

MEDICINAL PLANTS WITH ANTI-ALZHEIMER'S ACTIVITY: MECHANISMS AND PHYTOCONSTITUENTS – A REVIEW

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ABSTRACT

Alzheimer's disease (AD) is a progressive neurodegenerative disorder characterized by memory loss, cognitive impairment, and neuronal degeneration. Current synthetic drugs provide only symptomatic relief and are associated with adverse effects. Medicinal plants have emerged as promising alternatives due to their multitarget therapeutic potential and minimal toxicity. Various phytoconstituents such as alkaloids, flavonoids, terpenoids, and phenolic compounds exhibit neuroprotective effects through mechanisms including acetylcholinesterase inhibition, antioxidant activity, anti-inflammatory effects, and modulation of amyloid-beta pathways. This review highlights important medicinal plants, their bioactive compounds, and mechanisms involved in anti-Alzheimer's activity.

KEYWORDS: Alzheimer's disease, Medicinal plants, Neuroprotection, Phytoconstituents, Acetylcholinesterase,

Antioxidants.

1. INTRODUCTION

Alzheimer's disease is one of the most common neurodegenerative disorders affecting elderly populations worldwide. It is characterized by progressive loss of memory, cognitive decline,

and behavioral disturbances. The pathological features include accumulation of amyloid-beta plaques, neurofibrillary tangles, oxidative stress, and neuroinflammation.

Despite advances in pharmacotherapy, current drugs such as cholinesterase inhibitors provide only temporary symptomatic relief. Therefore, there is increasing interest in medicinal plants as alternative therapeutic agents due to their safety, affordability, and multitarget action.

2. Pathophysiology of Alzheimer's Disease

2.1 Amyloid Cascade Hypothesis

Deposition of amyloid-beta ($A\beta$) peptides leads to plaque formation, neuronal toxicity, and synaptic dysfunction.

2.2 Tau Protein Hyperphosphorylation

Abnormal tau protein causes neurofibrillary tangles and neuronal degeneration.

2.3 Oxidative Stress

Reactive oxygen species (ROS) damage neuronal cells and contribute to disease progression.

2.4 Neuroinflammation

Activation of microglia releases inflammatory cytokines, worsening neuronal damage.

2.5 Cholinergic Deficit

Reduction in acetylcholine levels leads to impaired memory and cognition.

3. Role of Medicinal Plants in Alzheimer's Disease

Medicinal plants have been widely used in traditional systems of medicine for improving memory and treating neurological disorders. They contain bioactive compounds capable of targeting multiple pathways involved in AD.

Studies show that plant-derived compounds can:

- Inhibit acetylcholinesterase

- Reduce amyloid-beta aggregation
- Act as antioxidants
- Suppress neuroinflammation

4. Important Medicinal Plants with Anti-Alzheimer's Activity

4.1 Ginkgo biloba

Phytoconstituents: Ginkgolides, flavonoids

Mechanism: Antioxidant, improves cerebral blood flow, neuroprotection

4.2 Withania somnifera (Ashwagandha) Phytoconstituents: Withanolides

Mechanism: Reduces amyloid plaques, enhances neuronal growth

4.3 Bacopa monnieri (Brahmi) Phytoconstituents: Bacosides

Mechanism: Enhances memory, antioxidant activity

4.4 Curcuma longa (Turmeric) Phytoconstituent: Curcumin

Mechanism: Anti-inflammatory, inhibits amyloid aggregation

4.5 Centella asiatica

Phytoconstituents: Asiaticoside

Mechanism: Neuroprotective, enhances cognitive function

4.6 Salvia officinalis (Sage)

Phytoconstituents: Rosmarinic acid, flavonoids Mechanism: Acetylcholinesterase inhibition

5. Phytoconstituents Responsible for Anti-Alzheimer's Activity**5.1 Alkaloids**

Example: Galantamine

Mechanism: Acetylcholinesterase inhibition

5.2 Flavonoids

Examples: Quercetin, Luteolin

Mechanism: Antioxidant, anti-inflammatory

5.3 Terpenoids

Example: Ginkgolides

Mechanism: Neuroprotection

5.4 Phenolic Compounds

Examples: Caffeic acid, Gallic acid Mechanism: Free radical scavenging

Plant phytochemicals exhibit multitarget activity, making them promising candidates for AD therapy.

6. Mechanisms of Anti-Alzheimer's Activity**6.1 Acetylcholinesterase Inhibition**

Increases acetylcholine levels, improving memory.

6.2 Antioxidant Activity

Neutralizes free radicals and prevents neuronal damage.

6.3 Anti-inflammatory Effects

Reduces neuroinflammation and cytokine production.

6.4 Anti-amyloid Activity

Prevents formation and aggregation of amyloid-beta plaques.

6.5 Neuroprotective Effects

Promotes neuronal survival and synaptic plasticity.

6.6 Enzyme Modulation

Inhibits enzymes such as β -secretase and GSK-3 β Nature.

7. Role of Polyherbal Formulations

Polyherbal formulations combine multiple plants to achieve synergistic effects.

They target multiple pathways simultaneously, improving therapeutic outcomes.

8. Advanced Research Approaches

In vitro and in vivo models.

In silico studies Nanotechnology-based delivery systems.

These approaches enhance drug delivery and bioavailability.

9. Challenges in Herbal Drug Development

Lack of standardization Variability in phytochemical composition.

Limited clinical trials Poor bioavailability.

10. Recent Advances

Recent studies highlight

Multi-target phytochemicals Nanocarrier-based herbal drugs Molecular docking studies

These advancements improve efficacy and reduce limitations.

11. Future Perspectives

Future research should focus on:

Clinical validation

Standardization of extracts

Identification of novel phytoconstituents Development of herbal-based drugs

CONCLUSION

Medicinal plants offer a promising approach for the management of Alzheimer's disease due to their multitarget mechanisms and safety profile. Phytoconstituents such as flavonoids, alkaloids, and terpenoids play a crucial role in neuroprotection. However, further research and clinical validation are required to establish their therapeutic efficacy.

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