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MEDICINAL IMPORTANCE OF *Bacopa monnieri* (L.) Pennell

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Abstract: *At present, the scientific evidence concerning the effect of Bacopa monnieri (L.) Pennell on brain activity together with working memory is less available. Therefore, we aimed to determine the medicinal importance of Bacopa monnieri (L.) Pennell on attention, cognitive processing, working memory, and cholinergic and monoaminergic functions in healthy elderly.*

Bacopa monnieri (L.) Pennell, commonly known as water hyssop, is an herb often used in Ayurveda. Supplementing Bacopa monnieri (L.) Pennell has been shown to improve Cognition, by means of reducing Anxiety. It is also reliable for improving Memory. Though effects of this nature are usually studied in the elderly, Bacopa monnieri (L.) Pennell appears to affect young people as well, making it a useful Nootropic.

Since Bacopa monnieri (L.) Pennell is also an Adaptogen, a relaxed person might experience a lack of motivation to work after supplementation. Theoretically, pairing Bacopa monnieri (L.) Pennell with a stimulant would ward off malaise, but this combination has not been tested.

Bacopa monnieri (L.) Pennell interacts with the dopamine and serotonergic systems, but its main mechanism concerns promoting neuron communication. It does this by enhancing the rate at which the nervous system can communicate by increasing the growth of nerve endings, also called dendrites. Bacopa monnieri (L.) Pennell is also an antioxidant.

Keywords: *Bacopa monnieri (L.) Pennell, Anti-oxidant, Anxiety, Bacopa monnieri (L.) Pennell, Memory and Adaptogen.*

Introduction: This plant is referred to in Sanskrit as *Aindri* [1] and in Latin as *Bacopa monnieri* (L.) Pennell. It is also known as "Water *Bacopa monnieri* (L.) Pennell".[2] It is a perennial herb found in wet and marshy regions throughout India [3]. Sebastian Pole described that *Bacopa monnieri* (L.) Pennell is a water-loving herb that is a "creeping annual that spreads along banks of rivers as creativity and awareness spread throughout us." The use of Bacopa in *Ayurvedic* medicine is reported from some sources to date as far back as 3000 BC and by other sources to approximately the 6th century AD. In the classical *Ayurvedic* text of *Charaka*, it is classified as *Medhya-Rasayan* (*Medhya*: memory enhancing and *Rasayan*: *Rejuvenating*). *Charaka* described the efficacy of bacopa in treating old age and age-related diseases, promoting memory and intellect, increasing the life span, providing nourishment and improving clarity of voice, complexion and luster.

Bacopa monnieri (L.) Pennell also known as water hyssop, *Bacopa monnieri* (L.) Pennell, is a creeping perennial with small oblong leaves and purple flowers, found in warm wetlands, and native to Australia and India. Commonly found as a weed in rice fields, *Bacopa monnieri* (L.) Pennell grows throughout East Asia and the United States [4]. The entire plant is used medicinally.

Unlike the potentially addictive and forceful action of widely used psychostimulants,

chronic and moderate administration of *Bacopa monnieri* (L.) Pennell appears to nourish rather than deplete neurons, an action compatible with 1400 years of *Ayurvedic* study. *Bacopa monnieri* (L.) Pennell was initially described around the 6th century A.D. in texts such as the *Charaka Samhita*, *Athar-Ved*, and *Susrutu Samhita* as a *Medhya Rasayana*–class herb taken to sharpen intellect and attenuate mental deficits. The herb was allegedly used by ancient Vedic scholars to memorize lengthy sacred hymns and scriptures.

Chemical Constituents: The main nootropic constituents of *Bacopa monnieri (L.) Pennell* are believed to be dammarane types of triterpenoid saponins known as bacosides, with jujubogenin or pseudo-jujubogenin moieties as aglycone units [5]. Bacosides comprise a family of 12 known analogs [6]. Novel saponins called bacopasides I–XII have been identified more recently [7-9]. The alkaloids Bacopa monnieri (L.) Pennellne, nicotine, and herpestine have been catalogued, along with D-mannitol, apigenin, hersaponin, monnierasides I–III, cucurbitacins and plantainoside B [10-15]. The constituent most studied has been bacoside A, which was found to be a blend of bacoside A_3, bacopacide II, bacopasaponin C, and a jujubogenin isomer of bacosaponin C [15]. These assays have been conducted using whole plant extract, and bacoside concentrations may vary depending upon the part from which they are extracted.

In one *Bacopa monnieri* (L.) Pennell sample, Rastogi et al. found this bacoside profile—bacopaside I (5.37%), bacoside A_3 (5.59%), bacopaside II (6.9%), bacopasaponin C isomer (7.08%), and bacopasaponin C (4.18%) [16]. The complete assay of *Bacopa monnieri* (L.) Pennell is an ongoing effort.

Plant Description: *Bacopa monnieri* (L.) Pennell is a glabrous, succulent, small, prostrate or creeping annual herb, found throughout India in wetlands and damp places. Stem is thin, green or purplish green, about 1-2 mm thick, 10-30 cm long, soft; nodes and internodes are prominent, glabrous; and taste slightly bitter [17]. Leaves are simple, opposite decussate, green, sessile, 0.6-2.5 cm long, 3-8 mm broad, obvate-oblong; and taste slightly bitter. Flowers are small, axillary and solitary, pedicels 6-30 mm long, bracteoles shorter than pedicels. Fruits are capsules upto 5 mm long, ovoid and glabrous. Root is thin, wiry, small, branched and creamish-yellow in color.

Scientific Classification

Kingdom	Plantae
Order	Lamiales
Family	Plantaginaceae (or Scrophulariaceae)
Genus	*Bacopa*
Species	*B. monnieri*
Binomial name	*Bacopa monnieri* (L.) Pennell

Source: https://en.wikipedia.org/wiki/Bacopa_monnieri

Ayurvedic Description of *Bacopa monneri* (L.) Pennell [18]

S.N.	***Ayurvedic Property***	***Bacopa monneria*** (L.) Pennell
1.	Rasa (Taste)	Tikta
2.	Guna (Properties, potency)	Laghu, snigdha
3.	Veerya (Vital fluid)	Ushna
4.	Vipak (Post digestion effect)	Katu

Manas, the outer mind, is the receptacle of sensory impressions from our sense organs, organizes them into categories, yet it has doubt about their true nature. *Buddhi* defines and judges them and brings about definite and determinate cognition. Thus while *Manas* simply assimilates sense-impressions and *Buddhi* defines them, *Ahankara*, the Ego, self-appropriates the perceived impressions for its own agenda. *Buddhi* determines their nature, differentiates them and crystallizes them into concepts. Its function, then, is to bring about certainty and distinctiveness in knowledge.

Rajas or active, stirring, desiring, passionate, moving; impelled towards action, which may be a negative if excessive or uncontrolled; it is positive when it overcomes inertia[19].

Tamas static, stable, inert; Negative aspects include heaviness, stubbornness, vice, ignorance, dullness, stagnation, or stupor.

Positive aspects include stability and reliability[20].

Sattva pure, lucid, serene, illumined, equipoised, spiritual; as the veil of the other two is gradually lifted, there arises sattvic qualities of virtue, higher wisdom, peace, desirelessness, and expansiveness [21].

The Three *Doshas*: Most people get caught up every day in their own thoughts, concerns, perceptions, opinion, and emotions–becoming so identified with a thought that the mind creates its own interpretation of the world which can sometimes exist only in our mind. Our innate *Doshic* constitution (*Deha Prakriti*) certainly influences the type of mental impressions which arise.

Kapha: Predominant person tends not to see the world through the filter of fear or anger and might interpret the banker‘s call as something positive perhaps a reward for being a loyal customer or some good news about her investments [22-24].

***Vata*:** Type mental disorders cause mental instability and agitation, which invariably creates fear, unrestrained thinking, anxiety, and typically an unrealistic pessimistic anticipation and perception of life events. The *Vata* mind is hyper-sensitive, hyper-reactive, agitated and lacking in endurance. The mind is excessive porous and affected by the manifestations of others and can launch prematurely into impulsive actions that are seen as mistakes a short time later [25-26].

***Pitta*:** Type mental disorders commonly occur due the tendency to be self-important, even narcissistic. *Pitta Dosha* when excessive in the mind often creates a fiercely focused but narrow, fanatic and confrontational mind. Excess aggression, hostility, blaming and criticism of others are the outer manifestations but misdirected desires and insecurity are root causes behind most *Pitta* mental disorders [27-29].

The Three *Gunas*: No one would say that the body has three legs, or that stomach pumps blood and brain digests food. The reason for this is that the body is easy to observe. We can easily list the main systems of the physical body, but we find it difficult to do so for mind. The mind appears as an amorphous or structure-less entity, rather than a structured instrument like the body. *Ayurveda* Initially understands mind through the qualities exhibited by its component elements. The *Sanskrit* word *guna* means quality. Whereas the *Doshas* influence both mind and body, the *Gunas* relate only to the mind.

Supports the Brain: As people age, it’s common for age-related brain degradation to happen. The active compounds in *Bacopa monnieri* (L.) Pennell, known as bacosides, are beginning to be evaluated for their effects on the brain and human health. Some research has shown the compounds in *Bacopa monnieri (L.) Pennell* to positively influence brain cells that prompt the regeneration of brain tissue. [30] In one animal study, long-term supplementation with bacosides showed therapeutic value against the rapid degeneration associated with Alzheimer’s disease. [31] Hopefully more will continue to explore its potential benefits for brain health.

Promotes Liver Health: The brain is not the only organ that benefits from *Bacopa monnieri* (L.) Pennell’s health-promoting compounds. The liver is the body’s main detoxifying organ, and studies suggest *Bacopa monnieri* (L.) Pennell may be useful for encouraging liver function following toxin damage. [32] With the daily onslaught of toxins in our environment and food, it’s no wonder so many seek safe, natural compounds that support proper liver function.

Protection against Neonatal Hypoglycemia: When it comes to newborn infants, low blood sugar (hypoglycemia) can result in serious and immediate brain damage, inducing future motor and cognitive impairment. Studies have found bacosides to be highly-active compounds that exhibit neuron-protecting effects in hypoglycemic infants. Therefore, many researchers believe that *Bacopa monnieri* (L.) Pennell extracts may be effective for protecting newborn brains against hypoglycemia-induced brain damage [33].

Positively Impacts Opioid Dependence: Doctors prescribe (and sometimes over-prescribe) opioids, like morphine and oxycodone, for pain management. Although these drugs are effective, their highly-addictive nature is a massive downside. Seventy-seven percent of chronic pain patients also suffer from depression and face an added risk of addiction. Researchers have discovered that bacosides may be helpful for enhancing the benefits of morphine while reducing the “high”, thus decreasing the risk for dependence [34-35]. In addition, studies indicate that bacosides offer protective benefits for organs commonly affected by opiate toxicity [36].

Fights Systemic Redness and Swelling: Any illness or irritation can cause redness and swelling in the body. No location more dangerous than the brain. *Bacopa monnieri* (L.) Pennell may be helpful at fighting this. Research

supports its use for managing systemic redness in the brain caused by the body's autoimmune response [37]. Much of the research is ongoing; however, the emerging data offers hope for new therapies in the treatment of chronic discomfort and redness.

Encourages Normal Blood Pressure: *Bacopa monnieri* (L.) Pennell has been shown to increase the utilization of nitric oxide in the body and also appears to encourage vascular muscle function, two benefits that positively influence normal blood pressure [38]. While promoting normal blood pressure is not one of *Bacopa monnieri* (L.) Pennell's most well-known uses, the herb may still provide a valuable, natural approach to those seeking this benefit.

Strong Antioxidant Activity: Antioxidants can we get too many of them? Many researchers are evaluating natural plants, herbs, and foods for their antioxidant potential and findings indicate that *Bacopa monnieri* (L.) Pennell is a good one. It provides protection against oxidative damage, a type of cellular damage caused by free radicals [39]. The herb has also been shown to enhance antioxidant activity in other organs, like the kidneys [40].

Organic is Best: As with any plant or herb, it's a good idea to know its source in order to decrease the likelihood of consuming pesticides, GMO's, and pollutants. If *Bacopa monnieri* (L.) Pennell has a caveat, it's that it's very absorbent and can easily accumulate pollutants and other contaminants, such as arsenic, if grown in or around contaminated areas. In more than one case, *Bacopa monnieri* (L.) Pennell samples taken from a semi-urban area contained noticeable levels of lead, copper, cadmium, and zinc which exceeded safe thresholds [41-42].

Effects of *Bacopa monnieri* (L.) Pennell: *Bacopa monnieri* (L.) Pennell works to improve cognitive function in people of all ages. It improves the way the mind works for better memory and clearer thinking. This herb also helps to improve mood. People who take the dried herb or extract report feeling an instant lift in their mood and a new way in which their brain functions. Those who seek information on Bacopa monnieri (L.) Pennell are often amazed at the many ailments this herb can provide treatment for. It can be taken internally or applied topically through an extract made from steeping the leaves of the plant and extracting the precious oils inside.

Elemental Analysis: Elemental concentrations of *B. monnieri* (L.) Pennell [43-47] herb were determined by various multi-elemental analysis techniques. A number of active elemental constituents of the medicinal plants are the metabolic products of the plant cells. A number of minor and trace elements play an important role in the metabolism processes. These important elemental constituents of the medicinal plant possess different curative capability for human diseases. As reported in there are 10 minor (mg/g) elements, viz. Al, Br, Ca, Cl, Fe, K, Mg, Na, P and V present in Bacopa monnieri (L.) Pennell plant [43]. Also, there are 12 trace (µg/g) elements viz. Ba, Co, Cr, Cs, Hg, La, Mn, Rb, Sc, Se, Th, and Zn detected in the Bacopa monnieri (L.) Pennell herb using neutron activation analysis (NAA) and Atomic Absorption Spectrometry (AAS) techniques. Again, in another report, elemental constituents of *Bacopa monnieri* (L.) Pennell herb have been analyzed using NAA and AAS techniques [44, 48]. There are 5 minor (w%) elements, viz. Al, Cl, Mg, Na, K, detected using NAA. The method involves thermal neutron irradiation in a reactor followed by counting at several intervals. Also, Cu, Co, Ni, Pb, Cr, Cd, Fe, Ca and Zn contents were determined by AAS. Concentration (w%) of 9 minor elements, viz. Na, Mg, Al, P, S, Cl, K, Ca, and Fe in *B. monnieri* (L.) Pennell herb were determined using the energy dispersive spectroscopy (EDS) technique [46]. Also, both minor (%) and trace (ppm) elemental concentrations of *Bacopa monnieri* (L.) Pennell herb were carried out using the proton-induced Xray emission (PIXE) technique [47]. The minor elementals, viz. Fe, Ca, P, K, Cl are found in w%. However, the trace elements of *Bacopa monnieri* (L.) Pennell, viz. V, Cr, Mn, Co, Cu, Zn, As, Br, Se, Rb, Sr are observed in ppm level.

Pharmacological Analysis: The pharmacological properties [49-58] of *B. monnieri* (L.) Pennell have been studied extensively and the activities have been attributed mainly to the presence of characteristic saponins (bacosides). Again, Bacopa is a very good natural antioxidant which shows neuroprotective properties in the memory centers of the brain and cell-protective effects [59]. Again, epilepsy is a neuronal disorder characterized by learning, cognitive and memory impairments.

It also inhibits acetylcholinesterase, activates choline acetyltransferase, and increases cerebral blood flow [60] and protects neurodegeneration in animal models [61-67]. The preliminary clinical studies of the above herb have shown improvement of cognitive function

in humans [68]. However, the major chemicals responsible for various curative properties of *Bacopa monnieri* (L.) Pennell herb have already been described in the earlier section the 'Chemical analysis'.

Toxicology Analysis: Aqueous extracts of *Bacopa monnieri* (L.) Pennell may elevate serum thyroxine and decrease spermatogenesis, sperm count, and fertility in male mice [69]. The rat LD50 was found to be 2400 mg/kg following a single oral administration [70]. The most commonly reported adverse side effects of *B. monnieri* (L.) Pennell in humans is nausea, increased intestinal motility, and gastrointestinal upset [31]. Toxic elements such as Cd, Cr, Hg, As, Rb, and Pb are present in the *B. monnieri* (L.) Pennell herb [43, 48, 46, 47, 71, 72]. These environmental toxicants cause poisonous effects on both plants and animals. The toxic and heavy metals such as Pb, Hg, etc. have been a regular constituent in the Indian traditional Ayurvedic medicines. The efficacy and side effects of these elements are evaluated by various authors. It has been expected that these may cause serious harm to patients taking such remedies.

Benefits of Using Bacopa monnieri (L.) Pennell

- *Bacopa monnieri* (L.) Pennell has been found to be very beneficial in the treatment of anxiety neurosis and mental fatigue. It has been found to significant improve IQ levels, general ability, behavioral patterns and mental concentration in children. *Bacopa monnieri* (L.) Pennell is useful for improving mental clarity, confidence and memory recall. For these uses of *Bacopa monnieri* (L.) Pennell, it has been widely used by students.
- *Bacopa monnieri* (L.) Pennell is also used for the treatment of epilepsy, insomnia, asthma and rheumatism.
- Studies have also shown *Bacopa monnieri* (L.) Pennell to possess anticancer activity.
- *Bacopa monnieri* (L.) Pennell is effective against diseases like bronchitis, asthma, hoarseness, arthritis, rheumatism, backache, constipation, hair loss, fevers, digestive problems etc.
- *Bacopa monnieri* (L.) Pennell is bitter in flavor, in India the plant is used in salads, soups, as a cooked lea vegetable, or pickled.
- Research has shown that *Bacopa monnieri* (L.) Pennell has Antioxidant, Cardiotonic and Anticancer properties.
- The plant is also used for all sorts of skin problems- eczema, psoriasis, abscess, ulcerations- it is said to stimulate the growth of skin, hair and nails.

Two chemicals in bacopa, bacosides A and B, improve the transmission of impulses between nerve cells in your brain. The neurobiological effects of these isolated molecules were found to increase protein kinase activity and new protein synthesis, specifically in cells in region of the brain associated with long-term memory. Bacopa also increases your level of serotonin, a brain chemical known to promote relaxation. The herb's ability to boost brain function while reducing anxiety may explain why it helps treat ADHD.

Aside from increasing intellectual and cognitive function, *Bacopa monnieri* (L.) Pennell induces a sense of calm and peace in its users. It is unique in its ability to invigorate mental processes whilst reducing the effects of stress and nervous anxiety. This makes *Bacopa monnieri* (L.) Pennell extremely applicable in highly stressful work or study environments where clarity of thought is as important as being able to work under pressure. Many people have the intelligence to perform to strict standards, but lack the composure and self-confidence to reach them. Additionally, *Bacopa monnieri* (L.) Pennell helps soothe the restlessness and distraction that nervousness causes. *Bacopa monnieri* (L.) Pennell is ideal for students and workers faced with this problem.

Conclusion: *Bacopa monnieri* (L.) Pennell has been used in traditional Indian medicine, the *Ayurveda*, for the treatment of anxiety, and in improving intellect and memory, for several centuries. In addition to memory boosting activity, it is also claimed to be useful in the treatment of cardiac, respiratory and neuropharmacological disorders like insomnia, insanity, depression, psychosis, epilepsy and stress. It has been reported to possess anti-inflammatory, analgesic, antipyretic, sedative, free radical scavenging and anti-lipid peroxidative activities. It is used also as a tranquillizer. The plant is anticancer, astringent, bitter, sweet, cooling, laxative, intellect promoting, anodyne, carminative, digestive, antioxidant, antimicrobial, antiinflammatroy, anticonvulsant, depurative, cardiotonic, bronchodialator, diuretic, emmenagogue, sudorfic, febrifuge and a tonic.

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