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Exploring the Neutraceutical Effects of Brahmi (*Bacopa monnieri*) in Agriculture: Potential Applications and Benefits

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ABSTRACT

Brahmi is a well proven herb of many medicinal properties. All the parts of the plant can be used as medicine. Brahmi leaves are a powerhouse of valuable alkaloids and triterpene saponins that can stimulate brain chemicals for sharper thinking, memory and learning.. Understanding the bioactive chemicals present in herbal plants, their capacity to strengthen the immune system, and the safety of the end products is necessary for the processing of brahmi. It has been observed that the extracts of brahmi plants can be a helpful component in the creation of herbal beverages that contain the phenolics as well as Vitamin C as antioxidant. Without the addition of chemicals like sweeteners, artificial flavors, or colors, they can be utilized as a base to create beverages with bioactive qualities and sufficient the organoleptic properties for the consumer to enjoy. The ayurvedic herbs have the greatest potential for benefiting the population, particularly those who live in countries where poverty and bad health are prevalent. *Bacopa monniera* is well known for its memory enhancing property in traditional Indian system of medicine. Cognitive-enhancing and neuromodulatory property of brahmi herbal drink, a nutraceutical product from *Bacopa monniera* extract. The development and use of brahmi in functional meals will benefit not only the general public's nutritional status, but also people suffering from degenerative diseases. Brahmi can be consumed as a vegetable and the leaf powder can be dried in a dryer and stored for several months without refrigeration. The dried brahmi leaf is ground into a powder that may be added to any dish to assist boost the nutritional value of the cuisine.

Keywords Brahmi, *Bacopa monnieri*, Beverages, Saponins, Nutraceutical effects.

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INTRODUCTION

Now, many garden enthusiasts are rediscovering the benefits of herbs. In addition, academic institutions

and pharmaceutical research facilities are becoming aware of the abundance of potentially beneficial compounds that are concealed in plants. Traditional medical practices for being investigated for clues and there is a strategy to promote the preservation of local medicinal Herbs. Nature deserves praise for her creativity and expertise in creating so many intricate compounds to entice pollinators and deter predators. There are still richest to be found (Jones 1996).

One of India's most ancient ayurvedic remedies is brahmi. It was created more than 3,000 years ago in India. Brahmi is renowned for improving mental disorders like memory loss and mood swing. The primary components in brahmi that improve the passage of nerve impulses are called saponins. Food with additional health advantages to those of standard diet is considered as functional food nutrients. The flavor of brahmi is distinct, strongly herbaceous, and it leaves a taste of very bitter after eating. There is a high demand for food products that really are nutritious and offer some practical benefits due to changes in lifestyles and great awareness of health. And also it offers a wide range of practical advantages (Devendra *et al.* 2018). List of medicinal plants with their useful parts and its function for human health are presented in Table 1.

Difference between brahmi and mandukaparni

The name brahmi was also used for Centella asiatica. By equating brahmi with manduuki and mandukaparni in the first century, Bhavaprakasha caused confusion. Even in Part I, Vol. 1 of the Ayurveda Pharmacopoeia of India brahmi's Hindi equivalent, Mandukaparni, was identified in volume 11. Centella asiatica and *Bacopa monnieri* have been used to compare two distinct medicines, mandukaparni and brahmi.

Brahmi and Manduakparni were treated separately by Charaka, Sushruta and Vagbhatta. These two medications are different from one another, according to a critical analysis of their comparative phytochemistry, pharmacology and therapeutic characteristics. Brahmi was employed as a specialised treatment for mental illnesses including epilepsy and insanity, while mandukaparni was being used as an overall brain tonic. While Mandukaparni is an abortion inducer, Brahmi encourages fertility and supports implantation (Charaka employed it as an im-

Table 1. List of medicinal plants with their useful parts and its function for human health.

Sl. No.	Plant name	Scientific name	Parts useful	Therapeutic value	Side effects
1	Ghritkumari	*Aloe vera*	Leaves	Burns, psoriasis, cold sores, acne, diabetes, constipation, dermatitis, genital herpes	Kidney problem, Heart disease
2	Basil	*Ocimum babsilicum*	Leaves	Stomach spasms, loss of appetite, intestinal gas, kidney conditions, fluid retention, snake and insect bites	Low blood sugar, risk of liver cancer
3	Gotu kala	*Centella asiatica*	Whole plant	Improve blood circulation, reduces swelling	Liver damage
4	Holy basil	*Ocimum tenuiflorum*	Leaves, flower	Headaches, treating diabetes, asthma, fever, cold, cough, flu, sore throat	Nausea, diarrhea
5	Chamomile	*Matricaria recutita*	Flower	Anxiety, relaxation, wound healing and reduce inflamation or swelling	Increases drowsiness
6	Pepper mint	*Metha piperita*	Leaves	Choleretic, antiseptic and invigorator, sore throat, cough, cold	Heartburn, dry mouth, nausea, vomiting
7	Garlic	*Allium sativum*	Cloves, root	Lower cholesterol and blood pressure	Risk of bleeding

Table 1. Continued.

Sl. No.	Plant name	Scientific name	Parts useful	Therapeutic value	Side effects
8	Ginger	*Zingiber officinale*	Rhizome, Root	Nausea, motion sickness	Bloating, gas, heartburn and nausea in certain people
9	Lemon grass	*Cymbopogon flexuosus*	Leaves, stem	Perfurmary, herbal tea	Dry mouth, dizziness, frequent urination
10	Sarpa gandha	*Rauvolfia serpentina*	Root	Improve blood sugar levels, digestion, sedative properties	Loss of appetite, nausea vomiting, diarrhea diarrhea
11	Brahmi	*Bacopa monnieri*	Whole plant	Asthma, mental and physical fatigue, memory enhancer	Nausea, stomach cramps

pregnating herb). Although both are used to treat skin conditions, their therapeutic outcomes differ. Bacopa monnieri's transverse slice through the midrib has an isobilateral histology, whereas *Centella asiatica's* is dorsiventral. The characteristics of *Centella asiatica* include a striated cuticle and a sparsely stratified, spongy parenchyma. *Bacopa monnieri* has a lot of stomatal openings and air cavities. Alkaloids, saponins, glycosides and tannins have all been identified in these two medications (Aparna *et al.* 2015).

The real identity of brahmi has been the subject of considerable misunderstanding. Both the *Bacopa monnieri* and *Cintella asiatica* (manduka parni, gotu kola) have been given the same name. Both are powerful herbs in their respective right, but according to Baba Hari Dass, *Cintella asiatica* is the "weaker brahmi" and Bacopa monnieri is the "stronger brahmi". Regionally, Bacopa is more utilized in the South India while Cintella is more utilized in the North. Although the classical writing did not do a good job of differentiating between these two plants, their characteristics are in fact distinct. Although they both primarily affect the nervous system, *Cintella* is a little heavier and has a stronger tonifying action, whereas *Bacopa* is lighter and has a mild detoxifying effect. Although he suggested that *Bacopa* was the most successful herb for treating mental disorders, Rishi charaka saw both of these herbs as being good for cognitive function (Anon 2017).

Brahmi

Brahmi is a herb with no aromatical properties and it is also a semi-aquatic, creeping, glabrous and succulent. It is a tiny, branch filled creeping herb. Its branches measures from 10 to 35 cm in length and it can reach a height of 2 to 3 feet. Its leaves are oval in shape and range in size from 3 to 8 mm. pairs of leaves grow along the stems. Tiny, tubular flowers with petals that are white with purple color. It has a delicate, succulent stem that is coated with hairs with glands. Roots emerge from the nodules and touch down in the ground right away. Fruit is shaped like an oval with a sharp apex (Jain *et al.* 2016).

Aublet initially defined the genus Bacopa in 1775. He named the species Bacopa after the specimen and the term Bacopa was derived from the Latin name that these plants were known by among the indigenous Caribe (American Indian) people of French Guiana at that time (Sudhakaran 2020).

Brahmi, a small creeping herb from the Scrophulariacae family (Stough *et al*. 2001) with tiny, oblong leaves, many branches and pale purple flowers. One of the oldest healing herbs used in Ayurvedic medicine, it is known as water hyssop, herb of grace, thyme leaved gratiola, Indian pennywort. It is now heavily marketed for its ability to improve learning, memory and focus as well as for treating systematic ailments like cardiovascular, liver, neurological, gastrointestinal and respiratory issues as well as melancholy and anxiety. Brahmi has also been demonstrated to have antibacterial, anti-diabetic, anticancer and anti-inflammatory properties (Nemetchek *et al.* 2017), (Abhishek *et al.* 2022).

Alkaloids, saponins, glycosides, flavonoids and its primary contribute to its therapeutic qualities. The

brahmi extract was subjected to a phytochemical examination, which identified a number of bioactive components in the extract. According to reports, the extract contains triterpenoids, alkaloids, glycosides, saponins and alcohol related chemicals. Alkaloids such as "Brahmine," "Herpestine" and "Nicotine" are present in the brahmi extract. The major bioactive component of brahmi is thought to be the dammarane type triterpenoids saponins, such as Bacoside A, 3-(-L-arabinopyronyl)-O-D-glucopyronaside. The two primary substances believed to be in charge of bacoside A and bacoside B's effectiveness as a neuroprotectant are found in brahmi (Dubey and Chinnathambi 2019).

Around the world, countries including India, Vietnam, Taiwan, Sri Lanka, Nepal, Pakistan and China are home to brahmi. Additionally, it is found in Florida and Hawaii and other moist Southern areas of the United States. Brahmi grows naturally in areas with plenty of water, such as marshes, wetlands or next to creeks and rivers. It favours moist soil with poor drainage, where it will thrive and form thick, sprawling mats. The plant, however, is highly resilient and will thrive in a variety of environments, even living in slightly saline waters (Lansdown *et al.* 2013, Puri 2003).

Since the beginning of time, brahmi has been known that learning abilities decline dramatically with age and those elements like emotional stress are crucial in causing these effects. For this reason, researchers have worked to find a source of potentially useful drugs that may postpone such symptoms or otherwise help with the illness. Although phytochemicals are recognized as substances with significant potential to achieve these goals, they have not yet been fully utilized. In order to support their usage in traditional medical systems, several plants are chosen and research has shown a variety of natural chemicals that may function as nootropic drugs. Bacopa monnieri is a herb which has traditionally been used as a brain tonic and is widely known for its ability to restore health in weak conditions. It is annual plant that grows in damp, moist and quaggy places all over the Indian landmass (Chunekar 1960, Satyavati *et al.* 1976).

The plant is commonly referred to as brahmi in India. The word "Brahma", which alludes to the Hindu legendary god thought to have created the world is the source of the name "Brahmi". Any substance that has the ability to regenerate the brain, which is the hub of all activity, is known as brahmi. Brahmi has been utilised by Ayurvedic doctors in India's republic for around three thousand years. The medicinal applications of this plant are recorded in the Charak samhita, a significant work on the Indian medical system. This herb can treat blood filtration, constipation and throat infections. It has been suggested as a treatment for anxiety, attention problems and cognitive impairment (Russo and Borelli 2005).

Along with the Charaka samhita, numerous ancient Ayurvedic writings have the first mention of BM (6th century AD) (Jain *et al.* 2017).The usage of this herb is frequently advised for managing a variety of mental problems, including loss of attention, poor cognition, anxiety, in addition to for improving learning abilities. Additionally, its efficacy has been confirmed by clinical studies in studies in human test subjects. The CDRI in India has also produced a chemically standardized extract of BM that is available for clinical usage (Dhawan and Singh 1996).

Theraupatic value of brahmi

The whole plant of brahmi is consumed as a decoction as a dieuretic. The entire plant is used as a kidney tonic as well as to treat beri-beri, scurvy, hoarseness and rheumatism. It is also regarded as a stimulant, diuretic and antispasmodic. Moreover, the entire plant is used as a stomachic and appetizer as well as a remedy for diarrhea. For gastrointestinal issues like colic and diarrhea, it is mostly used in China. A decoction from the brahmi leaves is used as an alternative medicine and to get rid of thread worms (Anon 2017).

An effective treatment option for mental illness, poor memory, mental tiredness, stress, depression, and psychotic illnesses is brahmi vati. The chemical composition of brahmi vati are ascorbic acid, nicotinic acid, brahmine, herpestine, alanine, hentri-acontane, octacosane, monnierin (saponin), hersaponin, bacoside A and B, bacogenins A1-A4, sitosterol (Gupta *et al.* 2017).

Table 2. Medicinal uses of brahmi.

Disease	Treatment
Insomnia	Take 3 g of brahmi powder with 100 mL of cow's milk before bed. It alleviates insomnia.
Memory booster	Add one part of dry brahmi, one part almonds and 1/4th of black pepper. Prepare 3 g tablets by pulverising each one in water. Take each pill with milk 2 times a day.
Acne	Few brahmi leaves are mixed with lemon juice, turmeric powder. Prepare the paste then apply it to face.
Anxiety and long-term headache	3 g of brahmi and some black pepper should be ground with water. Give the patient a strained solution for 3 to 4 times a day
Crude fiber	Brahmi oil is beneficial for the brain, nervous system and mind in addition to promoting hair growth when massaged into the scalp

Later research has revealed that the presence of bacoside A in BM may be responsible for the product's memory improving and neuroprotective effects (Dethe *et al.* 2016; Rajathei *et al.* 2014). According to reports, BM component bacopasides activates autophagy (Li *et al.* 2016).

Importance of *Bacopa monnieri* in terms of ethno-medicine

They assess how well medicinal herbs from *Bacopa monnieri* can treat disorder of mixed anxiety-depressive (MAD) condition. The *Bacopa monnieri* is important in adaptogenic properties. Examined the efficacy in rodents used as animal model and further prove it's activity in disease associated with stress, such as anxiety and depression. In mice, there was no evidence of motor incoordination when BM was administered at a level of 80 mg/kg. BM was also found to have anti-depressant (Sairam *et al.* 2002) and anti-anxiety effects. As a result, the extracts have great potential as a therapy tool for MAD disorder (Chatterjee *et al*. 2010).

Fresh *Bacopa monnieri* root is prepared into decoction and it is used as antidote in scorpion stings as well as snake bite. Three times a day, milk and brahmi root juice are given to people who are suffering from weakness and rheumatism. The fruit powder and dried brahmi root is burned and inhaled as smoke three times per day to treat bronchitis (Verma 2014).

For many years, *Bacopa monnieri* has been used locally to treat dermatitis, anaemia, diabetes and to enhance fertility and avoid miscarriage. It has also been used internationally to treat conditions like anxiety, epilepsy disorders, dementia, cough and rheumatism. They showed the BM methanolic extract exhibits anti depressant like effects in the animal behavioural models (Mannan *et al*. 2015).

The leaves are also consumed raw as well as by mixing with other alternative food. It is eaten to improve intellectual ability. Leaves are fried in ghee and it is used to treat voice hoarseness. It's ghrita or medicated ghee is taken with Pushkar amul (the root of the sauseria lappa), which improves improves the memory. In a single dose, 5 g of powdered leaves and 2 or 3 black peppercorns are used for bone fracture. For a week, animal legs that were swollen were treated with *Bacopa monnieri* leaf paste three times per day. As a remedy for asthma, it's leaves and stem are boiled in water, strained and then consumed directly daily twice for five to ten days. Warm paste is given to the stomach to relieve pain, and it's also used to treat inflammation of the urinary ducts. It's leaf juice be mixed with petroleum as a local therapy for treating rheumatism. It's leaves mixed with Piper longum seeds for the enhancement of memory. And also leaves are combined together with almonds which are crushed and consumed orally with sugar and water to improve memory (Verma 2014). Some of the medicinal uses of brahmi from Ayush division are presented in Table 2.

The primary nootropic components of brahmi are in dammarane forms of triterpenoid saponins which is also called as bacosides, with few more are acting as aglycone units which are jujubogenin or pseudo jujubogenin moieties (Sivaramakrishna *et al*. 2005).

There are 12 recognised analogues in the family

Table 3. Chemical composition of fresh *Bacopa monnieri* leaves per 100 g.

Component	Amount (/100g)
Moisture	88.4 g
Carbohydrates	5.9 g
Protein	2.1 g
Ash	1.9 g
Crude Fiber	1.05 g
Fat	0.6 g
Calcium	202.0 mg
Iron	7.8 mg
Energy	38 cal

of bacosides (Garai *et al.* 2009). Bacoside A was discovered to be a mixture of bacosaponin C, bacopaside II, bacoside A_3 and bacosaponin C has been the constituents that has the most attention (Deepak *et al*. 2005).

There is a behavioural study in the neuromolecular pathways that brahmi, an Ayurvedic herb, may use to enhance cognition in a low-toxicity manner. Although it has a long history of use, it is most known for its abilities to boost memory and the nervous system. Many of the in vitro and animal studies that have been done have shown potential therapeutic qualities. The effectiveness of brahmi as a nootropic in people has been supported by numerous randomized, double blind, placebo controlled experiments. Additionally, there is proof of potential Dementia, Parkinson's disease (Singh *et al.* 2021) and epilepsy are all diminished. Brahmi functions through the following mechanisms: β-amyloid reduction, improved cerebral blood flow, anti oxidant neuroprotection (through redox and enzymatic induction) and neurotransmitter release (Aguiar and Thomas 2013).

In indigenous systems of medicine, the entire plant is utilised as a nerve tonic, as well as for epilepsy and insanity. Additionally, it is used as a diuretic and to treat hoarseness, asthma and rheumatoid arthritis. Additionally, it is effective in lowering diabetes, fever and cough. This wonder plant is bringing awareness for its commercial cultivation around the world due to its natural capacity to improve memory and health. The herb is helpful in the siddha system of medicine for treating sore joints, joint swelling, peripheral neuritis, constipation and burning urine. Additionally, it is utilised for laryngitis, chest congestion, mental retardation and convulsions (Kulkarni *et al.* 2012).

Chemical composition of fresh *Bacopa monnieri* leaves per 100 g has been presented in Table 3 (Devendra *et al.* 2018).

Dosage

Brahmi has been consumed successfully in Ayurvedic system of medicine for many centuries and it is not known to have any negative effects at therapeutic doses. Bacopa is traditionally taken three times a day in doses: infusion of 8-16 mL, non standardized powder of 5-10 g and 30 mL of syrup. For adult 1:2 fluid extract dosages of a range from 5 to 12 mL per day, while children aged 6 to 12 should take 2.5 to 6 mL per day. To attain the medicinal/therapeutic benefits of brahmi, dosages of 200-400 mg daily in dosage for adults and 100 to 200 mg daily in smaller dosed for children are required for brahmi extracts standardized to 20% bacosides A and B (Snafi, 2013), (Anon 2004).

Additional, a scientific experiment to evaluate the effects of administering BM of 300 mg/day for 12 weeks on memory function discovered that those over 55 years old demonstrated considerably improved memory retention and acquisition when taking the herb (Morgan and Stevens 2010).

Another investigation looked at the impact of a standardised brahmi with dosage of 300 mg/day on elderly people's cognitive function (Williams *et al.* 2014), anxiety and depression. They came to conclusion that it was a plant that could potentially improve cognition function without the risk in elderly adults (Calabrese *et al.* 2008).

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