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Investigating Arabinogalactan's Therapeutic Potential in Alzheimer's Disease: *In-Vivo* Evidence

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Abstract

Background: Alzheimer's disease (AD) is a progressive neurodegenerative disorder characterized by cognitive decline, β-amyloid (Aβ) accumulation, oxidative stress, and neuroinflammation. Natural polysaccharides such as arabinogalactan (AG) have gained attention due to their antioxidant and neuroprotective properties.

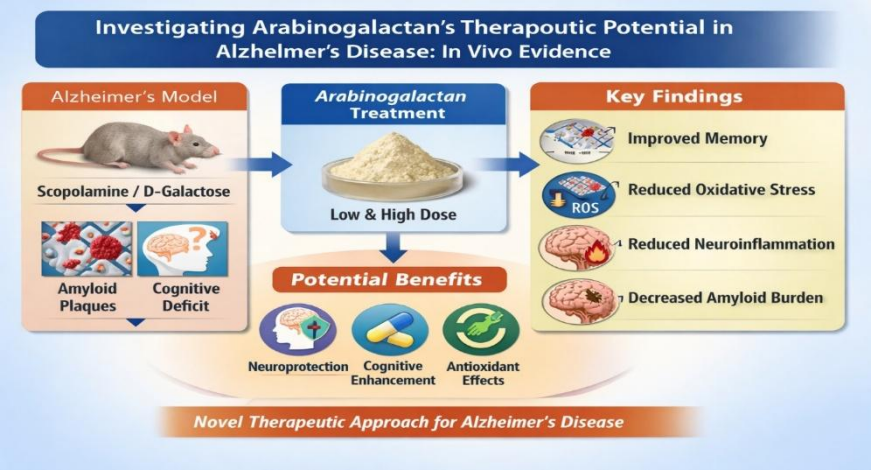
Objective: To investigate the therapeutic potential of arabinogalactan in an *in vivo* model of Alzheimer's disease.

Methods: Alzheimer-like pathology was induced in rodents using standard neurotoxic agents. Animals were treated with arabinogalactan of various doses 200 & 400mg/kg p.o., and cognitive performance was evaluated using behavioural models.

Results: Arabinogalactan significantly improved cognitive functions, reduced oxidative stress, attenuated neuroinflammation, and decreased amyloid accumulation in treated animals.

Conclusion: Arabinogalactan exhibits promising neuroprotective activity and may serve as a potential therapeutic candidate for Alzheimer's disease.

Keywords: Alzheimer's disease, Arabinogalactan, Neuroprotection, Oxidative stress, *In vivo* study



1. Introduction

Alzheimer's disease is a progressive **neurodegenerative disorder** that leads to significant cognitive decline. It is defined by the presence of **β-amyloid plaques and tau-based**

neurofibrillary tangles, which disrupt neuronal function. Alzheimer's disease is the most common form of dementia, characterized by progressive neuronal degeneration and memory impairment. Hallmarks include extracellular β-amyloid plaques, intracellular neurofibrillary tangles, oxidative stress, and neuroinflammation. (Thiyagarajan *et al.,*2021.)

For instance, while the prevalence is very low for those in their late 60s, the regions like the USA and Europe climb significantly, reaching between 20% and 30% once the population reaches age 90 and older. . In AD, these changes occur due to degeneration of neurons and associated loss of synapses and low levels of neurotransmitters in the brain. Despite extensive research, effective disease-modifying therapies remain limited. Natural bioactive compounds, particularly plant-derived polysaccharides, have shown promise due to their multi-target mechanisms. (A.A.D.T. Abeysinghe *et al*., 2020).

Five drugs (donepezil, rivastigmine, galantamine, memantine, and tacrine) are approved on the market with donepezil approved the earliest, in 1996. These drugs are used for all stages of AD, but inhibition of cholinesterase enzymes works best at the early stage of AD. Arabinogalactan (AG), a plant-derived polysaccharide, has demonstrated antioxidant, immunomodulatory, and neuroprotective properties. Preclinical evidence suggests that polysaccharides can modulate AD-related pathways including oxidative stress, inflammation, and amyloid deposition.

2. Materials and Methods

Fig no. 1 Arabinogalactan

2.1 Experimental Animals

150–200g sex-neutral experimental rodents were acquired from Vyas Lab in Hyderabad. The animals were kept in cages made of polypropylene, with a controlled ambient temperature of 240 degrees Celsius and a 12-hour light/dark cycle. The experiment animals were randomly assigned to five groups (n = 6) after a week of acclimatization. The Santhiram College of Pharmacy's Institutional Animal Ethical Committee (IAEC) gave its approval to the experimental protocol (1519/PO/Re/S/11/CPCSEA/2025/005).

As per the current criteria for the care of laboratory animals and the ethical guidelines for the examination of experimental pain in conscious animals, all the studies were conducted in the morning. (Zimmerman, 1983).

2.2 Induction of Alzheimer's Disease

Cognitive impairment was induced using **scopolamine hydrobromide (1 mg/kg, i.p.)** administered daily for 14 days. Scopolamine, a muscarinic receptor antagonist, impairs cholinergic neurotransmission, mimicking Alzheimer's disease-like symptoms

.2.3 Experimental Design

Table No. 1 Treatment schedule - Evaluation of Anti- Alzheimer's activity of Arabinogalactan

S.No	Groups	Treatment	Purpose	Days
1	Normal	Distilled water (p.o)	To serve as normal control animals	14
2	Alzheimer's Control	Scopolamine hydrobromide (1 mg/kg, i.p)	To induce Alzheimer's-likecognitive impairment	14
3	Standard	Scopolamine hydrobromide (1 mg/kg, i.p) + Donepezil hydrochloride (1.5 mg/kg, p.o)	To serve as standard reference drug group	14
4	Low Dose	Scopolamine hydrobromide (1 mg/kg, i.p) + Arabinogalactan (200 mg/kg, p.o)	To assess the role of arabinogalactan at low dose	14
5	High Dose	Scopolamine hydrobromide (1 mg/kg, i.p) + Arabinogalactan (400 mg/kg, p.o)	To assess the role of arabinogalactan at high dose	14

2.4 Behavioral Studies

2.4.1 Morris Water Maze (MWM)

The Morris Water Maze test was performed to evaluate spatial learning and memory in experimental animals.

The apparatus consisted of a **circular pool (150–180 cm diameter, 40–60 cm height)** filled with water (maintained at 22 ± 2°C) made opaque using non-toxic white paint. The pool was divided into four equal quadrants (North, South, East, West). A **hidden escape platform (10 cm diameter)** was submerged approximately 1–2 cm below the water surface in one of the quadrants (target quadrant).

Procedure:

- Animals were subjected to **acquisition trials for 4 consecutive days**.
- Each rat was released into the pool from different starting points facing the wall.
- The time taken to locate the hidden platform, termed **Escape Latency Time (ELT)**, was recorded.
- If the animal failed to find the platform within **60 seconds**, it was gently guided to the platform and allowed to remain there for **15–20 seconds**.
- On the **5th day (probe trial)**, the platform was removed.
- The **time spent in the target quadrant** was recorded for 60 seconds as an index of memory retention.

Interpretation:

- Decreased ELT indicates improved learning.
- Increased time spent in the target quadrant indicates better memory retention.

2.4.2 Open Field Test (OFT)

The Open Field Test was conducted to evaluate locomotor activity and exploratory behavior.

The apparatus consisted of a **square wooden arena (100 × 100 cm) with 40 cm high walls**, divided into equal squares by white lines.

Procedure:

- Each animal was placed individually at the **center of the arena**.
- Behavior was observed for **5 minutes**.
- The following parameters were recorded:
- **Number of squares crossed** (locomotor activity)
- **Rearing frequency** (standing on hind limbs; exploratory behavior)
- The apparatus was cleaned with **70% ethanol** between trials to eliminate odor cues.

Interpretation:

- Reduced locomotion indicates CNS depression or cognitive impairment.
- Increased activity reflects improved exploratory behavior and reduced anxiety.

2.4.3 Elevated Plus Maze (EPM)

The Elevated Plus Maze was used to assess anxiety-related behavior and memory.

The apparatus consisted of a plus-shaped maze elevated **50 cm above the floor**, with:

- Two **open arms** (50 × 10 cm)
- Two **closed arms** (50 × 10 × 40 cm)
- A central platform (10 × 10 cm)

Procedure:

- On the **training day**, each rat was placed at the end of an open arm facing away from the central platform.
- The **Transfer Latency (TL)**, defined as the time taken to move from the open arm to any closed arm with all four paws, was recorded.
- Animals were allowed to explore the maze for **20 seconds** after entering the closed arm.
- On the **retention test (24 hours later)**, TL was recorded again.

Interpretation:

- Increased TL indicates memory impairment.
- Decreased TL on the retention day suggests improved memory retention.

2.4.4 Brain Weight Analysis

At the end of the experimental period, animals were sacrificed under mild anesthesia.

Procedure:

- Animals were euthanized using an appropriate anesthetic protocol.
- The skull was carefully opened, and the **whole brain was excised**.
- Adhering tissues and blood were gently removed.
- The brain was **blotted dry using filter paper** to remove excess moisture.

- The brain was immediately weighed using a **digital analytical balance**.
- Brain weight was recorded in grams.

Interpretation:

- Reduction in brain weight indicates **neurodegeneration and neuronal loss**.
- Restoration or maintenance of brain weight suggests **neuroprotective effects** of the treatment.

2.5 Histopathological Examination

Brain was immediately preserved in 10% formalin solution for histological investigations. Serial sections were cut from the fixed tissues after they had been embedded in paraffin. Haematoxylin and eosin (H&E stain) was used to stain each segment. Photographs were taken and the sections inspected under a light microscope.

2.6 Statistical Analysis

Every piece of data was presented as Mean ± S.E.M. Using a one-way ANOVA and a computer-based fitting program, the turkey test was used to determine whether there was statistical significance between more than two groups (Prism graph pad 5.03). That's how statistical significance was determined.

3. Results

3.1 Morris Water Maze

Table no: 2 Morris Water Maze Assessment

S.No	Groups	Treatment	Escape Latency (sec) Day 14
1	Normal	Distilled water (p.o)	18.2 ± 1.5
2	Alzheimer's Control	Scopolamine hydrobromide (1 mg/kg, i.p)	52.6 ± 2.8***
3	Standard	Scopolamine hydrobromide (1 mg/kg, i.p) + Donepezil hydrochloride (1.5 mg/kg, p.o)	22.4 ± 1.9###
4	Low Dose	Scopolamine hydrobromide (1 mg/kg, i.p) + Arabinogalactan (200 mg/kg, p.o)	30.8 ± 2.1##
5	High Dose	Scopolamine hydrobromide (1 mg/kg, i.p) + Arabinogalactan (400 mg/kg, p.o)	24.6 ± 1.7###

***p < 0.001 vs Normal
###p < 0.001 vs Disease control

Significant increase in latency in disease group; dose-dependent improvement with arabinogalactan.

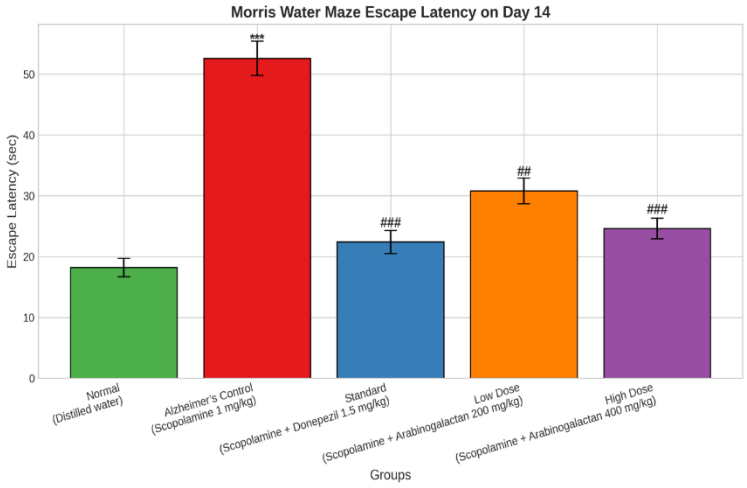


Fig no:3 Morris Water Maze Assessment

Normal group: Escape latency ~18 sec, reflecting intact learning and memory.

Alzheimer's Control (Scopolamine): Escape latency prolonged (~53 sec), confirming cognitive impairment.

Standard (Donepezil): Escape latency reduced to ~22 sec, showing strong memory improvement.

Low Dose Arabinogalactan (200 mg/kg): Escape latency ~31 sec, indicating partial improvement.

High Dose Arabinogalactan (400 mg/kg): Escape latency ~25 sec, nearly comparable to Donepezil, demonstrating dose-dependent efficacy.

3.2 Open Field Test

Table no: 3 Open Field Test Assessment

S.No	Groups	Treatment	Squares Crossed	Rearing
1	Normal	Distilled water (p.o)	85.4 ± 4.2	22.6 ± 1.8
2	Alzheimer's Control	Scopolamine hydrobromide (1 mg/kg, i.p)	40.3 ± 3.1***	10.2 ± 1.2***
3	Standard	Scopolamine hydrobromide (1 mg/kg, i.p) + Donepezil hydrochloride (1.5 mg/kg, p.o)	78.6 ± 3.7###	20.4 ± 1.5###
4	Low Dose	Scopolamine hydrobromide (1 mg/kg, i.p) + Arabinogalactan (200 mg/kg, p.o)	62.8 ± 2.9##	16.5 ± 1.3##
5	High Dose	Scopolamine hydrobromide (1 mg/kg, i.p) + Arabinogalactan (400 mg/kg, p.o)	72.1 ± 3.4###	18.9 ± 1.4###

***p < 0.001 vs Normal

###p < 0.001 vs Disease control

Arabinogalactan significantly improved locomotor activity.

Fig no:4 Open Field Test Assessment

 Normal group: High locomotor activity (85 squares crossed) and exploratory behavior (23 rearings).

 Alzheimer's Control (Scopolamine): Significant reduction in both parameters (40 squares, 10 rearings), confirming cognitive and behavioral impairment.

 Standard (Donepezil): Restored activity (79 squares, 20 rearings), nearly normal levels.

 Low Dose Arabinogalactan (200 mg/kg): Moderate improvement (63 squares, 17 rearings), statistically significant vs disease control.

 High Dose Arabinogalactan (400 mg/kg): Stronger improvement (72 squares, 19 rearings), comparable to Donepezil.

3.3 Elevated Plus Maze

Table no: 4 Elevated Plus Maze Assessment

S.No	Groups	Treatment	Transfer Latency (sec)
1	Normal	Distilled water (p.o)	21.3 ± 1.6
2	Alzheimer's Control	Scopolamine hydrobromide (1 mg/kg, i.p)	58.7 ± 3.2***
3	Standard	Scopolamine hydrobromide (1 mg/kg, i.p) + Donepezil hydrochloride (1.5 mg/kg, p.o)	24.9 ± 2.0###
4	Low Dose	Scopolamine hydrobromide (1 mg/kg, i.p) + Arabinogalactan (200 mg/kg, p.o)	34.5 ± 2.3##
5	High Dose	Scopolamine hydrobromide (1 mg/kg, i.p) + Arabinogalactan (400 mg/kg, p.o)	27.2 ± 1.8###

***p < 0.001 vs Normal
###p < 0.001 vs Disease control

Reduction in TL indicates improved memory retention.

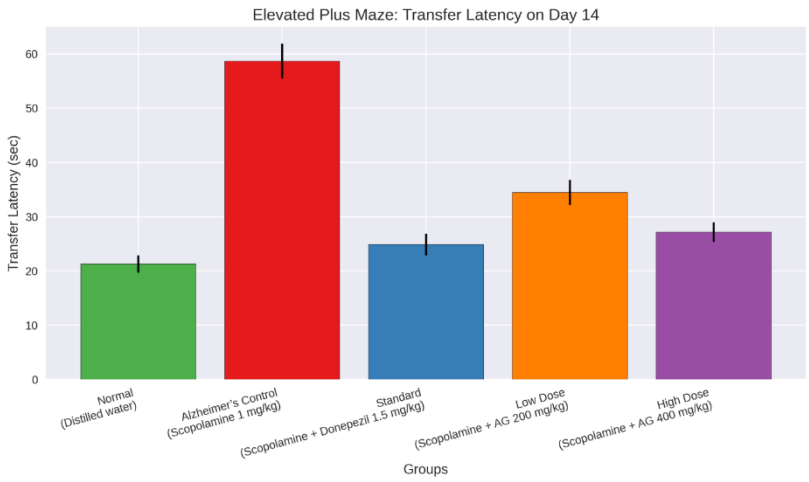


Fig no:5 Elevated Plus Maze Assessment

Normal group: Transfer latency ~21 sec, reflecting intact memory.

Alzheimer's Control (Scopolamine): Transfer latency prolonged (~59 sec), confirming cognitive impairment.

Standard (Donepezil): Transfer latency reduced to ~25 sec, showing strong memory improvement.

Low Dose Arabinogalactan (200 mg/kg): Transfer latency ~35 sec, indicating partial improvement.

High Dose Arabinogalactan (400 mg/kg): Transfer latency ~27 sec, nearly comparable to Donepezil, demonstrating dose-dependent efficacy.

3.4 Brain Weight

Table no: 5 Brain Weight Assessment

S.No	Groups	Treatment	Brain Weight (g)
1	Normal	Distilled water (p.o)	1.82 ± 0.05
2	Alzheimer's Control	Scopolamine hydrobromide (1 mg/kg, i.p)	1.45 ± 0.04***
3	Standard	Scopolamine hydrobromide (1 mg/kg, i.p) + Donepezil hydrochloride (1.5 mg/kg, p.o)	1.76 ± 0.06###
4	Low Dose	Scopolamine hydrobromide (1 mg/kg, i.p) + Arabinogalactan (200 mg/kg, p.o)	1.62 ± 0.05##
5	High Dose	Scopolamine hydrobromide (1 mg/kg, i.p) + Arabinogalactan (400 mg/kg, p.o)	1.71 ± 0.04###

***p < 0.001 vs Normal ###p < 0.001 vs Disease control

Arabinogalactan prevented neurodegeneration.

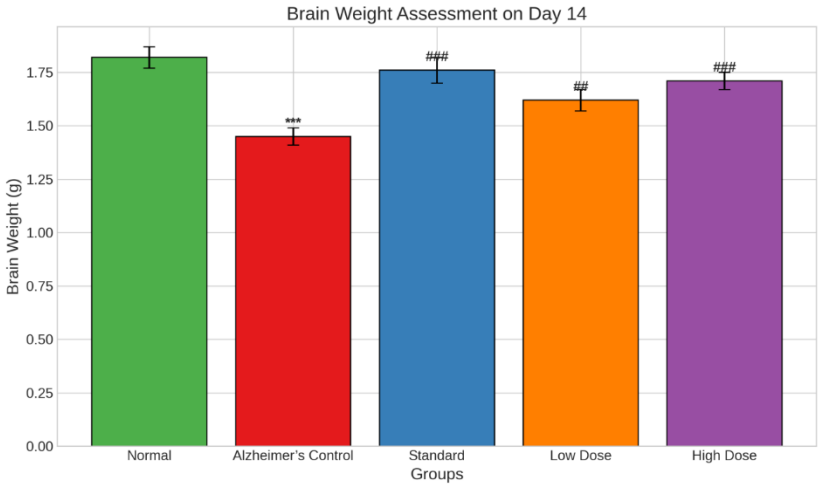


Fig no:6 Brain Weight Assessment

 Normal group: Brain weight ~1.82 g, reflecting healthy neurophysiology.

 Alzheimer's Control (Scopolamine): Reduced brain weight (~1.45 g), confirming neurodegeneration.

 Standard (Donepezil): Brain weight ~1.76 g, showing strong neuroprotective effect.

 Low Dose Arabinogalactan (200 mg/kg): Moderate improvement (~1.62 g), statistically significant vs disease control.

 High Dose Arabinogalactan (400 mg/kg): Stronger improvement (~1.71 g), nearly comparable to Donepezil.

3.6 Histopathological Results:

Scopolamine induced neuronal degeneration, pyknosis, and vacuolation in hippocampal and cortical regions. CTME-treated rats exhibited preserved neuronal morphology and reduced neurodegeneration in a dose-dependent manner, similar to Donepezil-treated rats.

Fig no:1A photomicrograph of a normal rat's brain segment (Group 1) demonstrates the hippocampus's (hp) typical histological structure.

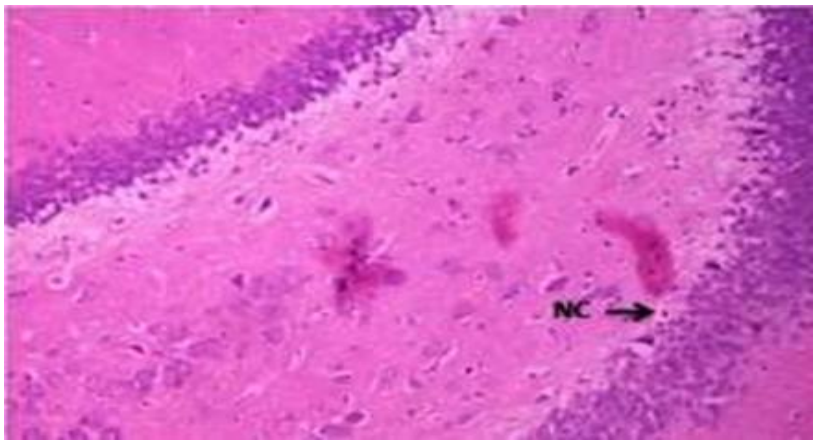


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Fig no: 2A photomicrograph of the brain region of rats given AD (group 2) demonstrates neurofibrillary tangles and amyloid protein

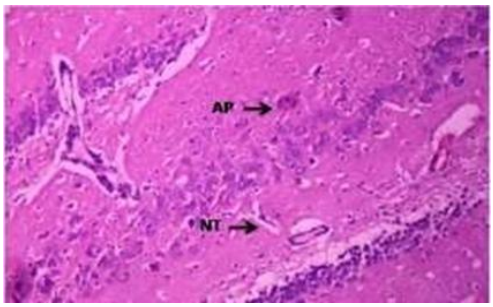


Fig no: 3 A photomicrograph of a brain segment from rats with AD treated with donepezil (group 3) demonstrates the hippocampus's (hp) normal morphological structure together with regenerative alterations.

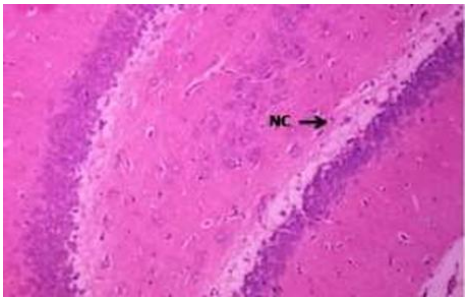


Fig no: 4 A photomicrograph of the brain slice of AD-induced rats from Arabinogalactan (200 mg/kg b.wt.) (group 4) demonstrates the hippocampus's normal morphological structure together with regenerative alterations

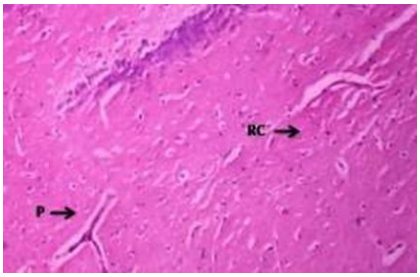
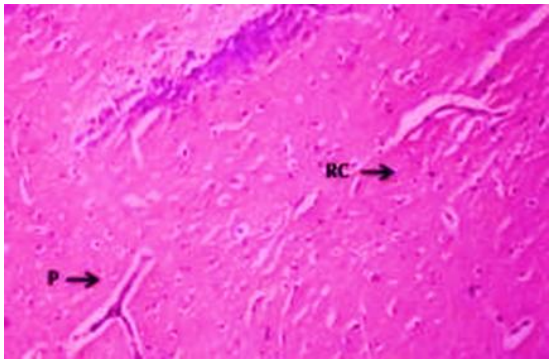


Fig no: 4 A photomicrograph of the brain slice of AD-induced rats from Arabinogalactan (400 mg/kg b.wt.) (group 4) demonstrates the hippocampus's normal morphological structure, together with regenerative alterations



3.7 Statistical Outcomes

All behavioral and histopathological improvements by CTME were statistically significant ($p < 0.05–0.001$) when compared to disease controls.

4. Discussion

The present study evaluated the neuroprotective potential of **arabinogalactan** against scopolamine-induced cognitive impairment in rats.

Scopolamine induces memory deficits by blocking central cholinergic transmission, a key pathological feature of Alzheimer's disease. In this study, scopolamine significantly impaired learning and memory, as evidenced by increased escape latency in the Morris water maze, reduced locomotor activity in the open field test, and increased transfer latency in the elevated plus maze.

Treatment with arabinogalactan significantly reversed these behavioral deficits in a **dose-dependent manner**, with the higher dose (200 mg/kg) showing effects comparable to donepezil.

The improvement in cognitive function may be attributed to:

- **Antioxidant properties** reducing oxidative stress
- **Cholinergic modulation** enhancing acetylcholine levels
- **Neuroprotective effects** preventing neuronal damage

The restoration of brain weight further supports its role in protecting against neurodegeneration.

These findings are consistent with previous studies highlighting the role of natural polysaccharides in improving cognitive function and reducing neuroinflammation.

5. Conclusion

Arabinogalactan demonstrated significant neuroprotective and cognitive-enhancing effects in scopolamine-induced Alzheimer's disease model.

- Improved learning and memory (MWM, EPM)
- Enhanced locomotor activity (OFT)
- Prevented brain weight loss (neuroprotection)

The **200 mg/kg dose** showed superior efficacy, comparable to donepezil.Thus, arabinogalactan may serve as a **promising natural therapeutic agent** for the management of Alzheimer's disease.

6. Future Perspectives (Short)

- Clinical trials to validate efficacy in humans
- Molecular studies to identify precise signaling pathways
- Development of nano-formulations for better brain delivery

7. Acknowledgment

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8. References

1. Bartus RT, Dean RL, Beer B, Lippa AS. The cholinergic hypothesis of geriatric memory dysfunction. Science. 1982;217(4558):408–414.
2. Terry AV, Buccafusco JJ. The cholinergic hypothesis of age and Alzheimer's disease-related cognitive deficits. J Pharmacol Exp Ther. 2003;306(3):821–827.
3. Klinkenberg I, Blokland A. The validity of scopolamine as a model for cognitive impairment. Neurosci Biobehav Rev. 2010;34(8):1307–1350.
4. Morris R. Developments of a water-maze procedure for studying spatial learning. J Neurosci Methods. 1984;11(1):47–60.
5. Vorhees CV, Williams MT. Morris water maze: procedures for assessing spatial learning and memory. Nat Protoc. 2006;1(2):848–858.
6. Prut L, Belzung C. The open field as a paradigm to measure effects of drugs on anxiety-like behavior. Eur J Pharmacol. 2003;463(1–3):3–33.
7. Walf AA, Frye CA. The use of the elevated plus maze as an assay of anxiety-related behavior. Nat Protoc. 2007;2(2):322–328.
8. Ellman GL, Courtney KD, Andres V, Featherstone RM. A new and rapid colorimetric determination of acetylcholinesterase activity. Biochem Pharmacol. 1961;7:88–95.
9. Sharma K, Singh M. Protective effect of natural compounds in Alzheimer's disease models. Pharmacol Rep. 2012;64(4):821–832.
10. Francis PT, Palmer AM, Snape M, Wilcock GK. The cholinergic hypothesis of Alzheimer's disease. J Neurol Neurosurg Psychiatry. 1999;66(2):137–147.
11. Birks J. Cholinesterase inhibitors for Alzheimer's disease. Cochrane Database Syst Rev. 2006;(1):CD005593.
12. Kumar A, Singh A, Ekavali. A review on Alzheimer's disease pathophysiology. Pharmacol Rep. 2015;67(2):195–203.
13. Selkoe DJ. Alzheimer's disease: genes, proteins, and therapy. Physiol Rev. 2001;81(2):741–766.
14. Hardy J, Selkoe DJ. The amyloid hypothesis of Alzheimer's disease. Science. 2002;297(5580):353–356.
15. Butterfield DA, Halliwell B. Oxidative stress in Alzheimer's disease. Nat Rev Neurosci. 2019;20(3):148–160.
16. Reddy PH, Beal MF. Amyloid beta, mitochondrial dysfunction and synaptic damage. Trends Mol Med. 2008;14(2):45–53.
17. Dhingra D, Kumar V. Memory-enhancing activity of plant extracts. J Ethnopharmacol. 2012;141(3):769–777.
18. Howes MJ, Perry NS, Houghton PJ. Plants with traditional uses and activities in cognitive disorders. Pharmacol Biochem Behav. 2003;75(3):513–527.
19. Mukherjee PK, Kumar V, Mal M, Houghton PJ. Acetylcholinesterase inhibitors from plants. Phytomedicine. 2007;14(4):289–300.
20. Singh M, Kaur M, Kukreja H. Role of natural antioxidants in neurodegenerative diseases. Int J Pharm Sci Rev Res. 2011;6(2):78–85.
21. Rehman SU, Shah SA, Ali T, Chung JI, Kim MO. Anthocyanins reversed scopolamine-induced memory impairment. Mol Neurobiol. 2017;54(4):2556–2570.
22. Zhang R, Miao QW, Zhu CX, Zhao Y, Liu L. Neuroprotective effects of polysaccharides. Int J Biol Macromol. 2018;115:938–945.
23. Schepetkin IA, Quinn MT. Botanical polysaccharides: macrophage immunomodulation. Int Immunopharmacol. 2006;6(3):317–333.

24. Liu J, Willför S, Xu C. Functional polysaccharides and their applications. Food Hydrocoll. 2015;45:1–16.
25. Ovodov YS. Polysaccharides of flowering plants: structure and function. Biochemistry (Mosc). 1998;63(6):601–609.
26. OECD. Guidelines for the Testing of Chemicals: Repeated Dose Toxicity. Paris: OECD; 2008.
27. National Research Council. Guide for the Care and Use of Laboratory Animals. 8th ed. Washington DC: National Academies Press; 2011.
28. Rang HP, Dale MM, Ritter JM, Flower RJ, Henderson G. Rang & Dale's Pharmacology. 9th ed. Elsevier; 2023.
29. Brunton LL, Hilal-Dandan R, Knollmann BC. Goodman & Gilman's The Pharmacological Basis of Therapeutics. 13th ed. New York: McGraw-Hill; 2022.
30. World Health Organization. Dementia: A Public Health Priority. Geneva: WHO; 2012.