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Ancient Remedies for Aging Minds: Ayurveda in the Management of Neurodegenerative Diseases

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Abstract

Ayurveda, the ancient Indian system of medicine, views mental health as a balance between body, mind, and spirit. It attributes mental disorders (Manasika Roga) to imbalances in the three doshas—Vata, Pitta, and Kapha—along with disruptions in the gunas: sattva (clarity), rajas (activity), and tamas (inertia). Age-related neurodegenerative conditions like Alzheimer's Disease (AD) and Parkinson's Disease (PD) are seen not merely as biological decline but as consequences of aggravated Vata dosha and depletion of Ojas (vital essence). Therapeutic strategies in Ayurveda aim to restore equilibrium through diet (Ahara), lifestyle practices (Dinacharya), herbal remedies (e.g., Ashwagandha, Brahmi), detoxification (Panchakarma), and mind-body techniques such as Abhyanga, Shirodhara, and meditation. These interventions are believed to support cognitive health, slow neural degeneration, and enhance resilience. Modern research supports many of these practices, showing that Ayurvedic herbs possess neuroprotective, anti-inflammatory, and antioxidant properties. While contemporary treatments often use a reductionist model, Ayurveda's systems-based approach may offer a valuable complementary framework for managing neurodegenerative diseases by addressing interconnected physiological and psychological processes.

Keywords: Neurodegeneration, Ayurveda, phytochemicals, *Bacopa monnieri*, *Mucuna pruriens*, *Withania somnifera*, Berberine

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Introduction

Ayurveda, rooted in the Vedic period and documented in classical texts like *Ashtanga Hrudaya*, *Charaka Samhita*, and *Sushruta Samhita,* is a holistic science of life (Kizhakkeveettil et al., 2024). A verse from *Ashtanga Hrudaya* emphasizes that to achieve Dharma (righteousness), Artha (lawful wealth), Kama (desire), and Moksha (liberation), one must lead a long, healthy life—with obedience (Vidheya) being essential for learning Ayurveda. Diseases (Rogas), such as neurodegenerative diseases (ND), are viewed as barriers to life's purpose and Ayurveda offers the tools to treat them (*Ashtanga Hrudaya Sutra Sthana, Chapter 1, Ayushkamiyam Adhyayam*, n.d.).

Ayurveda identifies *Shareerika* doshas (Vata, Pitta, Kapha) governing the body and *Manasika* doshas (Sattva, Rajas, Tamas) influencing the mind. Health is seen as a state of dynamic homeostasis, unique to each person. Imbalance leads to disease, and treatment is predominantly individualized. Ayurveda offers a framework to understand and manage NDs, affecting both body and mind, because *Manasika* and *Shareerika* doshas influence one another.

This review aims to examine the Ayurvedic principles on NDs and their relevance to modern medicine. We present an exploration of Ayurvedic concepts of dosha imbalance and *Ojas* depletion in ND, highlighting traditional therapeutic strategies, with supporting scientific evidence, and Ayurveda's potential as a complementary framework for managing NDs.

Methodology

A comprehensive literature search was conducted in PubMed, Google Scholar, Scopus, and Web of Science to identify relevant studies. The search strategy combined both Medical Subject Headings and terms related to key concepts, population, intervention, comparison between drugs, and outcomes. A sample search string for PubMed was: Neurodegenerative disorders, Alzheimer's disease, Parkinson's disease, herbal remedies, Ayurveda, and specific phytochemical names such as *Withania somnifera*, *Mucuna pruriens*, *Bacopa monnieri,* and *Berberis spp*. Reference lists of included articles and relevant reviews were also manually screened to identify additional eligible studies. Studies published in the last 30 years (1994-2025) were reviewed during the preparation of this article. Studies involving both genetic and toxin-induced *in vitro* and *in vivo* models of NDs were included. Based on the keyword search, articles focusing on the neuroprotective effects of the mentioned herbs on NDs were selected, with an emphasis on transparency of methodology and adherence to protocols for clinical trials, animal experimentation, and systematic reviews. The rest were excluded from the study. Data on Randomized Clinical Trials were extracted from PubMed, and information related to patents was obtained through Google Patents.

Introduction to Neurodegenerative Diseases (ND)

Neurodegeneration, common in the elderly, involves progressive loss of neurons (Herrero & Morelli, 2017). Improved healthcare systems have increased the lifespan and geriatric population, leading to higher economic burden, compromised health, and an increased risk of NDs.

NDs involve the physical, cognitive, and emotional states. Here, we discuss briefly the molecular mechanisms in Parkinson's Disease (PD) and Alzheimer's Disease (AD) and the role of Ayurvedic medicine in their management. While PD is predominantly a movement disorder, AD affects cognitive function (Safiri et al., 2024).

Molecular mechanisms in neurodegeneration: Neurodegeneration arises from diverse molecular mechanisms, including mitochondrial dysfunction, oxidative stress (OS), protein misfolding, impaired proteasomal degradation, ER stress, disrupted Ca^{2+} homeostasis, excitotoxicity, and neuroinflammation. Reactive oxygen species (ROS) mediate protein, lipid, and DNA damage. While cells possess antioxidant defence mechanisms, disrupted redox homeostasis leads to OS and mitochondrial damage (Melo et al., 2011).

Human and animal studies support the involvement of OS and mitochondrial dysfunction in diseases like AD and PD (Banerjee et al., 2009). Currently used drugs like dopamine agonists or cholinesterase inhibitors manage symptoms but do not halt disease progression.

Phytochemicals as alternative approaches in the management of neurodegeneration

Ayurveda offers a holistic approach to NDs, traditionally classified as *Vata Vyadhi*—conditions resulting from an aggravated Vata dosha. Treatments focus on balancing Vata, nourishing the nervous system, and improving cognitive function. Herbs like *Brahmi*, *Ashwagandha*, and *Turmeric* offer antioxidant, anti-inflammatory, and neuroprotective effects.

Natural phytochemicals from Ayurvedic sources act as multi-target agents, providing neuroprotection via adaptive stress responses that increase antioxidant enzymes, protein chaperones, and neurotrophic factors (Mattson, 2007). They modulate cell signaling pathways (e.g., PI3K/Akt, MAPK, and PKC), and protect against mitochondrial dysfunction (Spencer, 2008). They also chelate iron, preventing the formation of free radicals relevant to diseases like AD and PD (Sahu & Gray, 1997). They also influence gene expression and cell survival (Williams et al., 2004). Notably, these compounds inhibit multiple enzymes involved in neuronal death and degeneration (Spencer, 2009). These findings bridge traditional Ayurvedic wisdom with molecular insights into neuroprotection, presenting a promising integrative path for therapeutic innovation.

Here, we discuss the therapeutic potential of four important Ayurvedic sources of phytochemicals: *Bacopa monnieri*, *Mucuna pruriens*, *Withania somnifera*, and *Berberis* species in the amelioration of AD and PD.

Bacopa monnieri (BM): BM is a well-known Ayurvedic herb valued for its neuroprotective and cognition-enhancing properties. Its active constituents include saponins, flavonoids, alkaloids (e.g., nicotine, herpestine), glycosides, sterols, and amino acids like L-glutamate, aspartate, and serine (Abdul Manap et al., 2019). BM extracts exhibit potent antioxidant activity, particularly in the hippocampus, frontal cortex, and striatum (Chaudhari et al., 2017).

The herb's bacosides confer anti-inflammatory, antioxidant, anti-cancer, and anti-aggregation effects (Chaudhari et al., 2017). Studies in mice, roundworms, and fruit flies have shown that BM can reduce unwanted protein aggregation and oxidative stress, preserve dopamine neurons, restore lipid membrane integrity, and prevent cell death and behavioural deficits (Siddique et al., 2014).

BM extract improves cognitive function and cholinergic neuronal density in AD rats (Uabundit et al., 2010). BM diminishes amyloidogenic proteins and disaggregates preformed protein fibrils (Holcomb et al., 2006). They protect cholinergic systems, activate synaptic proteins, and induce synaptic plasticity (Le et al., 2013). BM blocks synaptic breakdown of the neurotransmitter acetylcholine, resulting in enhanced performance in memory tasks in a mouse model (Kishore et al., 2017) and partial restoration of cognitive function in Schizophrenia models (Piyabhan et al., 2019).

Mucuna pruriens (MP)*:* MP shows strong antioxidant and anti-inflammatory properties and has been effective in models of AD, PD, Amyotrophic Lateral Sclerosis (ALS), and stroke. The seeds contain 4–6% levodopa, offering double the anti-Parkinsonian effect of synthetic levodopa. In the PD mouse model, MP extract improves motor function, restores dopaminergic neurons, increases striatal dopamine, and reduces nitric oxide levels, microglial activation, and neuroinflammation (Yadav et al., 2013). In the PD fly model, it restores locomotion, prevents mitochondrial dysfunction, and lipid peroxidation (Poddighe et al., 2014). In ischemia models, it improves neurological function, regulates ion and neurotransmitter levels, and reduces ROS and markers of cell death. MP further restores mitochondrial activity (Baroli et al., 2019), enhances motor performance, and reduces neuroinflammation (Yadav et al., 2013).

Withania somnifera (WS): WS, commonly known as Ashwagandha, is a traditional *Rasayana* known for promoting vitality, cognitive function, and longevity (Wadhwa et al., 2016). Classical texts, *Charaka* and *Sushruta Samhita,* describe its role in strengthening the nervous system and enhancing

mental clarity (Mukherjee et al., 2021). Its therapeutic potential lies in a rich phytochemical matrix that includes withanolides (e.g., withaferin A, withanolide A/D, withanosides IV/VI/V), alkaloids (anaferine, tropine, choline, withananine), and saponins (sitoindoside VII/VIII). Additional bioactives include glycowithanolides, withanamides, flavonoids, phenolics, steroids, etc, all contributing to its neuroprotective and adaptogenic actions.

WS exhibits neuroprotective effects in AD by reducing protein accumulation, plaque burden, and cognitive deficits, enhancing microglial activation and phagocytosis (Tancreda et al., 2025). Withanolides inhibit tau hyperphosphorylation (Zhao et al., 2024) and support cholinergic function by Acetylcholine Esterase (AChE) inhibition and promoting neurite growth (Lerose et al., 2024). WS activates the Nuclear factor erythroid 2-related factor 2 (Nrf2) pathway by elevating antioxidant enzymes like SOD, catalase, and Glutathione Peroxidase (GPx), while reducing lipid peroxidation (Durg et al., 2015). It also attenuates inflammation by downregulating Nuclear Factor Kappa B (NF-κB), Interleukin-6 (IL-6), etc (Pandey et al., 2018). WS improves memory, reduces inflammation, and lowers aβ plaques (Gladen-Kolarsky et al., 2024).

In PD models, WS restores dopamine and its metabolites and thereby improves motor function (Prakash et al., 2014). Withanolide A reduces α-synuclein (protein) aggregation, enhances lifespan, and modulates insulin signaling (Akhoon et al., 2016). WS improves mitochondrial function and ATP production in dopaminergic cells (Wongtrakul et al., 2021) and regulates Brain Derived Neurotrophic Factor (BDNF) and SIRT1 in cortical neurons (Fanibunda et al., 2025). It also mitigates glutamate excitotoxicity and restores Glutathione Dehydrogenase (GDH) activity in the cortex and hippocampus of AD rats (Visweswari et al., 2021). In summary, WS improves mitochondrial health, enhances trophic support, and mitigates excitotoxicity.

Berberis spp.: *Berberis aristata* (Daruharidra), widely used in Indian and Chinese medicine, treats infections, dysentery, uterine disorders, and promotes wound healing (Potdar et al., 2012). Its active compound, berberine, an alkaloid, exhibits antibacterial, antifungal, antiviral, antioxidant, anti-inflammatory, and hypolipidemic effects (Imenshahidi & Hosseinzadeh, 2019). Berberine confers neuroprotection in AD through antioxidative, anticholinesterase, anti-amyloid, and anti-inflammatory mechanisms (Akbar et al., 2021; Cheng et al., 2022). It enhances neuronal survival and synaptic plasticity, reduces aβ and tau pathology, and inhibits enzymes responsible for synaptic breakdown of neurotransmitters viz. AChE and Butyrylcholine Esterase (BChE) (Singh & Kumar, 2023).

In PD, berberine promotes the synthesis of tetrahydrobiopterin in gut microbes, thereby increasing dopamine synthesis (Wang et al., 2021). It also mitigates non-motor symptoms such as GI dysfunction and mood disturbances via modulation of enteric neurotransmitters and brain monoamines (Liu et al., 2025).

Clinical trials and current patents:

While *in vitro* and *in vivo* studies are necessary to evaluate drug candidates, clinical trials become crucial for their human applications. Although drugs and phytochemicals from Ayurvedic origin have limited adverse effects, clinical testing is inevitable. Clinical trials with standardized BM extracts (Keenmind, Bacomind, CDRI 08, Bacognize) have demonstrated enhanced memory, cognition, attention, and stress resilience, with improvements in cholinergic and monoaminergic functions, and no adverse effects on sensory-motor performance in both healthy and cognitively impaired individuals (Kumar et al., 2022; Micheli et al., 2020; Mishra et al., 2019). In PD, MP powder showed better motor and non-motor symptom control, improved GI tolerability, and fewer side effects compared to synthetic levodopa (Radder et al., 2019). Ashwagandha root extract has been shown to significantly improve memory, psychomotor function, and stress response in both healthy adults and individuals with Mild Cognitive Impairment in multiple randomized trials (Choudhary et al., 2017; Gopukumar et al., 2021; Rai & Mishra, 2025). Table 1 summarizes clinical trials conducted using the listed phytochemicals.

Table 1: Clinical trials conducted with extracts from *Bacopa monnieri*, *Mucuna pruriens*, **and** *Withania somnifera*

Phytochemical/ Formulation	Study Population	Key Findings	References
B. monnieri extracts (Keenmind)	Healthy adults (18-60 years)	Enhanced verbal learning, early information processing, memory strengthening; improved accuracy in complex cognitive tasks.	Stough et al. 2001, Stough et al. 2008
B. monnieri extracts (Keenmind)	general population of 40-65 years	Enhanced memory.	Roodenrys et al. 2002
B. monnieri extracts (Bacomind)	Older adults	Improved memory, cognition, attention, working memory, and cholinergic and monoaminergic functions.	Morgan et al. 2010, Peth-Nui et al. 2012
Brahmi extract (CDRI 08)	Not specified (context implies general population)	Acute effects on stress and mood swings caused by multitasking.	Benson et al. 2014

Phytochemical/ Formulation	Study Population	Key Findings	References
B. monnieri extract (Bacognize)	Subjects with high cognitive abilities	Improved cognitive function and serum Ca 2+ levels, reduced distractibility, no alteration in sensory-motor performance.	Kumar et al. 2016
B. monnieri extract (Bacognize)	Elderly	Improved cognitive function; reduced anhedonia.	Mishra et al. 2019, Micheli et al. 2020
Mucuna pruriens powder	14 PD patients (compared to levodopa-carbidopa)	Similar clinical outcome to levodopa-carbidopa; long-term use showed improved outcome.	Radder et al. 2019, Cilia et al. 2018, Katzenschlager et al. 2004
Roasted *Mucuna pruriens* seed powder	PD patients	Safe, better tolerability, reduced gastrointestinal disturbances compared to levodopa-dopa decarboxylase administration.	Cilia et al. 2017
Withania somnifera root extract	Adults with Mild cognitive impairment (MCI)	Improved immediate and general memory, improvements in executive function, attention, and information processing speed.	Choudhary et al., 2017
Liposomal *Withania somnifera* root and leaf extract (ASH, NooGandha®)	Healthy adults between 18 and 60 years of age	Improvements in Word Recall, Choice Reaction Time, Picture Recognition, Digit Vigilance, Stroop Color-Word, and profile of mood states	Leonard et al., 2024
Ashwagandha extract standardized with Sominone (Somin-On™)	Adults with MCI	Improvements in visuospatial processing, working memory, immediate memory, and general memory	Rai & Mishra, 2025

Current Patents – Several Ayurvedic formulations have been tested for the treatment of NDs. US patent US20150306164A1 highlights the cognitive-enhancing properties of BM extracts for individuals under mental stress or cognitive fatigue. US20080132455A1 details a method to obtain Jujubogenin-enriched Bacopa fractions for use in treating anxiety, depression, cognitive, and epileptic disorders. Canadian patent CA2504201A1 discusses MP seed components to prolong levodopa efficacy and prevent its toxicity in PD. US6106839 and US3666802 describe combinations or isolates of MP with *Zingiber* and *Piper longum* that improve motor symptoms in PD

with greater bioavailability and minimal side effects (EP03809721NWB1). WO2023141607A2 and WO2017068600A1 cover stress-reducing and neuroprotective properties of WS extracts, including effects on cortisol and menopausal symptoms. US20130237556A1 claims that isoquinoline alkaloids from *Berberis* species can modulate protein aggregation through the different pathways (PI3K/Akt/GSK3), with therapeutic relevance in AD Table 2 summarizes current patents on extracts and formulations from the listed phytochemicals.

Table 2: Current patents on extracts and formulations from *Bacopa monnieri*, *Mucuna pruriens*, and *Withania somnifera*

Name / Formulation	Source Plant(s)	Key Active Compounds (if mentioned)	Therapeutic Use (as per patents/trials)	Relevant Patents
B. monnieri extracts	*B. monnieri* (stems, leaves, roots)	Not specified	Acutely enhance cognitive performance in mentally stressed, fatigued, and/ or cognitively challenged humans; prophylactic or therapeutic agent.	US2015030 6164A1
Fraction enriched with jujubogenin and pseudo-jujubogenin glycosides	*Bacopa* species	Jujubogenin and pseudo-jujubogenin glycosides (100% total Bacopa Saponin concentration)	Nutraceutical supplement to treat cognitive, anxiety, depressive, and epileptic disorders.	US 2008O1 32455A1
Mucuna pruriens seeds or components	*Mucuna pruriens*	Not specified	a broader therapeutic window in Levodopa treatment, to delay the need for combination therapy, to obtain a longer duration of Levodopa efficacy, and to prevent or alleviate acute and chronic Levodopa toxicity.	CA2504201 A1
Herbal combination powder	*Mucuna pruriens* seeds, *Zingiber officinalis* roots, *Piper longum* fruits	Not specified	Alleviating motor dysfunction of Parkinson's Disease.	US Patent 6,106,839

Name / Formulation	Source Plant(s)	Key Active Compounds (if mentioned)	Therapeutic Use (as per patents/trials)	Relevant Patents
L-DOPA from *Mucuna pruriens*	*Mucuna pruriens*	L-DOPA	Active principle for various applications.	US Patent 3,666,802
Mucuna pruriens seed extracts (without effective Levodopa)	*Mucuna pruriens*	Levodopa (specifically *without* a pharmaceutically effective amount of Levodopa)	Pharmaceutical composition without Levodopa-associated contraindications; faster bioavailability than Levodopa.	EP03809721 NWB1
compositions with the extract of Withania somnifera (WS)	*Withania somnifera (WS)*	Alkaloids like isopelletierine, anaferine, cuseohygrine, and anahygrine, steroidal lactones, saponins, and other anti-stress agents (sitoindosides and acylsteryl glucosides).	Modulate cortisol levels in a person, reduces stress, inhibits tumor growth, promotes rejuvenation, eases arthritis, and protects against neurode generation.	WO202314 1607A2
Enteric coated Ashwagandha extracts	*Withania somnifera (WS)*	withanolide glycosides and saponins	Stress reduction, immune system modulation, blood sugar control, and inflammation reduction. Notably, observed even when using smaller doses compared to Ashwagandha extracts without the enteric coating.	WO2017068 600A1
A composition containing berberine	*Coptis chinensis and Berberis species*	Berberine	Effectively reduces Amyloid β-peptide (aβ) and carboxyl-terminal fragments (CTFs).	US20130237 556A1

Challenges, future directions, and concluding remarks

This review examines four significant Ayurvedic herbal extracts and their therapeutic potential in the management of NDs (Figure 1). Compelling preclinical evidence supports their neuroprotective properties, warranting rigorous validation through human clinical studies. The intersection of

clinical trials and patents represents critical developments in translating traditional remedies into evidence-based therapeutics, accelerating the journey from the laboratory bench to patient bedside.

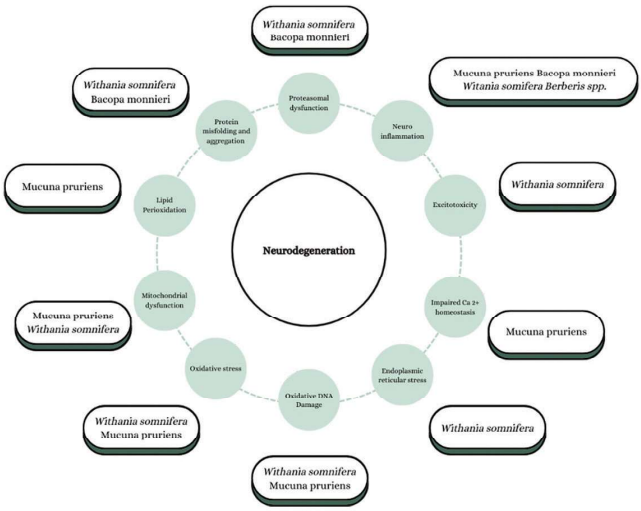

Figure 1: Schematic diagram shows the various factors leading to neurodegeneration in the inner circle. The outer circle lists the phytochemicals and the mechanistic pathways that they influence.

Despite promising advances, substantial challenges persist in this translational pathway. Key obstacles include conducting large-scale, methodologically rigorous clinical trials, establishing standardized protocols for herbal preparation and quality control, and fostering meaningful integration between traditional Ayurvedic practice and contemporary evidence-based medicine through interdisciplinary collaboration.

As the global burden of NDs continues to escalate, the therapeutic limitations of current conventional treatments underscore an urgent need for innovative and integrative approaches. Ayurveda's ancient wisdom, with its emphasis on disease prevention, personalized treatment, and holistic patient care, offers a compelling complementary framework that may enhance treatment outcomes and patient quality of life. Knowledge of herbal medicine equips non-prescribing professionals to ensure safe, informed, and culturally competent care — bridging traditional practices and modern health science to support whole-person well-being. Figure 2 represents a schematic illustration depicting the amalgamation of traditional Ayurvedic medicine and modern neuroscience for enhanced brain health management.

The convergence of traditional knowledge with modern scientific rigor represents not merely an alternative treatment paradigm but a necessary evolution toward more comprehensive and effective neurotherapeutic strategies.

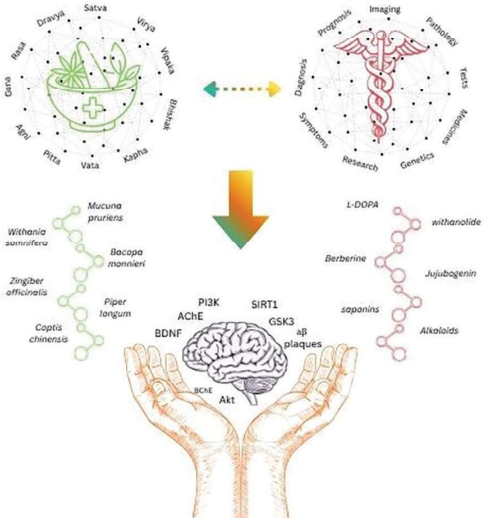

Figure 2: A schematic illustration depicting the amalgamation of traditional Ayurvedic medicine and modern neuroscience to enhance brain health management. Combining traditional knowledge with molecular neuroscience, researchers can elucidate mechanisms of neuroprotection, paving the way for personalized, holistic strategies to optimize brain function and prevent neurological decline

References

Abdul Manap, A. S., Vijayabalan, S., Madhavan, P., Chia, Y. Y., Arya, A., Wong, E. H., Rizwan, F., Bindal, U., & Koshy, S. (2019). *Bacopa monnieri* , a Neuroprotective Lead in Alzheimer Disease: A Review on Its Properties, Mechanisms of Action, and Preclinical and Clinical Studies. *Drug Target Insights*, *13*, 117739281986641. https://doi.org/10.1177/1177392819866412

Akbar, M., Shabbir, A., Rehman, K., Akash, M. S. H., & Shah, M. A. (2021). Neuroprotective potential of berberine in modulating Alzheimer's disease via multiple signaling pathways. *Journal of Food Biochemistry*, *45*(10). https://doi.org/10.1111/jfbc.13936

Akhoon, B. A., Pandey, S., Tiwari, S., & Pandey, R. (2016). Withanolide A offers neuroprotection, ameliorates stress resistance and prolongs the life expectancy of Caenorhabditis elegans. *Experimental Gerontology*, *78*, 47–56. https://doi.org/10.1016/j.exger.2016.03.004

Ashtanga Hrudaya Sutra Sthana, Chapter 1, Ayushkamiyam Adhyayam. (n.d.). https://www.easyayurveda.com/2012/08/31/ashtanga-hrudaya-sutra-sthana-chapter-1-basic-principles-of-ayurveda/

Banerjee, R., Starkov, A. A., Beal, M. F., & Thomas, B. (2009). Mitochondrial dysfunction in the limelight of Parkinson's disease pathogenesis. *Biochimica et Biophysica Acta (BBA) - Molecular Basis of Disease*, *1792*(7), 651–663. https://doi.org/10.1016/j.bbadis.2008.11.007

Baroli, B., Loi, E., Solari, P., Kasture, A., Moi, L., Muroni, P., Kasture, S., Setzu, M. D., Liscia, A., & Zavattari, P. (2019). Evaluation of oxidative stress mechanisms and the effects of phytotherapic extracts on Parkinson's disease *Drosophila PINK1*^{B9} model. *The FASEB Journal*, *33*(10), 11028–11034. https://doi.org/10.1096/fj.201901010

Chaudhari, K. S., Tiwari, N. R., Tiwari, R. R., & Sharma, R. S. (2017). Neurocognitive Effect of Nootropic Drug ***Brahmi*** (***Bacopa monnieri***) in Alzheimer's Disease. *Annals of Neurosciences*, *24*(2), 111–122. https://doi.org/10.1159/000475900

Cheng, Z., Kang, C., Che, S., Su, J., Sun, Q., Ge, T., Guo, Y., Lv, J., Sun, Z., Yang, W., Li, B., Li, X., & Cui, R. (2022). Berberine: A Promising Treatment for Neurodegenerative Diseases. *Frontiers in Pharmacology*, *13*, 845591. https://doi.org/10.3389/fphar.2022.845591

Choudhary, D., Bhattacharyya, S., & Bose, S. (2017). Efficacy and Safety of Ashwagandha (*Withania somnifera* (L.) *Dunal*) Root Extract in Improving Memory and Cognitive Functions. *Journal of Dietary Supplements*, *14*(6), 599–612. https://doi.org/10.1080/19390211.2017.1 284970

Durg, S., Dhadde, S. B., Vandal, R., Shivakumar, B. S., & Charan, C. S. (2015). *W ithania somnifera* (Ashwagandha) in neurobehavioural disorders induced by brain oxidative stress in rodents: A systematic review and meta-analysis. *Journal of Pharmacy and Pharmacology*, *67*(7), 879–899. https://doi.org/10.1111/jphp.12398

Fanibunda, S. E., Kukkemane, K., Ghai, U., Kolthur-Seetharam, U., Hingorani, L., Vaidya, A. D. B., & Vaidya, V. A. (2025). Withania somnifera Regulates Mitochondrial Biogenesis and Energetics in Rat Cortical Neurons: Role of BDNF and SIRT1. *Molecular Neurobiology*, *62*(8), 10277–10295. https://doi.org/10.1007/s12035-025-04920-7

Gladen-Kolarsky, N., Monestime, O., Bollen, M., Choi, J., Yang, L., Magaña, A. A., Maier, C. S., Soumyanath, A., & Gray, N. E. (2024). Withania somnifera (Ashwagandha) Improves Spatial Memory, Anxiety and Depressive-like Behavior in the 5xFAD Mouse Model of Alzheimer's Disease. Antioxidants, 13(10), 1164. https://doi.org/10.3 390/antiox13101164

Gopukumar, K., Thanawala, S., Somepalli, V., Rao, T. S. S., Thamatam, V. B., & Chauhan, S. (2021). Efficacy and Safety of Ashwagandha Root Extract on Cognitive Functions in Healthy, Stressed Adults: A Randomized, Double-Blind, Placebo-Controlled Study. *Evidence-Based Complementary and Alternative Medicine*, *2021*, 1–10. https://doi.org/10.1155/2021/8254344

Herrero, M. T., & Morelli, M. (2017). Multiple mechanisms of neurodegeneration and progression. *Progress in Neurobiology*, *155*, 1. https://doi.org/10.1016/j.pneurobio.2017.06.001

Holcomb, L. A., Dhanasekaran, M., Hitt, A. R., Young, K. A., Riggs, M., & Manyam, B. V. (2006). Bacopa monniera extract reduces amyloid levels in PSAPP mice. *Journal of Alzheimer's Disease*, *9*(3), 243–251. https://doi.org/10.3233/JAD-2006-9303

Imenshahidi, M., & Hosseinzadeh, H. (2019). Berberine and barberry (*Berberis vulgaris*): A clinical review. *Phytotherapy Research*, *33*(3), 504–523. https://doi.org/10.1002/ptr.6252

Kishore, L., Kaur, N., & Singh, R. (2017). Bacosine isolated from aerial parts of Bacopa monnieri improves the neuronal dysfunction in Streptozotocin-induced diabetic neuropathy. *Journal of Functional Foods*, *34*, 237–247. https://doi.org/10.1016/j.jff.2017.04.044

Kizhakkeveettil, A., Parla, J., Patwardhan, K., Sharma, A., & Sharma, S. (2024). History, Present and Prospect of Ayurveda. In Y. Shen, *History, Present and Prospect of World Traditional Medicine* (pp. 1–72). WORLD SCIENTIFIC. https://doi.org/10.1142/9789811282171_0001

Kumar, V., Malhotra, V., & Sinha, V. (2022). Evaluation of Individual Quality of Life (QOL) Among Patients with Tracheostomy Using WHO-QOL BREF Questionnaire. *Indian Journal of Otolaryngology and Head & Neck Surgery*, *74*(S3), 5207–5216. https://doi.org/10.1007/s120 70-020-02052-z

Le, X. T., Pham, H. T. N., Do, P. T., Fujiwara, H., Tanaka, K., Li, F., Van Nguyen, T., Nguyen, K. M., & Matsumoto, K. (2013). Bacopa monnieri Ameliorates Memory Deficits in Olfactory Bulbectomized Mice: Possible Involvement of Glutamatergic and Cholinergic Systems. *Neurochemical Research*, *38*(10), 2201–2215. https://doi.org/10.1007/s1 1064-013-1129-6

Lerose, V., Ponticelli, M., Benedetto, N., Carlucci, V., Lela, L., Tzvetkov, N. T., & Milella, L. (2024). Withania somnifera (L.) Dunal, a Potential Source of Phytochemicals for Treating Neurodegenerative Diseases: A Systematic Review. *Plants*, *13*(6), 771. https://doi.org/10.3390/plants 13060771

Liu, Z., Zhang, X., Sun, Y., Zheng, L., Zhang, C., Yu, X., Zhang, T., Song, J., Zhang, Y., & Zhu, J. (2025). Berberine Improves Depression-Like Behaviors and Gastrointestinal Dysfunction in 6-Hydroxydopamine-Induced Parkinson's Disease Rats. *Neurogastroenterology & Motility*, *37*(7), e70033. https://doi.org/10.1111/nmo.70033

Mattson, M. P. (2007). Calcium and neurodegeneration. *Aging Cell*, *6*(3), 337–350. https://doi.org/10.1111/j.1474-9726.2007.00275.x

Melo, A., Monteiro, L., Lima, R. M. F., De Oliveira, D. M., De Cerqueira, M. D., & El-Bachá, R. S. (2011). Oxidative Stress in Neurodegenerative Diseases: Mechanisms and Therapeutic Perspectives. *Oxidative Medicine and Cellular Longevity*, *2011*, 1–14. https://doi.org/10.1155/ 2011/467180

Micheli, L., Spitoni, S., Di Cesare Mannelli, L., Bilia, A. R., Ghelardini, C., & Pallanti, S. (2020). *Bacopa monnieri* as augmentation therapy in the treatment of anhedonia, preclinical and clinical evaluation. *Phytotherapy Research*, *34*(9), 2331–2340. https://doi.org/10.1002/ptr.6 684

Mishra, M., Mishra, A. K., & Mishra, U. (2019). Brahmi (Bacopa monnieri Linn) in the treatment of dementias – a pilot study. *Future Healthcare Journal*, *6*, s69. https://doi.org/10.7861/futurehosp.6-1-s69

Mukherjee, P. K., Banerjee, S., Biswas, S., Das, B., Kar, A., & Katiyar, C. K. (2021). Withania somnifera (L.) Dunal—Modern perspectives of an ancient Rasayana from Ayurveda. *Journal of Ethnopharmacology*, *264*, 113157. https://doi.org/10.1016/j.jep.2020.113157

Pandey, A., Bani, S., Dutt, P., Kumar Satti, N., Avtar Suri, K., & Nabi Qazi, G. (2018). Multifunctional neuroprotective effect of Withanone, a compound from Withania somnifera roots in alleviating cognitive dysfunction. *Cytokine*, *102*, 211–221. https:doi.org/10.1016/j.cyto.2017. 10.019

Piyabhan, P., Tingpej, P., & Duansak, N. (2019). Effect of pre- and post-treatment with Bacopa monnieri (Brahmi) on phencyclidine-induced disruptions in object recognition memory and cerebral calbindin, parvalbumin, and calretinin immunoreactivity in rats. Neuropsychiatric Disease and Treatment, Volume 15, 1103–1117. https://doi.org/10.2147/NDT.S193222

Poddighe, S., De Rose, F., Marotta, R., Ruffilli, R., Fanti, M., Secci, P. P., Mostallino, M. C., Setzu, M. D., Zuncheddu, M. A., Collu, I., Solla, P., Marrosu, F., Kasture, S., Acquas, E., & Liscia, A. (2014). Mucuna pruriens (Velvet bean) Rescues Motor, Olfactory, Mitochondrial and Synaptic Impairment in PINK1B9 Drosophila melanogaster Genetic Model of Parkinson's Disease. *PLoS ONE*, *9*(10), e110802. https://doi.org/10.1371/journal.pone.0110802

Potdar, D., Hirwani, R. R., & Dhulap, S. (2012). Phyto-chemical and pharmacological applications of Berberis aristata. *Fitoterapia*, *83*(5), 817–830. https://doi.org/10.1016/j.fitote.2012.04.012

Prakash, J., Chouhan, S., Yadav, S. K., Westfall, S., Rai, S. N., & Singh, S. P. (2014). Withania somnifera Alleviates Parkinsonian Phenotypes by Inhibiting Apoptotic Pathways in Dopaminergic Neurons. *Neurochemical Research*, *39*(12), 2527–2536. https://doi.org/10.1007/s1 1064-014-1443-7

Radder, D. L. M., De Vries, N. M., Riksen, N. P., Diamond, S. J., Gross, D., Gold, D. R., Heesakkers, J., Henderson, E., Hommel, A. L. A. J., Lennaerts, H. H., Busch, J., Dorsey, R. E., Andrejack, J., & Bloem, B. R. (2019). Multidisciplinary care for people with Parkinson's disease: The new kids on the block! *Expert Review of Neurotherapeutics*, *19*(2), 145–157. https://doi.org/10.1080/14737175.2019.1561285

Rai, H. P., & Mishra, D. N. (2025). Effect of ashwagandha (*Withania somnifera*) extract with Sominone (Somin-On™) to improve memory in adults with mild cognitive impairment: A randomized, double-blind, placebo-controlled study. *Journal of Psychopharmacology*, *39*(4), 350–363. https://doi.org/10.1177/02698811251324377

Safiri, S., Ghaffari Jolfayi, A., Fazlollahi, A., Morsali, S., Sarkesh, A., Daei Sorkhabi, A., Golabi, B., Aletaha, R., Motlagh Asghari, K., Hamidi, S., Mousavi, S. E., Jamalkhani, S., Karamzad, N., Shamekh, A., Mohammadinasab, R., Sullman, M. J. M., Şahin, F., & Kolahi, A.-A. (2024). Alzheimer's disease: A comprehensive review of epidemiology, risk factors, symptoms diagnosis,

management, caregiving, advanced treatments and associated challenges. *Frontiers in Medicine*, *11*, 1474043. https://doi.org/10.3389/fmed.2024.1474043

Sahu, S. C., & Gray, G. C. (1997). Lipid peroxidation and dna damage induced by morin and naringenin in isolated rat liver nuclei. *Food and Chemical Toxicology*, *35*(5), 443–447. https://doi.org/10.1016/S0278-6915(97)00011-2

Siddique, Y. H., Mujtaba, S. F., Faisal, M., Jyoti, S., & Naz, F. (2014). The effect of Bacopa monnieri leaf extract on dietary supplementation in transgenic Drosophila model of Parkinson's disease. *European Journal of Integrative Medicine*, *6*(5), 571–580. https://doi.org/10.1016/j.eujim. 2014.05.007

Singh, Y. P., & Kumar, H. (2023). Berberine derivatives as inhibitors of acetylcholinesterase: A systematic review. *Chemical Biology & Drug Design*, *102*(6), 1592–1603. https://doi.org/10.1111/cbdd.14337

Spencer, J. P. E. (2008). Flavonoids: Modulators of brain function? *British Journal of Nutrition*, *99*(E-S1), ES60–ES77. https://doi.org/10.1017/S00 07114508965776

Spencer, J. P. E. (2009). Flavonoids and brain health: Multiple effects underpinned by common mechanisms. *Genes & Nutrition*, *4*(4), 243–250. https://doi.org/10.1007/s12263-009-0136-3

Tancreda, G., Ravera, S., & Panfoli, I. (2025). Preclinical Evidence of Withania somnifera and Cordyceps spp.: Neuroprotective Properties for the Management of Alzheimer's Disease. *International Journal of Molecular Sciences*, *26*(11), 5403. https://doi.org/10.3390/ijms26115403

Uabundit, N., Wattanathorn, J., Mucimapura, S., & Ingkaninan, K. (2010). Cognitive enhancement and neuroprotective effects of Bacopa monnieri in Alzheimer's disease model. *Journal of Ethnopharmacology*, *127*(1), 26–31. https://doi.org/10.1016/j.jep.2009.09.056

Visweswari, G., Christopher, R., & Rajendra, W. (2021). *Withania somnifera against glutamate excitotoxicity and neuronal cell loss in a scopolamine-induced rat model of Alzheimer's disease*. https://doi.org/10.5281/ZENO DO.4426779

Wadhwa, R., Konar, A., & Kaul, S. C. (2016). Nootropic potential of Ashwagandha leaves: Beyond traditional root extracts. *Neurochemistry International*, *95*, 109–118. https://doi.org/10.1016/j.neuint.2015.09.001

Wang, Y., Tong, Q., Ma, S.-R., Zhao, Z.-X., Pan, L.-B., Cong, L., Han, P., Peng, R., Yu, H., Lin, Y., Gao, T.-L., Shou, J.-W., Li, X.-Y., Zhang, X.-F., Zhang, Z.-W., Fu, J., Wen, B.-Y., Yu, J.-B., Cao, X., & Jiang, J.-D. (2021). Oral berberine improves brain dopa/dopamine levels to ameliorate Parkinson's disease by regulating gut microbiota. *Signal Transduction and Targeted Therapy*, *6*(1), 77. https://doi.org/10.1038/s41392-020-00456-5

Williams, R. J., Spencer, J. P. E., & Rice-Evans, C. (2004). Flavonoids: Antioxidants or signalling molecules? *Free Radical Biology and Medicine*, *36*(7), 838–849. https://doi.org/10.1016/j.freeradbiomed.2004.01.001

Wongtrakul, J., Thongtan, T., Kumrapich, B., Saisawang, C., & Ketterman, A. J. (2021). Neuroprotective effects of Withania somnifera in the SH-SY5Y Parkinson cell model. *Heliyon*, *7*(10), e08172. https://doi.org/10.1016/j.heliyon.2021.e08172

Yadav, S. K., Prakash, J., Chouhan, S., & Singh, S. P. (2013). Mucuna pruriens seed extract reduces oxidative stress in nigrostriatal tissue and improves neurobehavioral activity in paraquat-induced Parkinsonian mouse model. Neurochemistry International, 62(8), 1039–1047. https://doi.org/10.1016/j.neuint.2013.03.015

Zhao, Z., Yuan, Y., Li, S., Wang, X., & Yang, X. (2024). Natural compounds from herbs and nutraceuticals as glycogen synthase kinase-3β inhibitors in Alzheimer's disease treatment. *CNS Neuroscience & Therapeutics*, *30*(8), e14885. https://doi.org/10.1111/cns.14885