

Identity and Attributes of Āyurvedic Medicinal Plant *Brāhmi/Aindri* from Antiquity to the Modern Age

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Abstract

Brāhmi-Aindri Bacopa monnieri Linn of Scrophulariaceae family is the most reputed medicinal plant of India traditionally known to possess memory and cognitive ability enhancing effect. The recent scientific studies have validated the 3000 years old traditional claims. But there are significant discrepancies in the textual versus botanical identities of this herb. Critical study of the ancient texts exhibit three classical plant names viz. *brāhmi*, *mandukaparṇī* and *aindri*. The former two are supposedly synonym names, one indicative of cognitive function effect and the other indicative of the morphology of the plant itself which is identifiable with the plant *Centella asiatica* Linn. The third name (*aindri*) is a separate plant identifiable with *Bacopa monnieri* Linn. Thus there is significantly conflicting textual versus botanical identity of *brāhmi*. However both these plants have similar medicinal effect. The recent clinical trials published by Con Stough and his team from Australia has lend significant credence to the traditional claims of memory enhancing and improving cognitive function by *Bacopa monnieri* (Stough, Lloyd, Clarke, et al, 2001, pp. 481-484; Stough, Downey, Lloyd, et al, 2008, pp. 1629-1634).

Bacopa monnieri contains Bacocides A and B and has potent memory and cognitive ability enhancer effect. There are rich experimental studies validating this attribute. Mode of action of the plant is still precisely not known. Studies are suggestive of multiple mechanisms of action largely simulating the *medhya rasāyana* effect as conceived in Āyurveda. The clinical trials are only few warranting further extended studies on the action potential of this important medicinal plant, more in human subjects before it is accepted as a proven medicine.

Key words: *Aindri*, Bacocides, *Bacopa monnieri*, *Brāhmi*, *Mandukaparṇī*, *Medhya*, Memory Enhancers, *Rasāyana*.

1. INTRODUCTION

Āyurveda is the oldest science of life, health care and cure in the world, its antiquity going back to the Vedas. The ancient knowledge-base is carried down the ages till today in the form of three pre-Christian classics namely *Caraka*, *Suśruta* and *Vāgbhaṭa* and three medieval texts namely, *Mādhava Nidāna*, *Śāraṅgādhar Saṃhitā* and *Bhāva Prakāśa*.

Āyurveda has its own fundamental principles, its unique biology, pathology,

diagnostics and *materia medica* featured by a large number of herbomineral formulations with vivid description of few thousands of medicinal plants in professional therapeutic use warranting new scientific studies in order to bring them in to the main stream medicare. *Brāhmi-Aindri* is one among many such potential medicinal plants. Āyurveda describes a set of plant drugs called *medhya rasāyanas* which are claimed to be neuronutrients with anti-stress and memory enhancer effect. *Brāhmi* falls into this category. Botanical identification of *brāhmi* had continued

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to be in controversy since long, though now the plant *Bacopa monnieri* is largely identified as *brāhmi* (*bacopa*) and is in popular use. A wide range of formulations and products containing *brāhmi* are already in the market popularly used by Ayurvedic practitioners.

The systematic scientific studies to ascertain and assess the efficacy of *Brāhmi* started in late 20th century. One of the early studies which reported memory enhancing and anxiolytic effect in *Brāhmi–Aindri Bacopa monnieri* was reported by Singh and Singh (1978-79) in the form of a Doctoral dissertation and few research publications in an Indian Journal (Singh, 2007, pp. 15-16 and Singh & Singh, 1980, pp. 133-148). Subsequently many studies were initiated in different institutions, among which the prominent ones were the work of Dhawan and Singh (1982, pp. 205-214; 1997, pp.359-365; Singh, Rastogi, Srimal, Dhawan, 1988, pp.70-75). But because of lack of really a robust clinical evaluation this important plant based drug could not be brought into the realm of real evidence based medication and further studies are in progress (Rastogi, Chappelli, Ramchandani and Singh, 2012, pp. 1-252).

2. THE HISTORICAL ACCOUNT

Bacopa monnieri Linn synonym *Herpestis monnieri* Linn, Vernacular name *Brāhmi/Andri*, family Scrophulariaceae is a perennial herb found throughout India in marshy regions. *Brāhmi* is mentioned frequently in religious, social and medical treatises of ancient and medieval India since the Vedic era. The most organized descriptions are available in Āyurvedic classics and in the Nighaṅṭu texts with vivid description of its therapeutic use specially its attributes in treatment of mental disorders. As such *Brāhmi* is an extremely important medicinal plant of Āyurveda, also described with certain other synonym names, some times becoming a problem in its textual identity.

Brāhmi is one of the most popularly used plant names in Ayurvedic herbal kingdom which refers to a very important drug plant of Ayurveda. In traditional style of herbal descriptions the Āyurvedic texts provide several synonyms of each plant, sometimes with overlapping usage. In the present context it is pertinent to refer to three overlapping names viz. *brāhmi*, *mandukaparṇī* and *aindri* to throw light on the controversy about the authentic Samskrit name of the this drug plant.

Caraka the foremost classical authority on Āyurveda mentions *brāhmi* along with *aindri* among the *prajasthāpana* group of drugs and again with *mandukaparṇī* in the *vayasthāpana* group of drugs. The same has been repeated in the context of *garbhassthāpan* group of drugs. *Mandukaparṇī* has been mentioned in the *Tiktaskandha*. In *rasāyana* chapter *mandukaparṇī* has been mentioned as *medhya rasāyana* with priority while *brāhmi* has not been mentioned as *medhya rasāyana*. Even in the formulation of *brahma rasāyana* only *mandukaparṇī* is mentioned, not *brāhmi*. But in *aindra rasāyana* only *brāhmi* is mentioned and *mandukaparṇī* has not been mentioned. Similarly in the treatment of *Apasmāra* (ie seizure disorder) *brāhmi* has been indicated, not *mandukaparṇī*. *Mandukaparṇī* has been included in *sāka varga* (vegetable category) but *brāhmi* has not been mentioned. *Brāhmi* has been mentioned in the treatment of *kuṣṭha* (ie leprosy) while *mandukaparṇī* is mentioned in the treatment of *kṣataḥṣina* disease (Pthisis). Similar trend is seen in *Suśruta saṃhitā* too. The *Samhitās* of Vāgbhaṭa mention *brāhmi* in *medhya* formulations for treatment of *apasmāra*, *kuṣṭha* and among *rasāyana* remedies while *mandukaparṇī* is mentioned among *sāka varga* ie edible vegetables and among the *rasāyana* remedies. Thus the descriptions of *brāhmi* and *mandukaparṇī* in *Samhitās* are suggestive of following contention:

1. *Brāhmi* and *Mandukaparṇī* have not been mentioned together in any context.

2. Although *mandukaparṇī* is the prime *medhya rasāyana* drug but it has not been mentioned in the treatment of mental and seizure disorders.
3. *Mandukaparṇī* is described with prominence in *Sāka varga*
4. Some of the uses of *brāhmi* and *mandukaparṇī* are common viz. *kuṣṭha*.

From the above mentioned literary account it seems that *brāhmi* and *mandukaparṇī* are synonym names of the same plant. *Brāhmi* is pharmacological name while *mandukaparṇī* is a morphologic name of the same plant. Dalhana, the commentator of *Suśruta Saṃhitā* consistently considers *brāhmi* and *mandukaparṇī* as one. In certain contexts another plant name *lavanika* has been used. The Nighaṇṭu texts too seem to consider *brāhmi* and *mandukaparṇī* as synonyms. However same degree of controversy seems to prevail on this issue but in modern times *mandukaparṇī* is used as *brāhmi*. In the efforts to reach the botanical identity of these plants the consensus grew in the past erroneously to take two different plants for these classical names viz.

1. *Mandukaparṇī* as *Centella asiatica* Linn. Urban.
2. *Brāhmi* as *Bacopa monnieri* Linn. Pennell.

According to Sharma PV the main reason for the prevailing controversy seems to be the ignorance of the scholars about the identity of the third and the most important plant name *aindri*. It is pertinent to note that *brāhmi* and *aindri* have been mentioned together in the texts in single places indicating that they are two different entities. Some contexts are as below:

1. *Prajāsthāpana varga* (Fertility promoters) *C. S. Sū* 4.
2. *Garbhasthāpana varga* (Sustainers of pregnancy) *C.S. Sā* 8
3. *Aindra rasāyana* (special formulation promoting cognition) *C.S. Ci.* 1.3

4. *Divyousadhi* (divine medicines) *C. S. Ci.* ¼

This indicates that *brāhmi* and *aindri* are classically two different plants with similar actions (Agrawal and Singh, 1998, pp.97-107; Singh, Singh, Sen, 1979, pp 1-6; Singh, Sinha, 1979, pp.7-14; Singh, Narsimhamurthy, Singh, 2008, pp.369-374). Thus on the basis of classical descriptions it is imperative to conclude that *brāhmi* and *mandukaparṇī* are synonymous. They are not two different botanicals. *Brāhmi* is the activity name while *mandukaparṇī* is the morphological name of the same plant. And these should be identified with the botanical plant *Centella asiatica* Linn Urban. On the other hand *aindri* and *indraballi* are synonym for another plant and they should be taken as *Bacopa monnieri* Linn. Pennell. The same is Dalhana's *lavanika*. This is the classical textual account of three plant entities. It seems, because of the lack of classical knowledge and dichotomy between the Śāstra and the Science the controversy about the classical nomenclature of these medicinal plants continued. It is irreversible literary loss to note that most of the contemporary scientific publications use the word *brāhmi* for *Bacopa monnieri* ignoring the name *aindri*. This is literally incorrect (*Caraka Saṃhitā*, edited by Sharma).

3. THE CONCEPT OF RASĀYANA REMEDIES

Since ancient times Āyurveda is practiced through its eight specialty branches. One of these eight specialties is called *rasāyana tantra* which deals with micronutrition, immunology, geriatrics and rejuvenation. *Rasāyana tantra* advocates rejuvenative life style, healthy dietetics and a range of herbomineral remedies which are claimed to supplement nourishing medicinal foods, enhance immunity and promote memory and cognitive functions. These vitalizing medicines improve the body-mind health by way of influencing the body through enriching the nutritional value of plasma as a direct nutrient and by metabolic boosting and by augmenting the process of microcirculation and

tissue perfusion. Besides the nonspecific generic action some of these *rasāyanas* are tissue and organ specific such as *medhya rasāyana* for brain, *hṛdyā rasāyana* for health of heart, *tvachya rasāyana* for skin, *caṣṣusya rasāyana* for eyes, *brīṣya rasāyana* for virility and so on (Rastogi, 2014; Singh, Narsimhamurthy, Singh, 2008, 369-374; Singh and Rastogi, 2012, pp. 177-190).

The *medhya* category of *rasāyanas* comprise of a large number of herbal plants and herbomineral compound formulations which are profusely used by Āyurvedic practitioners for treatment of a range of mental disorders such as anxiety states, stress disorders, seizure disorders, dementias and neuro-degenerative conditions. As these remedies are basically molecular nutrients they produce varying degree of neuroprotective, neuro-regenerative, anxiolytic, anti-stress, memory enhancer & immunomodulator effect. *Brāhmi/mandukaparnī* and *andri* are the most important members of *medhya rasāyana* group of drugs. In recent years there has been resurgence of interest in Ayurveda in general and its *rasāyana tantra* in particular because of its unique principles featured by pronature holistic and personalized treatment approach besides its rich cost-effective and safe green pharmacy. In recent years lot of research activities have been initiated in this field both from fundamental point of view and applied aspects including medicinal plants (Rastogi, 1990, pp.118-122; Satyavati, Raina, Sharma, 1976, pp. 112-118).

4. *BACOPA MONNIERI*

The plants *Bacopa monnieri* and *Centella asiatica* which represent *brāhmi/andri* and *mandukaparnī* are perennial herbs growing wild in marshy areas throughout India, Sri Lanka, China, Pakistan, Taiwan, Vietnam and Florida (Barrett, Strother, 1978, pp.408-419; Chopra, Nayar, Chopra, 1956; Chunekar, 1960; Con Kerry and Andrew, 2013). Both these plants are popularly known to be of medicinal value

especially for mental healthcare. *Centella asiatica* is also used as edible vegetable by some sections of the society while *Bacopa* being bitter in taste has no such usage. Rastogi et al (1996) reported a significant seasonal variation in the Bacoside concentration in *Bacopa monnieri*. Serial month wise collected fresh samples of this plant when studied chemically in relation to the five seasons of India revealed that Bacoside A and B were available in May while in rest of the months other compounds start appearing and disappearing.

The best characterized compounds in *Bacopa* are Dammarane-Type Triterpenoid Saponins known as Bacocides, with Jujubogmin or Pseudo jujubogmin moities as aglycone units. Bacocides comprise a family of dozen known analogs. Other Saponins called Bacopasides I-XII have been identified more recently. The Alkaloids *Brahmine*, nicotine and herpestisine have been catalogued, along with D-mannitol, apigenin, Hersaponin, Cucurbitacin and Plantainoside-B.

The most studied constituent has been Bacocide-A, which was found to be a blend of Bacocide A₃, Bacopacide II, Bacopasaponin C. The concentration of these constituents in the plant is variable (Basu, Rastogi, Dhar, 1967, p 84; Chakravarty, Garai, Masuca, Nakane, Kawahara, 2003, pp.215-217; Chakravarty, Sarkar, Masuda, Shiojima, Nakane, Kawahara, 2001 Chakravarty, Sarkar, Nakane, Kawahara, Masuca, 2002; Chandel, Kulshreshtha, Rastogi, Bacogenin, 1977, Channa, Dar, Yaqoob, Anjum, Sultani, Rahman, 2003; Duley, . Singh, Preethi and Rajan, 2012).

Pharmacologically *Bacopa monnieri* was shown to be antioxidant *in vitro*. It inhibits Acetylcholinesterase, activates Choline acetyltransferase and increases cerebral blood flow in rats. Studies have been reported to suggest protective effect in animal models of Neurodegeneration. Clinical studies have shown improvement on cognitive function and memory enhancing in human subjects (Aithal, Sirsi, 1961,

pp.2-5; Dar, Channa, 1999, pp. 167-174; Dhawan, Singh, 1996, pp.144-149; Dhyanasekaran, Tharakan, Holcomb, et al, 2007, pp.965-969; Hota, Barhwal, Baitharu, Prasad, Singh, Ilavazhagan, 2009, pp. 23-39; Jain, Khanna, Trehan, Pendse., Godhwani, 1994, pp.633-636; Stough, et al, 2001, pp.481-484; Stough, Downey, Lloyd, et al., 2008, pp. 1629-1634).

Common adverse effects are nausea, griping, and GIT upset and in animal models it was shown to affect spermatogenesis. However, no such effect has been reported from the many clinical trials on human beings.

5. THE MAJOR ACTION PROFILE

In classical terms the Āyurvedic name for *Bacopa* should have been *aindri*, not *brāhmi*. However in view of the popular connotation for the purpose of this review the author shall here after use the word *brāhmi – aindri* because most of the recent scientific studies as published erroneously use the name *brāhmi*, not *aindri*. However the science activists have correctly taken the lead from the ancient tradition and have pursued scientific activities to validate the *medhya* effect and its possible mechanism of action and the same will be briefly reviewed in this article but they have ignored the correct classical name. However the emphasis of this write up is more on the review of efficacy studies not so much mechanism studies.

The clinical term *medhya* denotes “beneficial to *medha*“ i.e. cognitive ability. Most of the studies conducted on this plant drug swing around its effect on cognitive ability and memory enhancing effect besides anxiolytic and anti-stress effect. Singh and Singh (1978) reported positive effect of *Bacopa* on immediate memory span, mental fatigue rate and on anxiety levels in cases of anxiety neurosis (Singh, 2001, 2003, 2007; Singh and Singh, 1980, pp. 133-148; Singh, Singh, Sen, 1979, pp.1-6; Singh, Sinha, et al, 1979, pp.7-14). Naila Sheikh et al (2007) studied the impact

of this drug on stress induced changes in plasma corticosterone and brain monoamines in rats. They also reported the adaptogenic effect in standardized extract of *Bacopa* in various models, showing the effect of this drug on brain amine levels in the cortex and hippocampus region of brain in rats, comparing the effect with *Panax* root power subjecting the animals to acute stress (Immobilization × 150 minutes once a day) and chronic unpredictable stress (different stressors for 7 days) resulting in significant rise in plasma corticosterone levels which was significantly counter acted by the test drugs. Earlier Amitadas et al (2002) conducted a comparative study of the standardized extract of *Bacopa monnieri* and *Ginkgo biloba* in rodents showing anti-cholinesterase and cognitive enhancing activities (Das, Shankar, Nath, Pal, Singh, Singh, 2002, pp. 893-900; Maher, Stough, Shelmerdine, Wesnes, Nathan, 2002, pp. 163-164). Singh et al (2008) reviewed the clinical and experimental studies on several *medhya rasāyana* plant drugs of Ayurveda including *brāhmi*, *mandukaparṇī* and *aśvagandhā* suggesting similar neuronutrient and neuroprotective effect in *medhya* category of plants (Singh, Narsimhamurthy, Singh, 2008, pp. 369-374).

Jayaprakash et al (2014) also reported similar findings. Kobayama et al (2005) reported neuro-regenerative effect of *aśvagandhā* in his in-vitro studies demonstrating that when the neurons were cultured in vitro with Withanolide-A the dendrites of neurons became elongated and the synapses got reconstructed. The induced Beta amyloid plaques were noticed to be dissolved. A several studies have been reported suggesting the beneficial effect of *Bacopa monniera* in allied diseases like Alzheimer disease, anxiety neurosis and depression (Bhattacharya, Kumar, Ghosal, 1999, pp. 111-112; Bhattacharya, Kumar, Ghosal, 2000, pp. 174-179; Bhattacharya, Ghosal, 1998, pp. 77-82; Calabrese, Gregory, Leo, et al. 2008,

707-713; Jyoti, Sharma, 2006, pp. 451-457; Uabundit, Wattanthorn, Mucimapura, Ingkaninan, 2010, pp.26-31).

Russo and Barroli (2005) in their review on *Bacopa monnieri* observed that the plant drug Bacopa does possess significant nootropic effect as well as anti-inflammatory and cardiogenic effect warranting extended clinical evaluation for safety and efficacy in human settings. Con Stough et al (2013) in their systematic review noticed eight human randomized controlled trials that met entry requirements ie double blinded high quality studies of which seven used a single 300 mg dose. No acute studies have yet shown a positive cognitive enhancement although there are some trials underway. These reviewers postulated that *Bacopa monnieri* is likely to exert cognitive enhancement through inflammatory, antioxidant or even removal of beta amyloid besides via blood flow or direct neurotransmitters. The exact mechanism is yet to be determined. This quality review concludes "High quality extracts of *Bacopa monnieri* appear highly promising for chronic treatment of age related cognitive decline. *Bacopa monnieri* extract may have multiple mechanisms of action on central nervous system such as anti-inflammatory, antioxidant, Beta amyloid cleansing besides improved cardiovascular functioning and increased dendrite connectivity (Holcomb, Dhanasekaran, Hitt, et al., 2006, pp.243-251; Limpeancholo, Jaipan, Rattanakaruna, et al., 2008, pp.112-117). Singh HK (2013) extensively reviewing his own studies on memory enhancing and associated effects of a Bacocides-enriched standardized extract of *Bacopa monnieri* suggests that *Bacopa* is a safe and moderately effective plant based medicine with significant memory enhancing, anxiolytic, learning promoting and neuroprotective effect(Singh, 2013, pp. 251-288).

Mathew et al (2012) reviewed the studies on cognitive-enhancing effects of *Bacopa monnieri* and the related clinical trials .The review admits that traditional knowledge-base is

suggestive of the fact that Bacopa enhances cognitive performance. Such traditional accounts have now been successfully tested through few randomized controlled clinical trials which were subjected to systematic review by Mathew et al 2012 with a view to examine the strength of scientific evidence as to whether Bacopa really enhances cognitive performance in human subjects. This review concludes that *Bacopa monnieri* improves memory free recall with evidence for enhancement in other cognitive abilities. The reviewers point out that research into nootropic effects of Bacopa is still in infancy.

Jayakumar et al 2012, 2014 investigated the process of participation of microRNA 124-CREB pathway – a parallel memory enhancing mechanism of standardized extract of Bacopa. Bacocide, the effective component of standardized extract has been reported to have memory enhancing effect. Jayakumar and Singh (2014) reported that standardized extract of *Bacopa monnieri* improves contextual fear memory by differentially regulating the activity of Histone Acetylation and protein phosphatases in hippocampus (Jayakumar, Hemant, Singh, Jois, Koilmani, 2014).

Charles P Duley et al 2012 observed that extract of Bacopa attenuates contextual associative learning deficits in aging rats brain induced by D-Galactose indicating neuroprotective impact in Bacopa extract (Dulcy, Singh, Preethi, Rajan, 2012, pp. 2053-2064; Emmanuval, Singh, Parkavi, Prisila, 2011, pp. 2136-2144).

6. CONCLUSION

There is significantly conflicting textual versus botanical identity of *Brāhmi* and *Aindri* identifiable with *Centella asiatica* and *Bacopa monnieri* respectively. However, both these plants are similar in action. Both are memory and cognitive ability enhancers. In traditional clinical practice often they are used interchangeably. It will be useful to launch comparative studies on these

two plants which may show different mechanisms of similar action. Obviously *Bacopa monnieri* has already been studied extensively and now there is considerable new scientific evidence to suggest its memory enhancer effect which validates the thousands of years old traditional textual and experience-based claims. In spite of many laboratory studies the actual mechanism of action of *Bacopa monnieri* is still not clearly known. Studies suggest the possibility of multiple mechanisms of action ranging from antioxidant, inflammatory, haemodynamic, direct neurotransmitteral and increased dendrites connectivity besides neuro-regenerative, neuronutrient and nonspecific neuroprotective effect conforming with the *Rasāyana* approach of Āyurveda.

This review is on two important medicinal plants which have been traditionally used in Āyurveda as “*medhya rasāyana*” for improvement of cognitive and related functions of the brain. As regards the identity of the plants this systematic review concludes as below.

1. *Brāhmi* and *Aindri* are two different plants with similar action.
2. *Brāhmi* and *Madhukaparnī* are synonymous and can be identified with *Centella asiatica* Linn. Urban.
3. *Aindri* and *Indrahalli* are synonymous and can be identified with *Bacopa monnieri* Linn. Pennell.
4. *Brāhmi* cannot be identified with *Bacopa monnieri* Linn. Pennell.
5. The experimental and clinical effects of both the above mentioned plants are similar on cognitive ability, reduction of anxiety level, mental fatigue etc.

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