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## An investigation into *Bacopa monnieri* phyto-chemicals and drying methods: A review

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**Abstract**

Ayurvedic medicines have the most potential to help people, especially those who reside in nations where poverty and poor health are common. The herb brahmi or *Bacopa monnieri* has numerous known medical benefits. The plant has essential components that can all be utilized medicinally. Rich in essential alkaloids and triterpene saponins, brahmi leaves have the potential to enhance cognitive functions such as memory, learning and logical thinking. Herb included herpestine and brahmine alkaloids. One of the finest specimens of an ayurvedic plant is the brahmi leaf, which has all the essential nutrients, antioxidants and phytochemicals in a single leaf. In today's market, dried foods are an integral part of the food supply chain. In the drying experiments, temperatures of 40, 50, and 60°C were employed. The total phenolic content, colour indices, and antioxidant activity were utilized to assess the quality of the dehydrated samples. The discovery and application of brahmi as functional foods will help those with degenerative disorders as well as improve the nutritional status of the general population. Leaf powder of brahmi can be dried using a dryer and kept for several months and without refrigeration. Brahmi can also be eaten as a vegetable. The powdered dried brahmi leaf can be added to any meal to help increase the nutritious content of the food.

**Keywords:** Antioxidants, phytochemicals, *Bacopa monnieri*, saponin and functional foods

**Introduction**

Herbal products have grown in popularity in recent years, both in developed and developing countries. Brahmi is a medicinal herb that has long been used in the East for therapeutic purposes and is gaining appeal in the West. The Sanskrit term brahmi signifies "Lord Brahma" or "Brahman." Brahman is the god responsible for all of the world's creative forces, and Lord Brahma is the Hindu moniker for cosmic awareness. The functional food processing industry is going to experience an indefinite change with the introduction of herbs such as brahmi as ingredients. The Indian market is flooded with food products that use brahmi referred to as a functional ingredient. With its huge potential to offer customers enhanced health benefits, using herbs like brahmi as a nutritional supplement component is set to revolutionize the functional food industry (Devendra *et al.*, 2018) <sup>[15]</sup>.

Brahmi is believed to be the key revitalizing herb for nerve and brain cells. (Ashalatha and Shenoy, 2016) <sup>[9]</sup> reported on a critical review on brahmi. The acknowledged source of brahmi is *Bacopa monnieri* of the Scrophulariaceae. In local languages, it is known as brahmi or nirbarhmi. It is a weak, creeping herbaceous plant that grows in marshes. Brahmi ghritam, mishra Kasneham, and other formulations use the whole plant. Insanity is relieved by combining brahmi Swarasa with Kustha and honey. Insanity, epilepsy and other sinful conditions are alleviated by old ghee prepared with brahmi swarasa. Epilepsy is treated with panchagavya ghrita and brahmi swarasa. To achieve lifespan, boost memory and intelligence, brahmi is given with honey for a long time. The chemical composition of brahmi leaves is provided in Table 1.

**Table 1:** Chemical composition of fresh brahmi leaves per 100 g (Source: Devendra *et al.*, 2018) <sup>[15]</sup>

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

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### Area and production

India has 15 agroclimatic zones and 17,000–18,000 distinct species of blooming species of plants of which 6000–7000 are believed to have medicinal properties. Many Indian communities employ these medicinal herbs, and their use is recorded in Indian medical systems including Swarigpa, Unani, Ayurveda, Siddha, homoeopathy, etc. Approximately 960 different types of medicinal plants are traded, and 178 of those species are consumed over 100 metric tonnes annually. Rajasthan has the largest percentage of land used for medicinal crops (56 percent) followed by UP (25 percent).

In terms of production of medicinal plants, Madhya Pradesh is first with 44 percent and Rajasthan is second with 19 percent (Shweta, 2022) [23].

Herbal processing refers to the techniques for preparing herbal resources and herbal preparations, as well as the manufacture of final herbal products, all with the purpose of ensuring the quality of herbal medicines. Depending on the desired use, herbal materials and preparations can be employed as therapeutic dosage forms or as beginning materials as well as intermediates in the preparation of finished herbal products. Inspection and sorting, basic processing and drying are all part of the post-harvest processing of herbs. The specifics of herbal processing may differ from one herb to the next. Some methods just need a few basic primary processing steps like washing, primary cutting and sectioning before they can be dried (WHO, 2018) [24]. The ayurvedic plants comprise an extensive array of organic substances, many of that have been used medicinally and may provide guidance for the development of new drugs. Ayurvedic herbs contain chemical compounds that help cure a range of mental health issues. People worldwide can benefit most from ayurvedic herbs, especially those who reside in nations where poverty and poor health are prevalent (Merina *et al.*, 2012) [19].

### Therapeutic insights of brahmi (*Bacopa monnieri*)

The brahmi, which have a high concentration of secondary metabolites that provide active substances that stimulate cell upgrading, improve physical and mental wellness. One of the most beneficial examples for an ayurvedic herb is the brahmi leaf, which has all the essential nutrients, antioxidants, and phytochemicals in a single leaf. The properties and applications of brahmi leaf for few disorders and other ailments have received significant attention in recent times. The leaf powder of brahmi can be dehydrated in a cabinet dryer then kept for a long time without refrigeration. Brahmi can also be eaten as a vegetable. The powdered dried brahmi leaf can be added to any meal to help increase the nutritious content of the food (Amaravathi *et al.*, 2020) [5].

*Bacopa monnieri* has a lot of promise in terms of treating cognitive diseases, as well as preventing oxidative damage and improving cognitive function in healthy people. Biomedical research on brahmi is still in its early stages, but preliminary findings like these are starting to open the floodgates. Longer-term research is needed to see if brahmi in combination with other substances, as prescribed by the Ayurvedic system, can provide synergistic benefits. Bacoside A, a triterpenoid saponin derived from *Bacopa monnieri* (L.) Wettst. (Scrophulariaceae), is a significant ingredient utilized as a memory enhancer. The active components in bacopa plant include bacoside A and B, which have antioxidant and hepato-protective properties (Aguiar and Borowski, 2013) [1].

*Bacopa monnieri* is containing a number of compounds that give it its therapeutic as well as medicinal effects. These are some of them are Brahmin, Saponin, Beta-sitosterol, Betulinic acid, Sigmasterol and D-mannitol. Brahmi is renowned as a herb that boosts the brain because of these phytochemicals, which increase brain health. Phyto-chemicals found in brahmi are nicotine, desaponin glycosides and herpestine. This herb is utilized as liver-enhancer, anti-diabetic, anti-pyretic (which will treat fever), anti-ulcerogenic, analgesic, carminative, anti-bacterial, anti-asthmatic and many other things because it has so many beneficial components (Anon, 2016) [6].

The extract contains between 40.0 and 50.0 percent total bacosides, with the highest percentages found in the chemical components bacoside A3 (>2.7 percent), bacoside II (>3.6 percent), and bacoside I (>4.5 percent). Patients were given this once daily intragastrically after 450 mg of dried powder had been dissolved in 80 ml of distilled water (Banerjee *et al.*, 2014) [12].

Ayurvedic medications known as rasayanas may act as radio protective agents while treating cancer. Rasayana medications have been used by Indians from the dawn of civilization, giving them an advantage over manufactured drugs. The safe and inexpensive human trials of rasayana medications are made possible by their benign character, which sets them apart from their synthetic counterparts. It is anticipated that when utilized as a radio protective medication in clinics, such organ-specific brahma rasayana could be beneficial in treating gastrointestinal and brain tumors (Baliga *et al.*, 2013) [11].

### Drying of brahmi leaves

Evidence of drying dates back to the prehistoric era, making it one of the oldest preservation techniques ever used by humans. A vital part of a food supply chain among the modern market is played by dried foods. Grain is the most significant component of fruits and vegetables, which are estimated to account for about 1 percent of the food industry's total drying. By lowering the water content, this technique essentially stops or slows down the microbial deterioration of food. A lot of aspects need to be taken into account when drying food in the functional food or nutraceutical sectors. An arrangement that reduces heat, oxidation and light exposure (*i.e.* less time duration with high heat 70 °C) may aid in the conservation of important bioactive chemicals (Ahmed *et al.*, 2013) [2].

The leafy vegetables had been air dried in an oven set at 60 °C for 10 to 12 hours after being steam blanched for about 5 minutes. Measurements were taken on both fresh and dried samples of specific proximate components, vitamins, minerals, anti-nutrients, and dialyzable minerals. The simplest and most useful way to preserve these sources of micronutrients seems to be dehydration, particularly in situations where they are abundant. As a workable food-based approach to reduce micronutrient deficiencies, traditional products including dried leafy vegetables can be recommended (Gupta *et al.*, 2013) [17].

Secondary metabolites, which are potential medication sources are abundant in medicinal plants. Traditional drying procedures for many economically important medicinal plants frequently result in product deterioration due to contamination and a loss in active principle content. As a result, there is an urgent need to regulate the post-harvest drying of many of these therapeutic plants in order to recover more active principles. The identification of bacoside A in dried leaves

powder from various Indian locations was achieved through the development and validation of an advanced thin-layer chromatographic method. Utilizing densitometry analysis to 598 nm, the 500 to 4000ng band<sup>-1</sup> concentration range was measured. Compact as well as well-resolved bands with bacoside A were found from brahmi leaves powder across various geographic regions with a retardation factor of 0.02 and 0.53. Bacoside A concentrations were found to be greatest and lowest in powdered leaf samples from Kerala and Jammu, respectively (Ahmed *et al.*, 2015)<sup>[3]</sup>.

In the drying experiments, temperatures of 40, 50 and 60 °C were utilized. The total phenolic content, antioxidant activity, and colour indices were utilized to assess the quality of the dehydrated samples. When the temperature was raised to 60 °C, the green hue was significantly reduced. The colour index for 40 and 50 °C was very close. The extract made from methanol for heat pump drier at 60 °C included the maximum amount of phenolic compounds, while none in the heat pump drier at 50 °C contained a small amount of phenolic compounds. The antioxidant activity of heat pump drying treatments was higher than that of none for drying treatments in heat pump drier due to higher drying times at the same temperature (Ataei *et al.*, 2015)<sup>[10]</sup>.

Medicinal plants are a diverse category of industrially important crops with high export and domestic value. The World Health Organization reports that in developing nations, 80 percent of people use traditional medicines, the majority of which are derived from plants, while twenty-five percent of pharmaceuticals in modern pharmacopoeia are derived from plants. Over the last two decades, there has been a significant increase in interest in traditional medical systems. This increased demand can be related to a growing recognition for natural goods that are safe, have few or no adverse effects, are easily attainable at reasonable prices, and they are frequently the only conveniently available source of healthcare for the impoverished in both developed as well as developing nations (Silpa *et al.*, 2021)<sup>[22]</sup>.

Pre-treatments are processing steps that are done before to drying in an attempt to reduce drying time and energy consumption and provide high-quality dried herbs (Deng *et al.*, 2019)<sup>[14]</sup>. When drying, blanching is beneficial for many different types of herbs. Blanching has a number of advantages, the most important of which is the reduction of colour deterioration. Blanching herbs was said to shorten their drying time. Steam blanching leaves for 15 seconds increased the rate of drying by a factor of 10 when compared to leaves that were not treated. The dried leaves that have been steam blanched have a higher ratio of chlorophyll a/b and better colour retention (Rocha *et al.*, 1993)<sup>[21]</sup>.

The freeze-drying of ethanol and methanol extracts of brahmi (*Bacopa monnieri*) was studied using infrared (IR). After optimum freeze-drying, the physiologically active phytochemicals could be maintained. The antibacterial properties of the freeze-dried extract were compared to gentamycin using a few gramme positive and gramme negative bacteria and found to be pretty satisfactory. The sublimation front advanced towards the inside of the sample as freeze-drying progressed, resulting in a longer diffusion path for the sublimed moisture that began at the sublimation (ice) front. As a result, the resistance of the diffusing water vapour increased. As a result, the internal moisture diffusion rate was discovered to decrease over time (Chakraborty *et al.*, 2012)<sup>[13]</sup>.

### Value addition of brahmi leaves

Drying newly harvested herb at 37 to 42 °C using hot air oven followed by grinding and sieving the dried herbs to a powder with a mesh size of 30 to 40. Use hexane to defat the powdered herb. Utilizing methanol, extract defatted powdered herb once again to produce an extract rich in bacosides. This extract is concentrated about one-twentieth of its original amount at lower pressure. Add the concentrated extract for acetone gradually to precipitate the bacosides. Using Nutsche vacuum filter to filter the bacosides and dissolving the raw material in two to ten parts water. Extracting the bacoside solution with n-butanol and moving the bacosides towards the solvent phase in a targeted manner. Separate and then concentrate the solvent part under vacuum to produce semi-dry bulk. Mixing two to ten parts of water with the partially dry material. Spray-dry the stabilized bacoside solution meanwhile preserving an air temperature at 90-110 °C in order to produce a stable free-flowing portion of brahmi that contains bacosides (Kahol *et al.*, 2004)<sup>[18]</sup>.

The fibre-rich herbal biscuits by integrating herbs that are protein and fibre rich, while keeping the usual herbal cookies intact were carried out. Tulsi leaves were used to make herbal biscuits in amounts of 1, 2 and 3 g, respectively. The addition of the tulsi leaves to the recipes had a substantial impact on the physicochemical and sensory properties of the biscuits. The study concludes that tulsi leaves may be effectively added to wheat flour cookies up to 1 percent level, producing biscuits with better nutritional value and acceptable sensory attributes. Therefore the development and utilization of these kinds of functional meals will improve the nutritional status of the general public and those suffering with degenerative diseases (Alam *et al.*, 2013)<sup>[4]</sup>.

Among the mental illnesses that can be treated with brahmi ghrita, the polyherbal ayurvedic composition, is recommended are unmada, apasmara, and graharogas. This investigation focuses on the physico-chemical analyses and pharmacognostical identification of the constituents of brahmi ghrita. A pharmacognostical study that included the two macroscopic along with powder microscopy of a crude medication revealed the quality and authenticity of every component of brahmi ghrita. The conditions were satisfied by the organoleptic properties of the coarse powder, which were derived from crude medications. The values at room temperature were as follows: 184.17 for saponification, 0.16075 for acid, 1.467 for the refractive index, 26.715 for iodine, and 0.9133 for specific gravity (Gubbannavar *et al.*, 2012)<sup>[16]</sup>.

At bedtime, mix 3 g of brahmi powder with 100 ml of cow's milk. It alleviates insomnia (Anon, 2017)<sup>[8]</sup>. The underutilized grain *i.e.* barnyard millet can be used to manufacture millet-based designer vermicelli with beneficial additives (0.5 percent powdered brahmi leaves, garden cress seed, 2 percent of germinated fenugreek seed, and ekanayakam root barks). The brahmi-based vermicelli made with (59.5: 40: 0.5) whole wheat flour, germinated barnyard millet and brahmi had an overall acceptance of 8.02 and 8.22 (Anon, 2018)<sup>[7]</sup>.

Functional drinks have a variety of advantages, especially in pandemic situations like the one we're in right now. Consumption of nutrient-dense foods and beverages is a daily requirement to prevent disease from attacking the body. Consumption of functional meals and drinks replaces healthy living since the bioactive components in them can combat

free radicals produced by the body as well as external sources. Foods and beverages need to be free of physical, chemical, and microbiological contamination in order to be considered safe and healthful for consumption (Pamela *et al.*, 2021)<sup>[20]</sup>.

Several experiments were carried out to incorporate brahmi into the process of making herbal biscuits. Primary unstructured trials revealed that brahmi, which has a strong bitter taste, could not be used even at a dosage of 5 g, thus more studies ranging from 0.5 to 2.0 g of brahmi per 100 g of standardized composite flour were planned. The optimal brahmi concentration for the production of herbal biscuits is 0.5 g (Zaker *et al.*, 2014)<sup>[25]</sup>.

### Conclusion

Brahmi is known as a well-known herb having many therapeutic benefits. Every part of the plant has medicinal use. Herbal products are very beneficial to health, and as a result, both in industrialized and Western countries, their use have grown significantly in recent years. In several Indian culinary goods, brahmi may be used as a beneficial food ingredient.

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