

(REVIEW ARTICLE)



## Pharmacognosy, phytochemistry and clinical applications of traditional medicinal plants as memory booster

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### Abstract

There are varieties of traditional medicinal plants widely used for boosting of memory. These plants include *Bacopa monnieri*, *Rhodiola rosea*, *Ginkgo biloba*, *Withania somnifera*, etc. Memory boosting effect of such plants is solely attributed to their active phytoconstituents. These constituents are also referred to as smart drugs. These are capable of crossing blood brain barriers. They also enhance the cognitive performance in the brain by acting on memory to make it much alert and focused. They are having memory boosting properties to boost the coordination between the neurons and brain. In present paper, attempts were made to cover pharmacognosy, phytochemistry and clinical applications of traditional medicinal plants as memory booster.

**Keywords:** Medicinal Plants; Phytochemistry; *Bacopa monnieri*; *Withania somnifera*; Memory booster.

### Graphical abstract



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## 1. Introduction

Use of herbal drugs for preparing ayurvedic medicines have been well reported in Indian system of traditional medicine (ISTM) and other traditional medicinal systems. In India and Indian sub-continental countries, most of the peoples from villages and tribal areas are still depends on ISTM. These systems are being used since 5000 years and possess esthetic value, more patient compliance and lesser side effects [1-13]. The ISTM has been developed by Guru-shishya parampara and mentioned in various books of ayurveda like Charak Samhita, Sushruta Samhita, Kapila hridayam, etc [14].

Memory is the ability of the brain to encode, store, and retrieve information. Encoding refers to the initial perception and registration of information. Storage is the retention of encoded information over time. Memory boosters are known by various names such smart drugs, smart nutrients, cognitive enhancers, brain enhancers and Nootropic herbs [15]. They are class of drugs that improve impaired human cognitive abilities that is the functions and capacities of the brain which leads to well-maintained mental performance eventually by enhancing in several aspects such as memory, motivation, concentration, and attention [16]. Forgetting is an important fact that reflects a breakdown in one of these stages of memory is an example of the memory failures [17-18].

Memory boosting herbs are used as supplements to enhance the many functions of the human brain. Cognition refers to the processes through which information coming from the senses is transformed, reduced, elaborated, recovered, and used. In light of current COVID-19 situation and as there is frequent complaining about memory loss; there is urgent need of exploring memory booster herbs.

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## 2. Ancient reference

Nootropic herbs are group of medicinal plants described in Ayurveda with many benefits, specifically to improve memory and intellect. Some ayurvedic herbs like Guduchi, Padma, Vacha, Kutaj, Shankhpushpi, Ghruta, Gugguli, Amalaki, Arjun, Amalaki, Ashwagandha and others are excellent herbs for slowing down the brain cell degeneration caused by Alzheimer's. They enhance the brain's ability to function, and therefore, provide stability when used consistently [19-20].

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## 3. Natural memory boosters

### 3.1. Nutrients

Phosphatidylserine, an amino acid found in soybeans, Aspartic acid and glutamic acid in Almond, and pregnenolone, a naturally-occurring hormone are some examples of natural supplements that can boost the memory. Together, they are believed to increase oxygen circulation to the brain, block against free radicals and promote neural growth [21-22].

### 3.2. Foods

Eating right diet help to maintained your brain healthy. Leafy greens and cruciferous vegetables like broccoli, cabbage, spinach and Swiss chard are recommended by some researchers, as are berries, plums, and cherry tomatoes. The Omega-3 fatty acids found in fish like salmon, herring, and anchovies are also thought to help memory retention [23].

### 3.3. Medicinal plants

A number of herbs traditionally employed in ISTM and other plant-based medicine systems such as Chinese herbal medicine system, Unani medicine system, have yielded positive results [24-26].

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## 4. Memory booster plants

There are number of plants reported in various literatures and in Ayurveda used for prophylaxis as supplement or in treatment of memory loss to enhance function of the brain.

### 4.1. *Ginkgo biloba*

#### 4.1.1. Description

*Ginkgo biloba* (Family- Ginkgoaceae), having common names such as Ginkgo, Kew tree, Ginkyo, Yinhsing, Fossil Tree, Ginkgo Folium, Salisburia Adiantifolia and Maidenhair tree (Fig.1). It has been a part of traditional Chinese and Japanese

medicine for many centuries. The Ginkgo tree reproduces after about 20 years old and continues to do so after it almost 1000 years of age. The tree has also proven to be very resistant to environmental pollution and some pathogens.

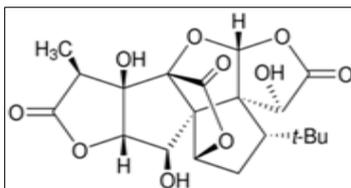
The medicinal use of the leaves is of relatively recent origin and more common in western phytotherapy, in comparison to the culinary and two medicinal use of the seed (ovule), by the Oriental herbal tradition, which presumably dates back to the year 2800 BC (Fig. 1)[27-28].



**Figure 1** *Ginkgo biloba* and marketed product.

#### 4.1.2. Chemical constituents

*G. biloba* mainly contains terpenoids, flavonoids, biflavonoids, organic acids, polyphenols, and many others. In that bilobalide and Ginkgolides. It can be classified in five forms (A, B, C, J, and M) all having the same molecular geometrical skeleton but different numbers and geometric locations of hydroxyl functional groups that has a pharmacological neuroprotective activity. It also contains flavonoids that are involved in memory enhancement property (Fig. 2) [29].



**Figure 2** Chemical Structure of Ginkgolide B.

#### 4.1.3. Uses

Ginkgo is commonly known as a brain herb or supplement nutrient for brain as it helps to enhance the brain performance. It helps to improve memory and thinking in healthy, young, and middle-aged people besides enhancing the concentration and focus and thinking skills of every consuming individual. The dose that works best seems to be 240 mg/day [30].

## 4.2. *Bacopa monniera*

### 4.2.1. Description

*Bacopa monnieri* (Brahmi) also known as *Herpestis monnieri* in Latin belongs to family Scrophulariaceae. Commonly it is known as water hyssop, and Brahmi (Fig. 3).

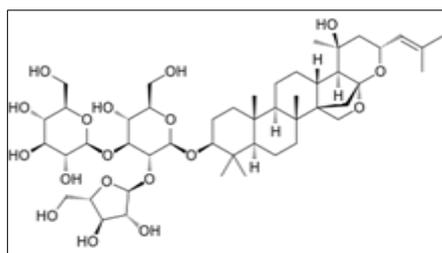
It has been used in the Ayurvedic system of medicine for the treatment of mental state of an individual. This herb can be locally found at the elevated level from sea at the altitudes of 4000–5000 feet and can be easily cultivated when there is sufficient water supply available and the genus *Bacopa* includes over 100 species of aquatic herbs (Fig. 3)[31].



**Figure 3** *Bacopa monniera* and marketed product

#### 4.2.2. Chemical constituents

Brahmi is known to contain steroidal saponin bacoside A1, bacoside A2, bacoside A3 (Fig. 4) and steroidal saponin bacoside B. Some other constituents present Brahmi are alkaloids brahmine, herpestine [32].



**Figure 4** Chemical Structure of Bacoside A3.

#### 4.2.3. Uses

*B. monnieri* was used as a brain tonic to enhance cognitive performance and to develop memory, learning, focus and concentration. It has antidepressant properties, antioxidant properties. It is also used to relieve patients with anxiety or epileptic disorders [33].

### 4.3. *Acorus calamus*

#### 4.3.1. Description

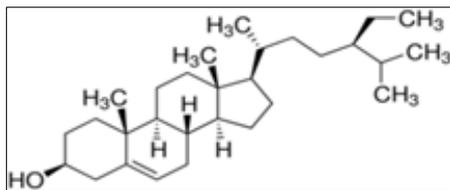
Latin name of *A. calamus* Linn. is commonly called as “Sweet flag” (Fig. 5) originates from the family of Araceae. It is a semi-aquatic, perennial, aromatic herb with creeping rhizomes, sword-shaped leaves, and spadix inflorescence. This species grows either as wild or cultivated crop throughout India in the Himalayas Mountain (Fig. 5)[34].



**Figure 5** *Acorus calamus* and powder.

#### 4.3.2. Chemical constituents

The main phytoconstituents of *A. calamus* are phenylpropanoids, sesquiterpenes, monoterpenes, steroids, flavones (Fig.1). Xanthone glycoside and triterpenoid saponins which are majorly responsible for all the therapeutic activities (Fig. 6) [35].



**Figure 6** Chemical Structure of  $\beta$  Sitosterol.

#### 4.3.3. Uses

The rhizomes of *A. calamus* are used in case of loss of memory and given in combination with other drugs such as *Centella asiatica*, *B. monnieri*, and *Rauwolfia serpentina* as a memory booster. *A. calamus* enhanced learning performance and it is well known for its memory-enhancing activity. Also shows memory boosting activity [36-37].

#### 4.4. *Rhodiola rosea*

##### 4.4.1. Description

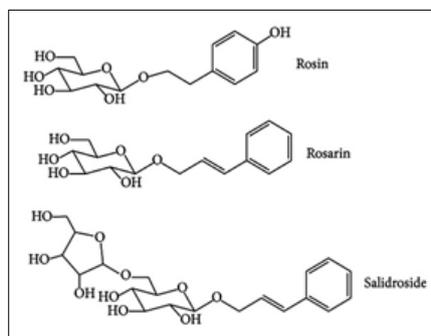
*Rhodiola rosea* is a perennial flowering plant having the family Crassulaceae (Fig. 7). It also known as golden root and Arctic root (Fig. 7). It grows naturally in wild Arctic regions of Europe, Asia, and North America and can be propagated as a groundcover. Flowers have 4 sepals and 4 petals, yellow to greenish yellow in color sometimes tipped with red, about 1 to 3mm long and blooming in summer (Fig. 7) [38].



**Figure 7** *Rhodiola rosea* and marketed product.

##### 4.4.2. Chemical constituents

*R. rosea* is essentially composed of rosine, rosarin, salidroside, flavonoids, 12 amino acids, 20 minerals, multivitamins, and tannins (Fig. 8). The antioxidant properties of Rhodiola are especially powerful for combating aging [39].



**Figure 8** Chemical Structure of Rosin, Rosarin, Salidroside.

##### 4.4.3. Uses

Studies on *R. rosea* have demonstrated that enhances memorization and concentration ability over prolonged periods. It increases the bioelectrical activity of the brain which improves memory and brain energy. In one study, the

standardized extract demonstrated significant improvements in physical fitness, psychomotor function, mental performance, and general well-being. Subjects receiving *R. rosea* extract also reported statistically significant reductions in mental fatigue, improved sleep patterns, a reduced need for sleep, greater mood stability, and a greater motivation to study [40].

#### 4.5. *Celastrus paniculatus*

##### 4.5.1. Description

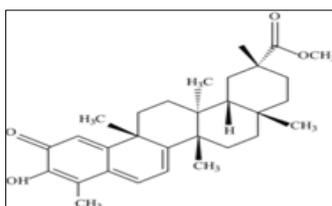
*Celastrus paniculatus* is commonly known as black oil plant. It is a climbing staff tree, and intellect tree (Fig.1). It belongs to a family Celastraceae. The plant grows throughout India at elevations up to 1800 m. *C. paniculatus* is a deciduous vine with stems up to 10 cm in diameter and 6 m long with rough, pale brown exfoliating bark covered densely with small, elongated lenticels. The leaves are simple, broad, and oval, obviate or elliptic in shape, with toothed margins. The seeds contain fatty acids and alkaloids and have sedative and antidepressant actions (Fig. 9) [41].



**Figure 9** *Celastrus paniculatus* and marketed product.

##### 4.5.2. Chemical constituents

The seeds yield brownish-yellow oil 52.2% with an unpleasant taste. This oil is reported to contain alkaloids like pristimerin, glycosides, proteins & amino acids, phenolic compounds, tannins, fixed oil, carbohydrates, phenolic compounds, flavonoids, and saponins are present in only aqueous extract while Sterols and triterpenoids are present in aqueous and ethanolic extracts (Fig. 10) [42].



**Figure 10** Chemical Structure of pristimerin.

##### 4.5.3. Uses

*Celastrus paniculatus* has reportedly shown good results in treating mental depression and in hastening the process of learning and memory in experimental animals. It also gave excellent results in treating panic attacks without any side effects. In one experimental study, the effect of *Celastrus* oil on learning and memory in a two-compartment passive avoidance task in rats was studied. Significant improvement was observed in the retention ability of the medicine-treated rats compared with the saline-administered controls. These studies clearly indicate that *Celastrus* oil directly support learning and memory [43].

#### 4.6. *Withania somnifera*

##### 4.6.1. Description

In Sanskrit *Withania somnifera* is called as Ashwagandha, belongs to the family Solanaceae, is cultivated in the soils that are unsuited for other crops and requires little care. It is a short, tender, perennial shrub. It is about 35–75 cm

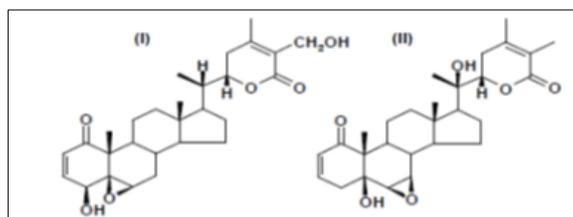
tall. The branches extend radially from a central stem. Leaves are dull green, elliptic, usually up to 10–12 cm (3.9–4.7 in) long. The flowers are small, green and bell-shaped. The ripe fruit is orange-red (Fig. 11) [44].



**Figure 11** *Withania somnifera* and marketed product

#### 4.6.2. Chemical constituents

The main phytochemical constituents of *Withania somnifera* are withanolides which are triterpenelactones - withaferin A, alkaloids, steroidal lactones, tropine, and cuscohygrine. Some 40 withanolides, 12 alkaloids, and numerous sitoindosides have been isolated. Withanolides are structurally similar to the ginsenosides, leading to a common name for *W. somnifera*, "Indian ginseng" (Fig. 12) [45].



**Figure 12** Chemical Structure of withaferine A (I) & withanolide A (II)

#### 4.6.3. Uses

Clinical investigations with the WS root extracts exert significant anti-aging effect in normal healthy but aged subjects. Its extract is used in combination with other herbal drugs for the reversal of cognitive deficits associated with old age, chronic illness and behavioral disorders. The WS induced increase in cortical muscarinic acetylcholine receptor capacity might have partly increased in the cognition-enhancing and memory-improving functions [46].

## 5. Physical exercise

Challenging your brain with simple exercise can also help your memory according to some scientists. Try to play crosswords or Sudoku in the morning, read paper daily or take a class on an activity or topic you are unfamiliar with, alone or in combination, these natural memory enhancers may stem the tide of memory loss and maybe even bring a little back [47].

## 6. Analysis of herbal drugs

Formulations containing either isolated phytoconstituents extracts or parts or whole drug are analyzed by routine quality control techniques. The quality control techniques include high performance thin layer chromatography, high performance liquid chromatography, UV-spectrophotometry, gas chromatography, etc [48-66].

## 7. Conclusion

Thus, these medicinal plants are effective in the treatment of disorders related to memory loss. In addition, it is advised that the quality of good lifestyle will be ensured with appropriate nootropic herbal extract treatment to heal the cognitive conditions followed with proper diet, exercise, and mindfulness to support all along.

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## Compliance with ethical standards

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### Disclosure of conflict of interest

The author declares no conflict of interest.

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