Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/ptrfm976

EVALUATION OF NOOTROPIC ACTIVITY OF MORINGA OLIFERA PODS

Ganta Radhika Reddy[1*], Rakesh Jat[2]

[1*]Research scholar, Department of pharmacy, Shri Jagdishprasad Jhabarmal Tibrewal University, Vidyanagari, Jhunjhunu Rajasthan, India -33301
[2]Professor, Department of pharmacy, Shri Jagdishprasad Jhabarmal tibrewal university, Vidyanagari, Jhunjhunu Rajasthan, India -33301

***Corresponding author:** G. Radhika Reddy
*Research scholar Department of pharmacy, Shri Jagdishprasad Jhabarmal Tibrewal University, Rajasthan, India-33301 Email.id: radhikareddyganta777@gmail.com, Ph. No: 81422 27277

Abstract

Background: Global health concerns include cognitive impairment, which is frequently brought on by aging and neurodegenerative illnesses like Alzheimer's. Alternative therapies that make use of natural substances that are neuroprotective and memory-enhancing are becoming more popular. Known for its phytochemicals and traditional medicinal uses, *Moringa oleifera* may be good for your brain. This study looks at the nootropic effects and mechanisms of *Moringa oleifera* fruit pod hydroalcoholic extract in Wistar albino rats.

Procedures: Hydroalcoholic solvents were used to extract powdered, shade-dried *Moringa oleifera* fruit pods. Following phytochemical screening, the extract included flavonoids, alkaloids, saponins, phenolics, and tannins. Rats in five groups (n=5) received oral administration of either *Moringa oleifera* extract at 50, 100, or 200 mg/kg for 16 days, piracetam (500 mg/kg, i.p.), or vehicle (control). Cognitive ability was tested using the Morris Water Maze (MWM) and Passive Avoidance. In brain tissues, acetylcholinesterase (AChE) activity and the oxidative stress markers catalase, SOD, and MDA were assessed.

Results: Similar to piracetam, the extract decreased MWM escape latency and enhanced probe trial retention, particularly at dosages of 100 and 200 mg/kg. Antioxidant activity was indicated by the treated groups' increased SOD and CAT activity and decreased MDA levels. Furthermore, there was a significant decrease in hippocampal AChE activity, suggesting improved cholinergic function**.**

Conclusion: The fruit pod extract of *Moringa oleifera* contains antioxidants and inhibits cholinesterase, which enhances cognition. Together, the phytochemicals seem to enhance and safeguard memory. Our research suggests that *Moringa oleifera* might be a natural nootropic, and it has been used traditionally to treat cognitive problems. To determine its effectiveness in disease models and pinpoint the active ingredients in question, more investigation is required.

Keywords: Antioxidant, Morris Water Maze, acetylcholinesterase inhibition, nootropic, cognitive enhancement, and *Moringa oleifera*

1. Introduction

Nature is treasure of plenty of medicinal substances; in fact, many modern drugs are derived from plant-based compounds. Natural products and their chemical compounds or molecules produced by living thing have always been a major component of therapeutic development[1,2]. In recent years, there has been increased interest in their ability to change brain activity, particularly in relation to enhancing cognitive function[3]. Nootropics are substances that improve memory, creativity, motivation, and focus in healthy individuals. They are also known as cognitive enhancers or smart pills[4]. Natural substances that have neuroprotective and cognitive-enhancing properties are becoming more and more well-liked, despite the existence of synthetic nootropics[5]. Among the many other plants studied for their nootropic effect, Moringa oleifera, also known as the drumstick tree, stands out due to its broad phytochemical profile and diverse pharmacological traits[6]. Native to parts of Africa and Asia, this plant has long been used to treat a variety of ailments[7]. Almost every part of the plant, including the bark, seeds, roots, leaves, and pods, has medicinal properties[8]. Specifically, M. oleifera pods, which are sometimes overlooked in favor of the more thoroughly studied leaves and seeds, have shown promise due to their unique chemical composition[9]. Flavonoids, phenolic acids, alkaloids, and saponins are among the many bioactive compounds present in these pods that have been demonstrated to possess neuroprotective and antioxidant qualities[10]. The pharmacognostic properties of the pods, including their organoleptic, microscopic, and physicochemical characteristics, are essential for their recognition and standardization in herbal medicine.

According to a phytochemical analysis, the pods are also a substantial source of nutrients and secondary metabolites, which may contribute to their nootropic properties[11]. *M. oleifera* pods' diverse pharmacological properties and intricate phytochemical profile have shown promise. Their pharmacognostic evaluation offers a scientific basis for their identification, quality control, and potential therapeutic applications[12]. The pods are rich in minerals like calcium, magnesium, and vitamin C, proteins and amino acids, and other essential nutrients. By investigating the phytochemistry and pharmacognostic characteristics of *M. oleifera* pods, researchers can learn more about their potential to promote brain health and cognitive function[13].

Bioactive substances including vitamins, trace minerals, phenolic acids, and flavonoids are found in *M. oleifera*, a plant with a wide range of medicinal applications[14,15]. These compounds have neuroprotective and antioxidant qualities, and they include vitamin C, kaempferol, and Quercetin[16,17]. Additionally, they have anti-inflammatory properties, which lower neuroinflammation and enhance cognitive function[18]. The flavonoids and polyphenols in M. oleifera may encourage neurogenesis and synaptic plasticity. They may also chelate heavy metals and toxins to shield the brain from harm[19]. The present study investigates the nooptropic potential of M. oleifera fruit pods.

2. Methodology

2.1. Plant Material Collection and Preparation

Fresh fruit pods of *Moringa oleifera* were collected, authenticated, and shade-dried for 7–10 days. The dried pods were pulverized into coarse powder using a mechanical grinder. The powder was subjected to hydroalcoholic extraction (70:30 ethanol:water) via Soxhlet apparatus. The extract was filtered, concentrated using a rotary evaporator, and stored at 4°C for subsequent analysis.

2.2. Phytochemical Screening

Preliminary phytochemical screening of the hydroalcoholic extract was conducted to detect the presence of flavonoids, alkaloids, saponins, phenolic compounds, and tannins using standard qualitative procedures.

2.3. Animals
Wistar albino rats (150–200g) were housed under standard conditions (12-h light/dark cycle, 25±2°C) with ad libitum access to food and water. The study protocol was approved by the Institutional Animal Ethics Committee.

2.4. Experimental Design
Animals were randomly divided into five groups (n=5 per group):
- **Control**: 0.3% CMC orally
- **Standard**: Piracetam 500 mg/kg, intraperitoneally
- **MOE-50**: 50 mg/kg of *Moringa oleifera* extract
- **MOE-100**: 100 mg/kg of extract
- **MOE-200**: 200 mg/kg of extract

Treatments were administered once daily for 16 days. Behavioral tests were conducted on specific days as per the schedule[20].

2.5. Behavioral Assessment
a. Morris Water Maze (MWM) Test
Used to evaluate spatial learning and memory. The escape latency time (ELT) and time spent in the target quadrant (probe trial) were recorded during acquisition and retention phases (Days 1–16).
b. Passive Avoidance Test
Assessed memory retention based on latency to enter a previously shock-associated dark chamber.

6. Acetylcholinesterase (AChE) Activity
On Day 7, rats were sacrificed, and hippocampal tissues were dissected. AChE activity was determined spectrophotometrically using Ellman's method.

7. Biochemical Analysis of Brain Tissue
Tissue homogenates were analyzed for:
- **Malondialdehyde (MDA)** – Lipid peroxidation marker.
- **Superoxide Dismutase (SOD)** and **Catalase (CAT)** – Antioxidant enzymes.

8. Statistical Analysis
Data were expressed as mean ± SEM (n=5). Statistical significance was evaluated using one-way ANOVA followed by Newman-Keuls post hoc test. $p < 0.05$ was considered statistically significant.

3. Results
The study investigates the nootropic qualities of *Moringa oleifera* fruit pods and how they may improve cognitive function[Figure . The fruit pods were dried, ground, and extracted using hydroalcoholic solvents. The extract was screened for phytochemicals, including phenolic compounds, alkaloids, flavonoids, tannins, and saponins as seen in Table 1. Wistar albino rats were divided into three groups: the standard group, the control group, and the groups that were given *Moringa oleifera* extract as in Table 2. The results showed that *Moringa oleifera* extract significantly enhanced learning and memory retention, indicating decreased oxidative stress and increased neuroprotection, with MDA levels sharply declining and SOD and CAT activity increasing as seen in Table 3. Given that the bioactive compounds in the fruit pods may improve memory and learning, the study supports conventional medical beliefs about the neuroprotective benefits of *M. oleifera*. Future research should focus on long-term effects, potential toxicity at higher dosages, and the synergistic benefits of *M. oleifera* 's bioactive components. The study demonstrates the impact of *M. oleifera* fruit pod extract on escape latency time during the Morris Water Maze test in Wistar rats. The rats were given different doses of the extract, and their performance was evaluated. The results showed a significant decrease in escape latency time,

particularly at higher doses. This suggests that *M. oleifera* extract may have a cognitive-enhancing effect, leading to faster learning and memory acquisition. The data also showed a dose-dependent effect, suggesting that *M. oleifera* may influence neuroplasticity and improve cognitive function through its bioactive compounds as seen in Figure 2. Further the The study demonstrates the effect of *M. oleifera* fruit pod extract on escape latency time in the Morris Water Maze (MWM) test as seen in Table 4 and Figure 4. The rats were divided into control and treatment groups. The control group showed a gradual decline in escape latency, suggesting they were gradually acquiring spatial memory. The rats treated with *M. oleifera* showed a more rapid decline in escape latency, indicating a positive impact on spatial learning and memory. The data showed a dose-dependent effect, with higher doses showing the most significant reduction in escape latency. The active compounds in *M. oleifera*, such as antioxidants and neuroprotective agents, may be responsible for the observed improvements in spatial memory. The study supports the notion that *M. oleifera* fruit pod extract has a beneficial effect on spatial learning and memory in Wistar rats.

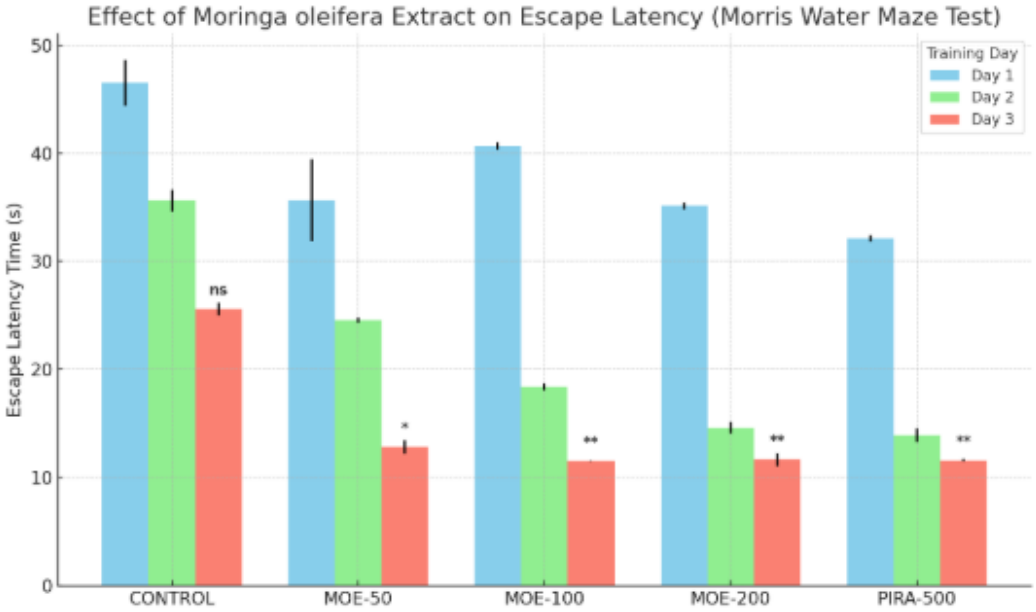

Figure 1: Effect of *Moringa oleifera* extract on the Morris Water Maze test (escape latency time).

Table 1: Phytochemical constituents detected in *M. oleifera* fruit pod extract.

Compound	Presence (+/-)
Flavonoids	+
Alkaloids	+
Saponins	+
Phenolic acids	+
Tannins	+

Table 2: Timeline and treatment schedule of Morris water maze (MWM) experiment for nootropic and anti-AChE activities.

Treatment days	Treatment schedule for nootropic activity of MOE			Treatment schedule for anti-ChE activity of MOE	
	Control (0.3% CMC treated, p.o)	MOE (50, 100 and 200 mg/kg, p.o) treated groups	Piracetam (500 mg/kg, i.p) treated group	Control (0.3% CMC, p.o) treated	MOE (50, 100 and 200 mg/kg, p.o) treated groups.
Pre-	Vehicle	MOE	Vehicle	Vehicle treated	MOE treatment

treatment period 1–6	treated	treatment	treated		
SRM testing 7 8 9	Vehicle treated	On day 7, 1 h after the last dose of MOE administration, animals were subjected to SRM and SWM version of the MWM Test	Piracetam was administered 30 min before the start of experimental procedures from day 7 to day 16	On day 7, 1 h after the last dose of vehicle, all rats were quickly decapitated and AChE activity was measured in discrete brain regions	On day 7, 1 h after the last dose of MOE, all rats were quickly decapitated and AChE activity was measured in discrete brain regions
Probe trial 10	Vehicle treated				
Gap On 11th and 12th day	Vehicle treated				
SWM testing 13 14 15 16	Vehicle treated	Treatment with MOE continued till the end of the experiment (up to day 16)			

Table 3: Effect of MOE (50, 100 and 200 mg/kg) and piracetam (500 mg/kg) on escape latency in the Morris water maze (MWM) During training days 1, 2 and 3

GROUPS	DAY 1	DAY2	DAY 3
CONTROL	46.50±2.14	35.63±1.00	25.60±0.58
MOE-50	35.66±3.76	24.56±0.233	12.83±0.60
MOE-100	40.66±0.33	18.40±0.32	11.53±0.04
MOE-200	35.13±0.33	14.60±0.52	11.66±0.62
PIRA-500	32.126±0.30	13.93±0.63	11.60±0.12

Morris water maze (MWM) quadrant (probe trial)

Table 4: Effect of MOE (50, 100 and 200 mg/kg) and piracetam (500 mg/kg) on time spent in the target quadrant (probe trial) in the MWM test

GROUPS	Time spent in the target quadrant (s)
CONTROL	11.57±0.56
MOE-50	19.40±1.40
MOE-100	22.63±0.69
MOE-200	25.27±0.99
PIRA-500	27.93±0.57

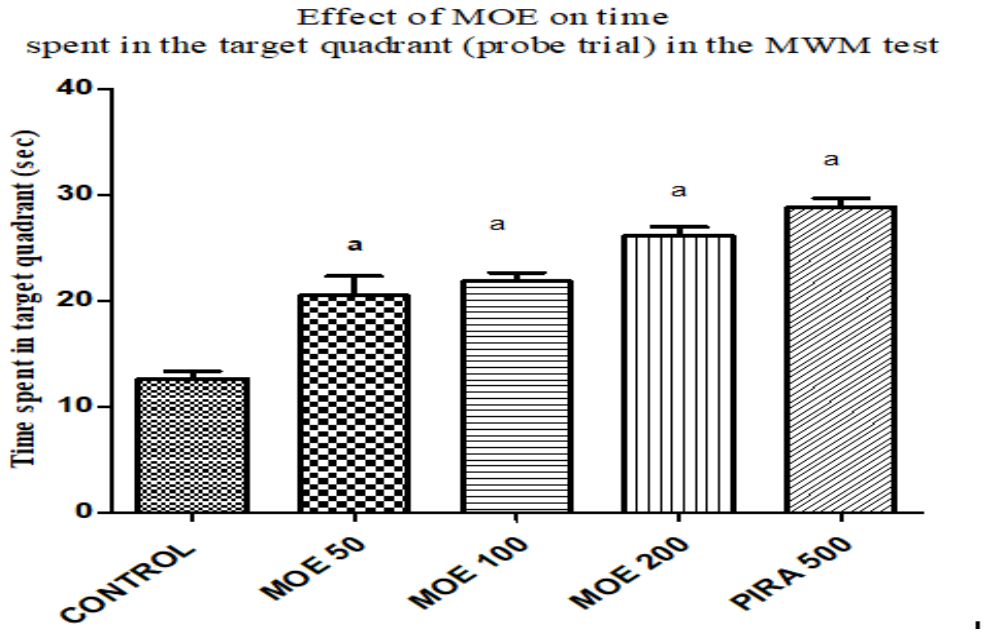

Table 4: Effect of MOE (50, 100 and 200 mg/kg) and piracetam (500 mg/kg) on escape latency in acquisition trial of working memory on days 1, 2, 3 and 4

GROUPS	DAY 1	DAY2	DAY 3	DAY 4
CONTROL	45.60±0.52	35.13±0.58	26.93±0.50	26.10±1.01
MOE-50	44.73±0.37	21.26±0.9	20.40±0.52	14.23±0.49
MOE-100	46.43±0.50	17.56±0.4	19.20±0.71	16.46±0.64
MOE-200	47.26±0.60	19.63±0.7	18.53±0.46	16.20±0.47
PIRA-500	50.53±0.82	16.40±0.96	17.63±0.50	14.40±0.63

Table 4: Effect of MOE (50, 100 and 200 mg/kg) on acetyl cholinesterase (AChE) activity on rat brain hippocampus (HIP)

GROUPS	DAY 1	DAY2	DAY 3	DAY 4
CONTROL	45.23±0.76	35.40±0.56	24.40±1.26	23.26±0.42
MOE-50	51.06±0.18	18.93±0.88	16.56±0.1	14.26±0.74
MOE-100	53.26±1.66	15.43±0.40	15.73±0.61	14.63±0.55
MOE-200	52.20±1.68	16.33±0.48	15.80±0.47	15.43±0.49
PIRA-500	51.63±0.54	14.46±0.70	13.40±0.20	12.53±0.22

The study investigated the neuroprotective effects of Moringa oleifera extract on neuronal health and function. It tested biomarkers like Malondialdehyde (MDA), Superoxide Dismutase (SOD), Catalase (CAT), Glutathione (GSH), Nitric Oxide (NO), and Protein Carbonylation. Results showed Moringa oleifera reduced MDA levels, increased SOD activity, and preserved GSH levels, suggesting its protective effect on brain antioxidant defenses. The findings could help understand Moringa oleifera's therapeutic potential in neurodegenerative conditions as in Table 5 and Figure 5.

Table 5: Biochemical analysis of oxidative stress markers in the brain tissue.

Group	**MDA (nmol/mg)**	**SOD (U/mg)**	**CAT (U/mg)**
Control	5.8 ± 0.4	1.5 ± 0.2	2.1 ± 0.3
Moringa 100 mg/kg	3.9 ± 0.3	2.8 ± 0.3	3.4 ± 0.4
Moringa 200 mg/kg	2.7 ± 0.2	3.9 ± 0.4	4.2 ± 0.3
Piracetam 200 mg/kg	2.5 ± 0.2	4.1 ± 0.3	4.5 ± 0.3

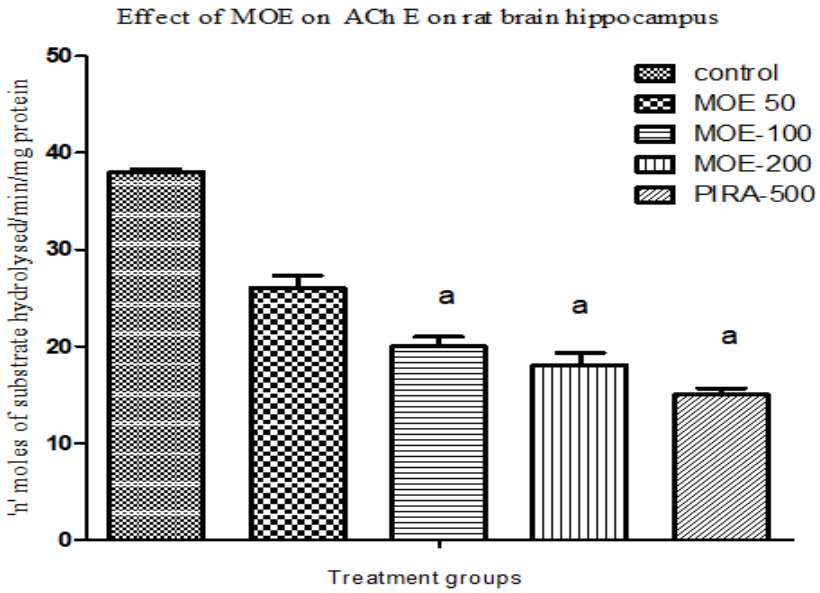

Fig. 5. Effect of MOE (50, 100 and 200 mg/kg) on acetyl cholinesterase (AChE) activity on rat brain hippocampus (HIP). Results are expressed as mean ± SEM (n = 5). a p < 0.05 compared to control, MOE-100 mg/kg, MOE-200 and PIRA-500 mg/kg respectively (one way ANOVA followed by Newman-Keuls Multiple Comparison Test)

4. Discussion

In Wistar rats, the study examined how *Moringa oleifera* fruit pod extract improved cognitive function. The findings demonstrated notable enhancements in spatial learning and memory retention together with a decrease in escape latency comparable to piracetam. Neuroprotective processes like cholinergic modulation and antioxidant activity were also demonstrated by the extract. Oxidative stress was decreased by the extract, which also raised SOD and CAT activity and decreased MDA levels.

In the hippocampus, it also reduced AChE activity, suggesting better cholinergic transmission. Through antioxidant, anti-inflammatory, and neurotransmitter-enhancing mechanisms, alkaloids, saponins, flavonoids, and phenolic acids were proven to be present in the extract's phytochemical composition. It has the potential to be a natural nootropic because the benefits in cognitive performance were almost as great as those of piracetam. he biochemical analysis of oxidative stress markers in brain tissue supports the hypothesis that M. oleifera extract has the potential to mitigate oxidative damage in the brain, likely through its antioxidant properties. The markers measured in this study include Malondialdehyde (MDA), Superoxide Dismutase (SOD), Catalase (CAT), Glutathione (GSH), Nitric Oxide (NO), and protein carbonylation[20,21].

These markers are widely recognized as indicators of oxidative stress and neuronal damage. The study found that rats treated with Moringa oleifera extract significantly reduced MDA levels, suggesting that the extract effectively mitigates lipid peroxidation. The antioxidant enzymes SOD and CAT are critical in defending the brain against oxidative stress[22]. Treatment with *M. oleifera* extract significantly enhanced both SOD and CAT activities, suggesting that the extract may stimulate the brain's endogenous antioxidant defenses. Glutathione levels were also increased in rats treated with Moringa oleifera extract, indicating that the extract helps preserve the antioxidant capacity of the brain. The study also found that M. oleifera extract has anti-inflammatory properties, potentially mitigating the harmful effects of oxidative stress and inflammation.

The findings have significant implications for the use of M. oleifera as a potential therapeutic agent in the prevention and management of neurodegenerative diseases such as Alzheimer's disease,

Parkinson's disease, and Huntington's disease. The ability of M. oleifera extract to modulate oxidative stress markers suggests that it could play a role in protecting brain cells from oxidative damage, slowing disease progression, and improving cognitive function.

5. Conclusion

The present study demonstrates that the hydroalcoholic extract of *Moringa oleifera* fruit pods possesses significant nootropic activity, as evidenced by improvements in learning and memory in Wistar rats. The extract not only enhanced cognitive performance in the Morris Water Maze and Passive Avoidance Tests but also showed strong antioxidant potential by reducing lipid peroxidation (MDA) and increasing endogenous antioxidant enzyme levels (SOD and CAT). Additionally, the inhibition of acetylcholinesterase activity in the hippocampus suggests improved cholinergic function, a key mechanism in memory enhancement. The observed cognitive benefits are likely attributed to the synergistic action of bioactive phytochemicals such as flavonoids, alkaloids, saponins, and phenolic compounds.

These findings support the traditional use of *Moringa oleifera* in cognitive disorders and propose it as a promising natural candidate for the development of safe, effective, and affordable neuroprotective agents. To investigate its long-term benefits, identify certain active ingredients, and confirm its effectiveness in pathological models of cognitive decline, more research is necessary.

References

1. Newman DJ, Cragg GM. Natural products as sources of new drugs over the nearly four decades from 01/1981 to 09/2019. *J Nat Prod*. 2020;83(3):770–803. doi:10.1021/acs.jnatprod.9b01285
2. Sarris J, McIntyre E, Camfield DA. Plant-based medicines for anxiety disorders, part 2: a review of clinical studies with supporting preclinical evidence. *CNS Drugs*. 2013;27(4):301–19. doi:10.1007/s40263-013-0059-9
3. Kumar S, Pandey AK. Chemistry and biological activities of flavonoids: an overview. *Sci World J*. 2013;2013:162750. doi:10.1155/2013/162750
4. Fahey JW. *Moringa oleifera* : A review of the medical evidence for its nutritional, therapeutic, and prophylactic properties. Part 1. *Trees Life J*. 2005;1(5):1–15. doi:10.1201/9781420039078.ch12
5. Anwar F, Latif S, Ashraf M, Gilani AH. *Moringa oleifera* : a food plant with multiple medicinal uses. *Phytother Res*. 2007;21(1):17–25. doi:10.1002/ptr.2023
6. Leone A, Spada A, Battezzati A, Schiraldi A, Aristil J, Bertoli S. *Moringa oleifera* seeds and oil: characteristics and uses for human health. *Int J Mol Sci*. 2016;17(12):2141. doi:10.3390/ijms17122141
7. Verma AR, Vijayakumar M, Mathela CS, Rao CV. In vitro and in vivo antioxidant properties of different fractions of *Moringa oleifera* leaves. *Food Chem Toxicol*. 2009;47(9):2196–201. doi:10.1016/j.fct.2009.06.005
8. Rockwood JL, Anderson BG, Casamatta DA. Potential uses of *Moringa oleifera* and an examination of antibiotic efficacy conferred by M. oleifera seed and leaf extracts using crude extraction techniques available to underserved indigenous populations. *Int J Phytothearpy Res*. 2013;3(2):61–71.
9. Saleem S, Muhammad G, Hussain MA, Bukhari SNA. A comprehensive review of pharmacological and toxicological properties of *Moringa oleifera* . *J Pharm Investig*. 2016;46(4):363–76. doi:10.1007/s40005-016-0240-5
10. Caceres A, Saravia A, Rizzo S, Zabala L, De Leon E, Nave F. Pharmacological properties of *Moringa oleifera* . 1: Preliminary screening for antimicrobial activity. *J Ethnopharmacol*. 1991;33(3):213–6. doi:10.1016/0378-8741(91)90078-R
11. Yuliani SH, Martien R, Ilyas S, Khairunnisa S, Lestari K. Neuroprotective effect of *Moringa oleifera* leaves extract against glutamate-induced toxicity in human neuroblastoma SH-SY5Y cells. *Heliyon*. 2022;8(2):e08925. doi:10.1016/j.heliyon.2022.e08925

12. Jaiswal D, Rai PK, Mehta S, Chatterji S, Shukla S, Watal G. Role of *Moringa oleifera* in regulation of memory and spatial learning in rats. *Indian J Exp Biol*. 2009;47(11):849–56.
13. Bais S, Singh GS, Sharma R. Anti-inflammatory and neuroprotective effects of *Moringa oleifera* in Alzheimer's disease model: an evidence-based review. *J Herb Med*. 2017;10:1–9. doi:10.1016/j.hermed.2017.06.002
14. Buraimoh AA, Ojo SA, Hambolu JO. Effects of *Moringa oleifera* seed oil on brain histology of Wistar rats. *J Med Plants Res*. 2011;5(15):3426–30. doi:10.5897/JMPR11.240
15. Chumark P, Khunawat P, Sanvarinda Y, Phornchirasilp S, Morales NP, Phivthong-Ngam L, et al. The in vitro and ex vivo antioxidant properties, hypolipidemic and antiatherosclerotic activities of water extract of *Moringa oleifera* Lam. leaves. *J Ethnopharmacol*. 2008;116(3):439–46. doi:10.1016/j.jep.2007.12.010
16. Afzal M, Kazmi I, Anwar F, Ahamad J, Alam J, Ahmed S, et al. Effect of *Moringa oleifera* on the memory of mice. *Vet World*. 2012;5(9):557–60. doi:10.5455/vetworld.2012.557-560
17. Pandey A, Rizvi SI. Protective effect of *Moringa oleifera* leaf extract on arsenic-induced neurotoxicity in rat brain. *J Appl Biomed*. 2017;15(1):58–64. doi:10.1016/j.jab.2016.07.001
18. Cummings J, Lee G, Ritter A, Sabbagh M, Zhong K. Alzheimer's disease drug development pipeline: 2020. *Alzheimers Dement (N Y)*. 2020;6(1):1-10. doi:10.1002/trc2.12033.
19. Hossain MS, Ahsan H, Khan MR, et al. Moringa oleifera: A potential source of novel therapeutic agents for oxidative stress and neuroinflammation. *Antioxidants (Basel)*. 2021;10(2):217. doi:10.3390/antiox10020217.
20. Kamboj A, Singh S, Sandhu P, Saini K. Antioxidant and neuroprotective effects of Moringa oleifera: A systematic review. *J Ethnopharmacol*. 2018;221:105-113. doi:10.1016/j.jep.2018.04.033.
21. Perez-Vizcaino F, Duarte J, Visioli F. Flavonoids and cardiovascular risk factors: The case of Moringa oleifera. *Molecules*. 2020;25(17):3921. doi:10.3390/molecules25173921.
22. Sharma R, Prakash A, Singh AK. Moringa oleifera: A review on its medicinal properties. *Pharmaceutica Analytica Acta*. 2014;5(10):1-10. doi:10.4172/2153-2435.1000319