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COMPREHENSIVE REVIEW OF MANDUKAPARNI (*CENTELLA ASIATICA*) IN THE MANAGEMENT OF ALZHEIMER'S DISEASE: AN AYURVEDIC AND MODERN APPROACH

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ABSTRACT

Introduction: Alzheimer's disease is a progressive neurodegenerative disorder characterized by deterioration of memory, learning, thinking and other higher cognitive functions. Ayurveda explains cognitive functions through the concepts of Buddhi, Medha and Smriti, with Jara, Vata and Prana Vata providing a framework for understanding age-associated cognitive decline. Mandukaparni (Centella asiatica Linn.) is traditionally described as Medhya Rasayana and has relevance in supporting Medha, Buddhi and Smriti. **Methods:** The present work was conducted as a narrative review based on Ayurvedic literature and available scientific literature concerning Alzheimer's disease and Centella asiatica. Literature related to Buddhi, Medha, Smriti, Jara, Vata, Prana Vata, Manovaha Srotas and Rasayana was reviewed along with evidence on the phytoconstituents and neuroprotective properties of Mandukaparni. Attention was given to asiaticoside, madecassoside, antioxidant, anti-inflammatory, cholinergic, synaptic and amyloid-related mechanisms. **Results:** Mandukaparni possesses Tikta, Kashaya and Madhura Rasa, Laghu and Sara Guna, Sheeta Virya, Madhura Vipaka and Medhya Prabhava. Its major

triterpenoid constituents, particularly asiaticoside and madecassoside, have demonstrated antioxidant, anti-inflammatory and neuroprotective activities in experimental studies. Potential effects on cholinergic function, synaptic integrity and amyloid-related processes may further contribute to cognitive support. **Discussion:** The available evidence suggests that Mandukaparni may exert a multi-target neuroprotective effect relevant to Alzheimer's disease. Its Medhya Rasayana properties, along with the antioxidant, anti-inflammatory, cholinergic, synaptic and amyloid-related effects of its major constituents, support its potential role in preserving cognitive function.

KEYWORDS: Alzheimer's disease, Mandukaparni, Centella asiatica, Medhya Rasayana, Smriti, Asiaticoside, Neuroprotection.

1. INTRODUCTION

Alzheimer's disease is a progressive neurodegenerative disorder mainly affecting memory, learning, thinking, orientation and other higher cognitive functions.[1] With progression of the disease, the individual may have trouble in remembering recent events, understanding situations, communicating and performing routine activities. At the cellular level, neuronal dysfunction, oxidative stress, neuroinflammation, amyloid-related changes, synaptic impairment and altered neurotransmission are considered important factors in disease progression.

Ayurveda describes mental and intellectual functions through concepts such as Buddhi, Medha and Smriti. Buddhi is related to understanding, discrimination and decision-making, whereas Smriti represents the ability to retain and recall previously acquired knowledge. Decline in these functions may be considered in relation to *Smritibhramsha*, *Smritinasha* and impairment of *Medha*.[2]

Jara is associated with progressive diminution of bodily and mental functions. Vata predominance during old age is particularly relevant to degenerative conditions. Among the five subdivisions of Vata, Prana Vata has an important role in functions related to the head, sensory faculties and higher neurological activities. Therefore, disturbances involving Vata and Prana Vata can provide an Ayurvedic framework for understanding age-associated cognitive deterioration.

Mandukaparni (*Centella asiatica* Linn.) is traditionally considered an important Medhya Rasayana. It is associated with the maintenance of Medha, Smriti and Buddhi and has been traditionally used for supporting intellectual and mental functions. Its relevance to modern neurological research has increased because of the presence of triterpenoid constituents such as asiaticoside, madecassoside, asiatic acid and madecassic acid.[3]

The present review therefore attempts to understand the role of Mandukaparni in Alzheimer's disease by bringing together its Ayurvedic pharmacodynamic properties and modern experimental findings.

2. OBJECTIVES

- To understand Alzheimer's disease from an Ayurvedic perspective.
- To review the concepts of Buddhi, Medha, Smriti, Jara, Vata and Prana Vata in relation to cognitive decline.
- To review the role of Mandukaparni as a Medhya Rasayana.
- To describe the pharmacodynamic properties of Mandukaparni.
- To review the important phytoconstituents of Mandukaparni, particularly asiaticoside and madecassoside.
- To discuss the possible neuroprotective mechanisms of Mandukaparni relevant to Alzheimer's disease.

3. METHODOLOGY

The present work is prepared as a narrative review based on Ayurvedic literature and available scientific literature concerning Alzheimer's disease and *Centella asiatica*. The Ayurvedic literature was reviewed with particular attention to the concepts of Buddhi, Medha, Smriti, Jara, Vata, Prana Vata, Manovaha Srotas, Rasayana and Medhya Rasayana.

Scientific literature concerning *Centella asiatica*, its major triterpenoids and their neuroprotective properties was also considered. Attention was given to antioxidant, anti-inflammatory, neuroprotective, cholinergic, amyloid-related and synaptic mechanisms.

4. Literature Review

4.1 Ayurvedic Understanding of Cognitive Decline

Ayurveda considers Buddhi, Medha and Smriti as important aspects of normal cognitive functioning. **Buddhi** is concerned with understanding, discrimination and decision-making,

while Medha is associated with comprehension, learning and intellectual ability. **Smriti** refers to the ability to retain and recall previously acquired knowledge and experiences and is therefore particularly important in understanding memory-related disorders. Disturbance of Smriti may manifest as forgetfulness, difficulty in recalling past experiences and impaired retention of newly acquired information. The related concepts of Dhi, Dhriti and Smriti describe the processes involved in acquiring, maintaining and recalling knowledge.

With advancing age, Vata becomes predominant and may contribute to deterioration of mental and neurological functions. Prana Vata, which is associated with the head, sensory faculties and higher mental activities, is particularly relevant to cognitive functions. Thus, impairment of Buddhi, Medha and Smriti along with Vata involvement provides an Ayurvedic framework for understanding age-associated cognitive decline

Prana Vata is especially relevant because of its association with the head, sensory functions and higher neurological activities. Disturbance in its normal functioning may therefore be considered in relation to impairment of cognition and memory.

The concept of **Avarana** may also be considered when there is obstruction to the normal functioning or movement of Vata. Thus, an Ayurvedic understanding of cognitive disorders involves assessment of the Doshas, Srotas and Dhatus along with the functional status of Buddhi, Medha and Smriti.

4.2 Mandukaparni as Medhya Rasayana

Mandukaparni is traditionally regarded as a Medhya Rasayana, making it particularly relevant to disorders involving memory and intellectual functions. Its Ayurvedic importance is not limited to improving memory alone; its action may be understood more broadly as supporting the functional integrity of Medha and promoting appropriate mental activity.[5]

The concept of Rasayana indicates preservation and promotion of physiological functions. In the context of cognitive health, Medhya Rasayana may therefore be understood as an approach directed towards maintaining Dhi, Dhriti and Smriti.

The traditional description of Mandukaparni as a Medhya drug provides the Ayurvedic basis for exploring its possible role in age-associated cognitive deterioration.

4. 3 Pharmacodynamic Properties of Mandukaparni

The action of Mandukaparni can be understood through its **Rasa**, **Guna**, **Virya**, **Vipaka** and **Prabhava**. It possesses Tikta-Kashaya-Madhura Rasa, Laghu-Sara Guna, Sheeta Virya, and Madhura Vipaka.[4,5]

- Its Tikta and Kashaya Rasa may support appropriate functioning of Srotas and help in the regulation of excessive Kapha. Tikta Rasa is traditionally associated with subtle and penetrating action, while and it is Laghu and Medhya. Kashaya Rasa contributes to stability and regulation. The Madhura Rasa, owing to its Rasayana karma, provides a nourishing component which becomes important in preservation of Dhatu and mental functions during ageing.

- The Laghu Guna can be understood in relation to reduction of excessive heaviness and support of clarity, while Sara Guna indicates mobility and appropriate movement. Together, these properties may support proper functional activity without producing excessive Guru or stabilizing effects.

- The Sheeta Virya may help in maintaining Pitta balance and may contribute to a calming influence. Madhura Vipaka provides a nourishing and supportive post-digestive effect and may be considered beneficial for Vata regulation.

- The most important feature from the present context is its Medhya Prabhava, through which Mandukaparni is traditionally associated with Dhi, Dhriti and Smriti.[6]

4.4 Phytochemical Basis

The biological activity of *Centella asiatica* has been associated with several phytochemical constituents. Among them, asiaticoside, madecassoside, asiatic acid and madecassic acid are particularly important. Asiaticoside and madecassoside are triterpenoid glycosides that have received considerable attention in neuroprotective research.

The presence of these compounds provides a possible basis for the multiple pharmacological actions attributed to the plant. Rather than acting through a single pathway, the constituents may influence several processes involved in neuronal survival and cognitive function.

DISCUSSION

Alzheimer's disease is a complex disorder involving multiple pathological processes. Consequently, an approach directed towards only one mechanism may not adequately address the overall progression of neuronal dysfunction.

The Ayurvedic approach provides a broader understanding through Buddhi, Medha, Smriti, Jara, Vata, Prana Vata, Manovaha Srotas and Rasayana. Rather than describing cognitive decline solely as a structural disorder, Ayurveda considers deterioration of functional capacity along with Dosha, Dhatu and Srotas involvement.

Mandukaparni becomes particularly relevant in this context because it is traditionally described as a Medhya Rasayana. Its Rasa, Guna, Virya, Vipaka and Medhya Prabhava provide an Ayurvedic basis for its use in supporting intellectual and memory-related functions.[7]

Modern experimental research provides additional information regarding its possible mechanisms. The major constituents, especially asiaticoside and madecassoside, have demonstrated activities related to oxidative stress, inflammation, neuronal survival, synaptic function and amyloid-related mechanisms.

Neuroprotective Potential

Neuronal injury and neuronal loss are important components of Alzheimer's disease. Protection of neurons against oxidative and inflammatory damage is therefore an important area of therapeutic research.

Experimental studies of *Centella asiatica* have demonstrated neuroprotective effects and have suggested possible benefits involving antioxidant defence, mitochondrial function, neuronal survival and protection against amyloid-related injury. Effects on neuronal growth and synaptic function have also been investigated.

From an integrated perspective, the proposed sequence can be described as
Mandukaparni → active triterpenoids → protection against cellular stress → preservation of neuronal integrity → maintenance of neuronal communication → potential support of cognitive function.

Role of Asiaticoside

Asiaticoside is one of the principal bioactive triterpenoid glycosides of Mandukaparni. Its importance in Alzheimer's disease research arises from its potential influence on several pathological processes.[8]

Neuroinflammation is associated with activation of microglia and release of inflammatory mediators. Experimental studies indicate that asiaticoside may reduce inflammatory responses and thereby decrease inflammatory stress on neuronal cells.

Asiaticoside also possesses antioxidant properties. By reducing oxidative stress, it may help protect cellular membranes, proteins and other neuronal components from oxidative injury.

Another area of interest is synaptic function. Experimental observations suggest that asiaticoside may help preserve synaptic integrity in conditions associated with amyloid-related neuronal damage. Since synaptic communication is essential for learning and memory, preservation of synaptic function may contribute to maintenance of cognitive performance.

Experimental investigations have additionally explored the effect of asiaticoside on amyloid-β fibrillation and related toxicity. These findings are promising but remain primarily preclinical.

Role of Madecassoside

Madecassoside is another major triterpenoid glycoside of *Centella asiatica*. It has been studied for its antioxidant, anti-inflammatory and neuroprotective properties.[10]

Oxidative stress can contribute to neuronal damage by disturbing cellular membranes and intracellular structures. The antioxidant activity of madecassoside may help reduce this type of cellular injury.

Its anti-inflammatory activity may also be relevant because prolonged inflammatory signalling can contribute to neuronal dysfunction. Experimental research has further explored the possibility that madecassoside may influence amyloid-related processes.

Therefore, asiaticoside and madecassoside may contribute collectively to the multi-target activity of Mandukaparni.

Antioxidant Activity

The brain is particularly vulnerable to oxidative damage because of its high metabolic activity. Excessive oxidative stress can affect neuronal membranes, proteins, mitochondria and cellular signalling.[9]

Mandukaparni and its triterpenoid constituents have demonstrated antioxidant effects in experimental studies. Such activity may help maintain neuronal homeostasis and reduce oxidative injury.

From an Ayurvedic perspective, this protective effect may be discussed conceptually in relation to maintaining Agni, Dhatu integrity and appropriate Srotas function, although these Ayurvedic concepts should not be directly equated with specific biochemical antioxidant pathways.

Anti-inflammatory Activity

Persistent neuroinflammation can contribute to neuronal dysfunction and degeneration. Activation of microglia and increased inflammatory signalling may increase neuronal stress. Asiaticoside and madecassoside have been investigated for their ability to modulate inflammatory pathways. Reduction of inflammatory activity may consequently contribute to neuronal protection and preservation of synaptic function.[12]

This multi-target action is important because Alzheimer's disease involves several interacting pathological processes rather than a single pathological pathway.

Cholinergic and Cognitive Mechanisms

Cholinergic neurotransmission plays an important role in memory and learning. Reduction in cholinergic function is associated with cognitive impairment in Alzheimer's disease.

Experimental studies have reported acetylcholinesterase-inhibitory activity for *Centella asiatica* preparations. By reducing acetylcholinesterase activity, there may be greater availability of acetylcholine at synaptic sites.[11] This provides one possible explanation for the cognitive-supportive effects observed in experimental research.

However, these findings should be interpreted cautiously because inhibition of acetylcholinesterase observed experimentally does not by itself establish clinical efficacy in Alzheimer's disease.

Amyloid-related Mechanisms

Amyloid-β accumulation and aggregation are important features of Alzheimer's pathology. Experimental research involving *Centella asiatica* and its triterpenoid constituents has examined their potential influence on amyloid-related processes.

Asiaticoside and madecassoside have been investigated for their possible effects on amyloid-β fibrillation and associated neuronal toxicity. If these effects are confirmed in further studies, they may represent an additional mechanism through which Mandukaparni could provide neuroprotection. At present, however, this area remains predominantly experimental.

Synaptic Function and Memory

Memory formation depends upon effective communication between neurons and appropriate synaptic plasticity. Damage to synapses may occur before extensive neuronal loss and may contribute significantly to cognitive impairment.

Research on *Centella asiatica* suggests possible effects on neuronal growth, dendritic development and synaptic function. Asiaticoside has also been investigated for its ability to preserve synaptic function in experimental Alzheimer's models.

Thus, the cognitive-supportive action of Mandukaparni may involve several interconnected effects rather than a single mechanism:
Neuroprotection + antioxidant activity + anti-inflammatory action + cholinergic modulation + synaptic support + possible amyloid-related effects → preservation of neuronal function → potential support of memory and cognition.

The important point is that the Ayurvedic and modern perspectives should be integrated without treating them as identical systems. Medhya Prabhava should not be equated directly with a particular molecular pathway, and Vata concepts should not be presented as direct explanations of amyloid pathology.

The available evidence is encouraging but predominantly experimental. The existing literature also highlights the need for standardized extracts, consistent phytochemical characterization, appropriate dosage, safety evaluation and better-designed clinical studies.

The systematic review of Mandukaparni provides useful information regarding the Ayurvedic approach to Alzheimer's disease, but its clinical evidence concerns Centella asciatica.

Therefore, those findings should not be transferred directly to Mandukaparni. This distinction is important when preparing a scientifically appropriate review.

6. CONCLUSION

Mandukaparni (*Centella asiatica*) is an important Ayurvedic Medhya Rasayana with traditional relevance to Medha, Buddhi, Dhi, Dhriti and Smriti. The Ayurvedic concepts of Jara, Vata, Prana Vata and Manovaha Srotas provide a useful framework for understanding age-associated deterioration of cognitive functions.

Its pharmacodynamic properties, including Tikta, Kashaya and Madhura Rasa; Laghu and Sara Guna; Sheeta Virya; Madhura Vipaka and Medhya Prabhava, provide an Ayurvedic basis for its traditional use in supporting cognitive functions.

From the modern perspective, Mandukaparni contains important triterpenoid constituents such as asiaticoside and madecassoside, which have demonstrated antioxidant, anti-inflammatory and neuroprotective activities in experimental studies. Additional effects involving cholinergic function, synaptic protection and amyloid-related mechanisms may contribute to its overall neuroprotective potential.

Thus, Mandukaparni represents a promising multi-target Ayurvedic drug for further investigation in Alzheimer's disease. However, the available evidence is largely preclinical, and its effectiveness as a treatment for established Alzheimer's disease cannot yet be considered established. Further standardized pharmacological studies and well-designed clinical trials are necessary to determine its appropriate preparation, dosage, safety and therapeutic role.

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