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HARITAKI (TERMINALIA CHEBULA) AS A NEUROPROTECTIVE AGENT: A COMPREHENSIVE REVIEW

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ABSTRACT

Haritaki (Terminalia chebula), a cornerstone herb in Ayurvedic medicine, has long been revered for its broad-spectrum therapeutic properties, particularly its effects on the nervous system. Classical Ayurvedic texts describe *Haritaki* as a "*Medhya Rasayana*" - a cognition-enhancing and rejuvenating agent - highlighting its role in maintaining neurological health and mental clarity. In recent decades, modern scientific research has begun to validate these traditional claims, uncovering a wide range of neuroprotective mechanisms including antioxidant, anti-inflammatory, anti-apoptotic, and neuroregenerative effects. This comprehensive review aims to bridge classical Ayurvedic knowledge with current biomedical findings by exploring the pharmacological actions of *Haritaki* in the context of neurodegenerative diseases, cognitive dysfunction, and central nervous system disorders. The review also evaluates in vitro and in vivo studies, molecular pathways involved, and potential clinical applications. By integrating ancient wisdom with contemporary evidence, this review synthesizes traditional Ayurvedic insights with contemporary scientific findings, highlighting *Haritaki's* multifaceted role in neuroprotection.

INTRODUCTION

Neurodegenerative diseases such as Alzheimer's, Parkinson's, and Huntington's disease represent a growing global health concern due to their increasing prevalence and the lack of

definitive cures. As researchers continue to explore novel therapeutic strategies, there is a renewed interest in traditional medicinal plants known for their neuroprotective potential. One such plant is *Terminalia chebula*, commonly known as *Haritaki*, acornerstone of Ayurvedic medicine that has been historically used for a wide range of ailments, including those affecting the nervous system.

Haritaki is rich in bioactive compounds such as chebulinic acid, gallic acid, and ellagic acid, which have demonstrated antioxidant, anti-inflammatory, and anti-apoptotic properties. These pharmacological attributes suggest its potential in modulating key pathological processes associated with neurodegeneration, including oxidative stress, mitochondrial dysfunction, and neuroinflammation. Recent preclinical and in vitro studies have begun to elucidate the molecular mechanisms by which *Haritaki* and its constituents exert neuroprotective effects.

This comprehensive review aims to consolidate current scientific evidence on the neuroprotective potential of *Haritaki*. It explores the phytochemistry, pharmacodynamics, and emerging mechanistic insights relevant to neurological health, while also identifying research gaps and future directions for clinical application. By bridging traditional knowledge and modern neuroscience, this review seeks to provide a foundation for further investigation into *Haritaki* as a promising natural neurotherapeutic agent.

1. Ayurvedic Perspective[1]

Haritaki consists of the pericarp of mature fruits of *Terminalia chebula* Retz. (Fam. Combretaceae), a moderate sized or large tree found throughout India, chiefly in deciduous forests and areas of light rainfall, but occasionally also in slightly moist forests, upto about 1500 m elevation, throughout India, flowers appear from April, August and Fruits ripen from October-January.

DESCRIPTION

a) Macroscopic

Intact fruit yellowish-brown, ovoid, 20-35 mm long, 13-25 mm wide, wrinkled and ribbed longitudinally, pericarp fibrous, 3-4 mm thick, non-adherent to the seed, taste, astringent.

b) Microscopic

Transverse section of pericarp shows epicarp consisting of one layer of epidermal cells inner tangential and upper portions of radial wall thick, mesocarp, 2-3 layers of collenchyma,

followed by a broad zone of parenchyma in which fibres and selereids in group and vascular bundles scattered, fibres with peg like out growth and simple pitted walls, sclereids of various shapes and sizes but mostly elongated, tannins and raphides in parenchyma, endocarp consists of thick-walled sclercids of various shapes and sizes, mostly elongated, epidermal surface view reveal polygonal cells, uniformly thick walled, several of them divided into two by a thin septa, starch grains simple rounded or oval in shape, measuring 2-7 µ in diameter, found in plenty in almost all calls of mesocarp Powder-Brownish in colour, under microscope shows a few fibres, vessels with simple pits and groups of sclereids.

SYNONYMS

Sanskrit – *Abhaya, Kayastha, Siva, Pathya, Vijaya*

Assamese – Shilikha

Bengali – Haritaki

English – Myrobalan

Gujrati – Hirdo, Himaja, Pulo harda

Hindi – Harre, Harad, Harar

Kannada- Alalekai

Kashmiri- Halela

Malayalam – Katukka

Marathi – Hirda, Haritaki, Harad ,Hireda

Oriya – Harida

Punjabi -Halela, Harar

Tamil – kadukkai

Telugu – Karaka, Karakkaya

Urdu – Halela

PROPERTIES AND ACTION

Rasa - Madhura, Amla, Katu, Tikta, Kasaya

Guna – Laghu, Ruksha

Virya – Ushna

Vipaka - Madhura

Karma – Chakshushya, Dipana, Hridya, Medhya, Sarvadoshaprasamana, Rasayana, Anulomana.

MATERIAL AND METHOD

Classical texts have been studied and various Terms and formulations of *Haritaki* describing neuroprotective role are compiled.

From following classical texts

Sr.No	Text	Description	Reference
1	*Charak Samhita*	*Vayasthapana,Buddhi-Indriya-bala pradam, Vayasthapana* *Smriti-Buddhi-Pramoha* *Vayasthapana*	*Cha.Su.1* *Cha.Chi.1* *Cha.su.4/50*
2	*Sushrut Samhita*	*Vayasthapana,Rasayana, Medhya*	*Su.Chi.27*
3	*Ashtang Hridaya*	*Medha-Smriti-Bala* *Medhya-Vayasthapana,Buddhi-Indriya-Balaprada*	*A.U.39* *A.Su.6/155*
4	*Bhavprakash Nighantu*	*Medhya ,Rasayana*	*Haritakyadivarga*
5	*Raj Nighantu*	*Medhya,Vayasthapana,Rasayana, Buddhi-Smritiprada*	*Aamradivarga*
6	*Kaiyadev Nighantu*	*Medhya,Vayasthapana,Rasayana, Bala-Buddhi-Smritiprada*	*Aushadivarga*
7	*Dhanvantari Nighantu*	*Medhya*	*Guduchyadivarga*

Sr.no	Formulations	Description	Reference
1	*Abhayamalak avleha*[2]	*Smriti,Medha*	*A.U.39/24*
2	*Haritaki rasayana*[3]	*Rasayana*	*A.U.39/146*
3	*Bramharasayana*[4]	*Medha-Smriti-Bala pradam*	*Cha.chi.1/56*
4	*Haritakyadi rasayana*[5]	*Indriya-Buddhi-Bala pradam*	*Cha.chi.1/1/76*
5	*Mahapaishachik ghrita*[6]	*Buddhi-Smritikar*	*Cha.chi.1/48*
6	*Lashunadya ghrita*[6]	*Apasmar*	*Cha.chi.1/51*
7	*Mahapaishachik ghrita*[7]	*Unmad ,Apsmar*	*Bhaishajya Ratnavali, Chakradatta 20/34-37*
8	*Trigunakhya rasa*[8]	*Kampavata*	*Rasamanjiri/ Bruhatnighanturatnakar*
9	*Dwigunakhya rasa*[9]	*Kampavata*	*Rasamanjiri*
10	*Suptachetana vati*[10]	*Chittabhrama, Apsmara*	*Rasakamdhenu*
11	*Shoonyatvahar agad*[11]	*Vaatajroga, Shoonyata*	*Rasakamdhenu*
12	*Trikatraya loha*[12]	*Unmada, Apsmara, Vaatvyadhi*	
13	*Yogaraja rasa*[13]	*Apsmara*	*Rasakamdhenu*

2. Neuroprotective Phytochemicals of *Terminalia chebula*

Terminalia chebula, commonly known as *Haritaki*, is a traditional Ayurvedic herb renowned for its *Rasayana* (rejuvenating) properties. Recent pharmacological studies have highlighted

its neuroprotective potential, attributed to various bioactive phytochemicals present in the fruit.

Compound	Phytochemical Class	Neuroprotective Mechanism / CNS Relevance	References
Gallic acid	Phenolic acid	Reduces oxidative stress, protects dopaminergic neurons in Parkinson's models, anti-apoptotic	Nigam et al., 2020; Sharma et al., 2025
Ellagic acid	Phenolic acid	Neuroprotective via anti-inflammatory and antioxidant pathways, improves memory in Alzheimer's models	Nigam et al., 2020
Chebulagic acid	Hydrolyzable tannin	Inhibits neuroinflammation, COX/LOX inhibition, prevents excitotoxicity	Lakshmi Prasad et al., 2006
Chebulinic acid	Hydrolyzable tannin	Antioxidant, anti-inflammatory, neuronal protection against ischemic injury	Ponnusankar et al., 2011
Rutin	Flavonoid	Improves cognitive function, reduces oxidative stress, protective in Alzheimer's and stroke models	Nigam et al., 2020
Quercetin	Flavonoid	Neuroprotective in Parkinson's & Alzheimer's, reduces neuronal apoptosis, antioxidant	Nigam et al., 2020
Vitamin C (Ascorbic acid)	Vitamin	Potent antioxidant, prevents neurodegeneration, enhances neurotransmission	R. Ashwini et al., 2011
β-sitosterol	Sterol	Antioxidant, reduces cholesterol-linked neurodegeneration, protective in Alzheimer's	Bharat Reddy D et al., 2009
Ferulic acid	Phenolic (Other bioactive)	Neuroprotective against ischemia & Alzheimer's, reduces amyloid-induced neurotoxicity	Rangsriwong et al., 2009
p-Coumaric acid	Phenolic (Other bioactive)	Antioxidant, protects against oxidative neuronal damage	Chia Lin Chang & Che San Lin, 2012
Caffeic acid	Phenolic (Other bioactive)	Neuroprotection in neuroinflammation & oxidative stress-induced neuronal apoptosis	Rangsriwong et al., 2009

3. Modern Research on Neuroprotective Effects of *Terminalia chebula*

Section	Study Focus	Model Used	Key Findings	Proposed Mechanisms
3.1	Protection against oxidative stress and amyloid toxicity[14]	PC12 neuronal cells (H_2O_2, Aβ25–35)	Methanol and water extracts improved cell viability and reduced ROS and	Antioxidant activity, calcium homeostasis regulation

			calcium overload; ellagic acid suppressed Aβ-induced damage	
3.2	Neuroprotection in cerebral ischemia–reperfusion injury[15]	BV2 microglial cells (OGD/R) and MCAO mouse model	Polyphenol-rich extracts reduced oxidative stress, apoptosis, and mitochondrial dysfunction; improved neurological outcomes	Nrf2/HO-1 pathway activation, antioxidant enzyme enhancement
3.3	Comparison of antioxidant and neuroprotective properties[16]	PC12 cells under oxidative stress	Methanol and water extracts showed strong ROS scavenging and neuronal protection; ethanol extract less effective	Free radical scavenging, hydrogen peroxide and hydroxyl radical reduction
3.4	Mechanisms in Alzheimer's disease (review)[17]	In vitro and in vivo experimental evidence	Extracts inhibited AChE, reduced oxidative stress, amyloid toxicity, and neuroinflammation	Cholinergic enhancement, antioxidant and anti-inflammatory actions
3.5	Anti-amnesic effects in scopolamine-induced model[18]	Scopolamine-induced amnesia in mice	Improved learning and memory; restored acetylcholine levels; reduced oxidative stress markers	Cholinergic modulation, oxidative stress attenuation

4. DISCUSSION

Classical Ayurvedic texts consistently describe *Terminalia chebula* (Haritaki) as *Medhya*, *Rasayana* and *Vayasthapana*, indicating its role in enhancing intellect, memory and preventing age-related decline. Its inclusion in formulations for *Unmada*, *Apasmara* and *Smriti-bhramsha* suggests traditional recognition of its neuroprotective and cognitive benefits. Modern studies support these classical claims by demonstrating that Haritaki contains bioactive phytochemicals with strong antioxidant, anti-inflammatory and anti-apoptotic properties. Experimental models show protection against oxidative stress, amyloid toxicity, ischemic injury and memory impairment through mechanisms such as free radical scavenging, cholinergic modulation and activation of endogenous antioxidant pathways.

Overall, the correlation between Ayurvedic descriptions and contemporary scientific evidence highlights *Terminalia chebula* as a potential neuroprotective agent, justifying its further exploration in the management of neurodegenerative disorders**.**

5. CONCLUSION

The present review highlights the significance of *Terminalia chebula* (Haritaki) as an important Ayurvedic drug for maintaining neurological health. Classical references consistently attribute properties such as *Medhya*, *Rasayana* and *Vayasthapana* to Haritaki, indicating its role in supporting cognitive functions and preventing deterioration of mental faculties. Its incorporation in several formulations prescribed for conditions resembling neurological and neuropsychiatric disorders further strengthens its traditional relevance. Contemporary pharmacological studies provide supportive evidence for these traditional claims. The neuroprotective activity of Haritaki is largely associated with its diverse phytoconstituents, which exhibit antioxidant, anti-inflammatory and neuro-modulatory actions. Experimental findings demonstrate its ability to protect neurons from oxidative damage, improve memory and modulate key pathways involved in neurodegeneration. In conclusion, Haritaki represents a valuable link between traditional wisdom and modern neuroscience. Its multifaceted neuroprotective actions suggest potential therapeutic utility, warranting systematic clinical studies to establish its effectiveness in neurological disorders.

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