ayurvedic herb. It has been recognized for its brain and memory enhancement characteristics. Brahmi is not Gotu Kola (*Centella asiatica*). Some reference books say that gotu kola is called brahmi in Sanskrit. Both are esteemed Ayurvedic herbs and different. They look nothing alike besides mental functioning; it is useful in skin diseases, ulcer, asthma, leucoderma, dyspepsia, epilepsy, anxiety. Bacopa is prescribed as anti-depressants, sedatives, or thyroid medication. Other benefits are anti-allergic, free radicals scavenging effect and as herbal supplement in Epilepsy, anxiety and depression. Know its beneficial actions on brain, memory, mental deficiency, Alzheimer's disease, learning skills, anxiety, depression, stress, epilepsy and ADHD children. In a study on this its effects on children, it showed significant improvement in exploratory drive, improved perceptual image of patterns and increased perceptual organization and reasoning ability. *Bacopa monnieri* is known as an adaptogen that is it has the ability to alleviate both the subjective impressions of stress and its physical repercussions. Next, *Bacopa monnieri* boost synaptogenesis, or the rate of communication between neurons along synapses. It is believed to amplify the electrical impulses that the neurons use to communicate. Healthy and vibrant minds have trillions of such structures, constantly sending information back and forth across elaborate pathways. Bacopa also boosts production of Tryptophan Hydroxylase (TPH2), another synapse support enzyme. The natural Bacopa ingredient Bacoside A makes this communication more efficient, while making receptors better able to receive and process messages, especially in the hippocampus. This is the region of the brain that is intimately involved in processing memories for storage or recall. Bacoside A that assists in the release of nitric oxide allowing relaxation of the aorta and veins and blood to flow more smoothly through the body and aids circulation; and Bacoside B, a protein valued for nourishing nerve cells in the brain. Research is also being done on the use of nitric oxide to treat stroke and Alzheimer's sufferers. Triterpenoidsaponins and Bacosides of *B. monnieri* play key role for enhancing nerve impulse transmission. Bacosides support the repair of damaged neurons by enhancing kinase activity, neuronal synthesis, restoration and regeneration of synaptic activity resulting in nerve impulse transmission. These effects make it a wonderful nerve tonic or nerve nourishing agent as against the neuroleptic drugs that modulate the behavior. A recent scientific study showed that brahmi has potent antioxidant properties. Along with the more familiar antioxidants, beta sitosterol, a powerful fatty acid in brahmi, acts to relieve many degenerative conditions. It is not clear how *B. monnieri* produced this effect of increasing serotonin content. But in future as the understanding of these neurochemicals would grow, *B. monnieri* might emerge as the standard and natural treatment for anxiety and depression. Bacopa also relieves anxiety and its anxiolytic properties as among its best effects. It can thwart anxiety attacks before they happen. Thus there can be a connection between anti-anxiety support and better cognition and mere absence of anxious thoughts allows many to think clearly and more coherently. This enables the user to sustain a longer attention span without being distracted by negative thoughts. Comparative clinical and experimental studies, conducted on these two drugs also indicated that both

these drugs possess varying degrees of psychotropic effects. However *B. monnieri* is relatively more potent drug as compared to *C. asiatica*. Recent research has focused on bio prospecting and genetic engineering of this plant. The results of the studies on *Bacopa*'s cognitive enhancing effects, specifically memory, learning, and concentration support the traditional ayurvedic claims (Mukherjee and Dey, 1996). Different studies have been propounded to explain its method of working. According to one it does this on the chemical level by decreasing environmental stressor response biomarkers like HSP70. The result is that the user fails to even perceive stress. For people who are prone to anxiety attacks, this function can help keep them feeling balanced and confident under stressful conditions. However, recent interest has focus on *Bacopa monnieri*'s cognitive enhancements. The triterpenoidsaponins and their bacosides are responsible for *Bacopa*'s ability to enhance nerve impulse transmission. The bacosides aid in repair of damaged neurons by enhancing kinase activity, neuronal synthesis and restoration of synaptic activity and ultimately nerve impulse transmission.

Acknowledgement

The authors are thankful to Shri Satyavrat Samvedi, President and Dr. Yasoda Saxena Principal, Vedic Kanya P.G. College, Raja Park for their support, encouragement and cooperation.

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Source of support: Nil, Conflict of interest: None Declared

	QUICK RESPONSE CODE
	ISSN (Online) : 2277 –4572
Website http://www.ipsionline.com	

How to cite this article:

Archana Pareek and Ashwani Kumar. Bioprospecting and genetic transformation of *Bacopa monnieri* L. the source of traditional Indian Ayurvedic medicine: A review. *J Pharm Sci Innov.* 2014;3(6):504-506 <http://dx.doi.org/10.7897/2277-4572.036205>