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Research Article

Comparative Analysis of *Prunus Armeniaca* (L.) And *Murraya Paniculata* (L.) For Their Phytochemical Profile, Cholinesterase Inhibitory Activity and Memory Enhancement Potential

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ABSTRACT
Introduction: The goal of the current study was to evaluate the memory enhancement effectiveness of crude extract of the kernels and leaves of *Prunus armeniaca* (L.) and *Murraya paniculata* (L.).
Methods: Amnesia was induced using the scopolamine-induced amnesia paradigm. Memory enhancement was assessed using the Morris water maze (MWM) and the passive avoidance test (PAT). The total phenolic and flavonoid content were determined using the Folin-Ciocalteu assay and aluminium chloride (AlCL3). Both plants' methanolic extracts were evaluated for anticholinesterase activity using Ellman's spectrophotometer.
Results: Preliminary phytochemical analysis of three different plant extracts showed the existence of tannin, phenolic compounds, glycoside, alkaloids, terpenoids, flavonoids, and saponins. Significant findings were attained by ethyl acetate and methanolic extracts. Methanolic extract revealed high TPC and TFC values, further methanolic extract of *Prunus armeniaca* (200mg/kg p.o.) showed the strongest memory enhancement activity on scopolamine (0.3mg/kg i.p.) induced amnesia model, parameters like Escape latency time (ELT), delay in entering the shock-free zone (SFZ) (sec). *P. armeniaca* methanolic extract (90.47 ± 0.459) at 320 g/ml concentration was shown to be potent. Inhibitory concentration (IC50) data from *P. armeniaca* and *M. paniculata* extracts show that the strongest AChE inhibition activity was exhibited by *P. armeniaca* methanolic extract (IC50 = 20.14 g/ml), followed by *M. paniculata* methanolic extract (IC50 = 68.43 g/ml) when compared to galantamine (IC50 = 7.63 g/ml).
Discussion: The current study demonstrates that PA therapy enhances memory consolidation and provides evidence that it may potentially enhance memory retrieval in a task designed especially to evaluate the memory system. Therefore, *Prunus armeniaca* may be a viable option for treating amnesia and cognitive impairment.

KEYWORDS: Leaves and kernels, Extract, Memory enhancement activity, Phytochemicals, MWM.

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1. INTRODUCTION

The ability to perceive sensory inputs, happenings, information, etc., store them for a brief or extended length of time, and then retrieve the unchanged information later, whenever necessary, is known as memory. The process of creating and retaining memory depends upon synaptic plasticity via long-term potentiation, which in turn is affected by several circumstances, including as growing older, genetic factors, illnesses like Alzheimer's, stroke, vitamin deficiencies, and environmental influences, etc. Dementia is the term used to describe a reduction in brain activity related to memory processing. It may have several causative factors ranging from aging, strokes, neurological issues such as Parkinson, Alzheimer's disease, multiple sclerosis, Huntington's disease, and progressive supranuclear palsy [1,2]. The effects of ageing, stress, and emotions include high BP, memory loss, anxiety disorder, amnesia, and dementia. The two primary types of memory are short-term memory (STM) and long-term memory (LTM). Short-term memory is a fragile system where information is stored for only a brief period, typically lasting a few seconds or minutes. However, through practice and repetition, STM can be improved, and the more frequently information is rehearsed, the more likely it is to be transferred to long-term memory. Long-term memory, on the other hand, stores information for much longer periods. Within LTM, there are different types of memories, including episodic memories (EM), which are personal recollections of specific events that occurred at particular moments in time. Semantic memories (SM) refer to factual information, such as the names of planets or the color of someone's hair, which are not tied to a specific time or place. Lastly, procedural memory (PM) involves habits and skills that are so well-learned they can be performed without conscious thought [1].

Nootropics or smart drugs are substances used to improve cognitive function by virtue of the cognitive benefits they produce such as augmenting the level of neurotransmitters, improving brain oxygen supply, or promoting neuroregeneration. With an equal increase in life expectancy, the prevalence of dementia and age-related brain diseases is sharply rising. According to estimates, 50–60% of dementia cases in those over 65 are caused by Alzheimer's disease, a complex, multivariate, progressive, neurological illness that mostly affects the elderly. Besides this, the persistent demand for better intellectual performance in this competitive age has compelled people to use such medicines which could improve cognitive functions[1]. Most pharmaceuticals currently in use are derived from plants, as are most medicines. Because they are readily available, the plant's therapeutic uses are efficient, affordable, and safe[2]. Herbal drugs have been always in high demand for various therapeutic purposes due to their lower cost, effectiveness, and lesser side effects. Uses of herbal nootropics are also not an exception to this. Plants such as Centella asiatica, Bacopa monniera, Hypericum perforatum, Terminalia chebula, and Curcuma longa are scientifically proven for their beneficial effects on cognitive functions. Thus, it is quite worthwhile to explore other natural nootropic agents to widen the choice of people for herbal nootropics[2]. A substance that improves focus and memory is called a cognitive enhancer[3]. The first synthetic cognitive enhancers to be widely used were amphetamines. The word "nootropic" refers to substances that are designed to enhance learning and memory abilities. These substances are known to increase the brain's resistance to conditions that can disrupt memory, such as hypoxia and electroconvulsive shock. Additionally, nootropics are believed to protect the brain from various chemical or physical injuries, including those caused by substances like barbiturates, scopolamine, or aluminum chloride. They also work by improving the efficacy of tonic cortical and subcortical control mechanisms. One of the key characteristics of nootropics is their exceedingly low toxicity and minimal side effects.

The term "smart medications" can refer to memory boosters, cognitive enhancers, and some nootropics. Some cognitive enhancers are there in the market, promise to boost mental functions like motivation, focus, attention, memory and cognition like some drugs, supplements, foods and neutraceuticals.[4]

Natural antioxidants found in plants include ascorbic a cid, tocopherol, carotenoids, flavonoids, and phenolic a cids[5,6]. Plants produce an extensive range of organic molecules; formerly, these compounds were referred metabolites, particularly flavanoid[7]. Flavonoids are the member of several types of plant polyphenols family, and a large number of flavonoids over 10,000 have been extracted and isolated from natural resources such as vegetables, plants and wines[8]. It has been observed in the studies that flavonoids have the potential to cross the blood brain barrier (BBB) indicates that these phytoconstituents may have a direct effect on the brain[9].

Many study articles have shown that flavanoids have a n important function in neurodegenerative illnesses, inc luding memory augmentation[10-16]. Plants are able to produce a wide range of secondary metabolites like phenolic compounds in response to adverse conditions such as intense light exposure, low temperature, pathogen infection and nutritional deficiency[17]. Polyphenols can permeate blood brain barrier, influence ageing processes due to their antioxidant, anti-inflammatory, and neuroprotective characteristics[18-20].

1.1 Current scenario:

Brain is the most intricately organ in the human body. Both neuropathological disorders and the ageing of the brain entail the process of neurodegeneration. More than 70% of the population in India takes herbal medicines to treat illnesses. The low cost of herbal medicine is a result of its accessibility. The value of using herbal remedies will grow in the future because they contain a variety of plants, minerals, and fungi that have not yet been fully investigated[21-23]. Plants are well known for their beneficial effect on cognitive functions. A high-level interest in herbal medicines has been also witnessed in the past decade. Neurological issues have traditionally been treated with herbal

medicine. Herbal medicines are an invaluable source of novel lead compounds due to the structural diversity of the phytoconstituents present in them. The newly discovered lead compounds can be a potential drug against therapeutic targets[24]. As herbal medication is less harmful and has fewer side effects, it will be the only form of healthcare used in the future meditation system. The bioactive extract needs to go through regulatory or limited animal safety tests[25, 26.] Approximately 25 to 50 percent of today's medications were first sourced from plants. A significant rise in scientific interest has been observed in recent years, in the identification and characterization process of new medicinal plants that can treat neurodegenerative illnesses and brain damage brought on by stroke. In previous studies it has been observed that more than 120 traditional medicinal plants used in the treatment of illnesses of the central nervous system (CNS) in Asian countries[27].

1.2 Murraya paniculata: orange jasmine, or Murraya paniculata, has long been used to cure a variety of conditions, including pain and inflammation, and is acknowledged for its medicinal qualities in Traditional Chinese Medicine (TCM)[28]. Its long history of use as a medicinal plant, which combines pharmacological effectiveness with cultural belief, supports its application in TCM[29]. Murraya paniculata has pharmacological characteristics that include antinociceptive, anti-inflammatory, and antioxidant effects. Because of these benefits, it's a useful part of Traditional Medicine (TM) for treating inflammatory diseases and osteoarticular problems[30].Such a wide range of biological activities highlight the plant's importance in TM as a medicinal agent[29]. Murraya paniculata is identified for its role in TM, particularly in relation to reproductive health. In traditional practices, it is often employed to facilitate abortion and manage reproductive conditions, making it a significant element in certain medicinal formulations. A notable fraction obtained from the plant, referred to as fraction G, has demonstrated free radical scavenging effects and the ability to inhibit cancer cell adhesion and migration, which suggests potential applications in cancer treatment [31].



Figure 1: Murraya paniculata (Orange jasmine)

1.3 *Prunus armeniaca*: *Prunus armeniaca* is primarily used in Traditional Medicine (TM) to nourish the lungs, relieve cough, and lubricate the intestines. The seeds, also known as "xing ren," are frequently utilized in remedies meant to relieve respiratory conditions like asthma and cough. They are frequently found in herbal mixes intended to improve lung function and are well known for their capacity to reduce coughs[32]. In TM, *Prunus armeniaca* can be prepared in several ways to harness its medicinal benefits. These preparations include decoctions, powders, confections or paste. Practitioners often create formulas using combined herbs, and *Prunus armeniaca* is frequently paired with the *Crataegus pinnatifida* (Hawthorn fruit), *Salvia miltiorrhiza* (Danshen), *Alisma orientalis* (Alisma), *Bupleurum chinense* (Chai Hu) and Cassia obtusifolia (Jian Ren Shen) [33]. The plant's long-standing use in herbal medicine is shown in the nearly 2,000-year history of Prunus armeniaca in TM. This solidifies its standing as a functional diet as well as a therapeutic agent in conventional medical procedures, demonstrating the breadth of TM's understanding of natural materials and their advantageous effects on health [34].

Both *Murraya paniculata* and *Prunus armeniaca* showcase the depth of Traditional Medicine (TM) in utilizing natural plants for their diverse therapeutic properties. Their distinct yet complementary benefits illustrate TM's comprehensive approach to health, integrating a wide range of medicinal plants to treat various ailments and enhance overall well-being.



Figure 2: Prunus armeniaca (Apricot)

2. MATERIAL AND METHODS

2.1 Plant material:

Murraya paniculata leaves were collected from the Govind Ballabh Pant University of Agriculture & Technology Pantnagar, Uttarakhand, INDIA. These were shade dried and their specimen sample (NISCAIR/RHMD/Consult/2021/4140-41-1) had been deposited in the CSIR-NISCAIR, New Delhi.

Kernels of *Prunus armeniaca* were collected from the Dhanachuli band, Uttarakhand, INDIA. The plant samples were dried under shade and their specimen sample (NISCAIR/RHMD/Consult/2021/4140-41-2) had been deposited in the CSIR-NISCAIR, New Delhi.

2.2 Extraction of plants:

Fresh fruits (*Prunus armeniaca*) were collected. They were brought to the lab, where the seed kernel was extracted by hammering the individual stones. The skin was then peeled off, the kernels were shade dried, and finally mechanically ground. The fresh leaves (*Murraya paniculata*) were collected. They were fetched to the laboratory and after shade drying of aerial parts of the plant for two weeks; it was crushed to make powder.

2.2.1 Cold Maceration: Plant materials were extracted by using the cold maceration method; after collection of plant samples (leaves and kernels) were washed, cleaned, and dried in shade properly. The plant material was processed into coarse powder form and then it was extracted over the course of 4-5 days using several organic solvents from non- polar to polar range respectively (petroleum ether, ethyl acetate, and methanol). Non- extractable components like cellular components and insoluble elements were removed by using filter paper.

The extract was then removed in a beaker and evaporated to remove the excessive moisture, and an airtight container was used to collect the extract[35].

Following equation was used to calculate extraction yield of all extracts:

$$\text{Percentage Yield (\%)} = \frac{\text{Actual yield} \times 100}{\text{Theoretical yield}}$$

2.3 Qualitative Phytochemical Estimation of Extracts:

To determine the presence of various phytoconstituents, thorough phytochemical testing was carried out i.e., carbohydrates, proteins, alkaloids, flavonoids, saponins, glycosides, amino acids, terpenoids, steroids, tannins, and phenolic compounds in extracts by using standard procedures[35].

2.3.1 Spectrophotometric Quantification of Total Phenolic Content (TPC):

The Folin-Ciocalteu Assay was performed to estimate the TPC in the plant extract. The combination of reaction mixture was prepared using extracts with 2.5 mL of the Folin-Ciocalteu Reagent, 2 mL of 7.5% sodium carbonate, and 0.2 mL of the stock solution. The final volume was making up by using distilled water up to 7 mL. Before the absorbance at 760 nm was measured spectrophotometrically, the resulting solutions were allowed to stand for 2 hours at room temperature (20 to 25^{0}C). Standard solutions containing mg/gm Gallic Acid Equivalent (GAE) were used to create calibration curves. Gallic acid was prepared at five increasing concentrations of 20, 40, 60, 80, and 100 g/mL, respectively. Polyphenols are among the reducing substances to which the Folin-Ciocalteu reagent is sensitive. Upon response, they give out a blue colour. Spectrophotometric analysis was used to measure this blue colour[36].

2.3.2 Spectrophotometric Quantification of Total Flavonoid Content (TFC):

The determination of TFC was done by using the Aluminum chloride (AlCL3) method[37]. 0.5 ml of the extract is combined with 2 ml of distilled water, followed by the addition of 0.15 ml of sodium nitrite (5%) and vigorous mixing. Next, add 0.15 ml of 10% aluminum chloride and leave it for approximately 6 minutes after the 6-minute interval. Consequently, 2 ml of sodium hydroxide (4%) was added. The mixture was shaken properly to mix it thoroughly. UV spectrophotometer was used to estimate the absorbance of the mixture was at 510nm. Standard solutions of Rutin Equivalent (GAE) mg/gm were used to compose

Calibration curves. Rutin was prepared at five concentrations of 20 to 100 g/mL. Total flavonoid content (TFC) was calculated using calibration curve end result expressed as mg of rutin equivalent per gram of dry extract weight[38.]

2.4 Acetylcholinesterase activity: Using a standardized spectrophotometric approach known as Ellman's method, different extracts have been evaluated for acetylcholinesterase inhibitory activity[39]. The acetylcholinesterase (Ache) enzymes hydrolyzes & degrade the substrate acetylthiocholine, resulting product is thiocholine, which further interacts with nitrobenzoate, which may be identified and detected at 412 nm. A test tube containing, 1710 µL of 50 mM Tris-HCl buffer (pH 8.0), 250 µL of plant extracts at concentrations ranging from 25 to 400 g/ml, 10 µL of 6.67 U/ml acetylcholinesterase enzyme, and 20 µL of 10 mM DTNB (5,5'-dithio-bis [2-nitrobenzoic acid]) in buffer were added. Stock solution of standard galathamine was prepared in same serial concentration as the test extract by dissolving in 50 mM Tris-HCl buffer (pH 8.0). The mixture was incubated for 15 minutes at a temperature of 37°C for 15. Subsequently, 10 µL of acetylthiocholine iodide (200 mM) in buffer was also added to the mixture, and the absorbance was measured in every 10 seconds for 3 minutes at 412 nm, against a blank sample containing buffer. The % acetylcholinesterase enzyme inhibition was calculated as shown below-

Percentage inhibition = 100 – (Change of sample absorbance / Change of blank absorbance) × 100.

The protocol for the experiment was followed in triplicate. Using MS Excel software, the percentage inhibition on the y-axis was plotted against the extract / fraction concentrations on the x-axis. The concentration of extracts or fractions that inhibit acetylcholine hydrolysis by 50%, expressed as an IC50 value. The IC50 values were derived from the plot's linear regression equation.

2.5 Assessment of learning and memory:

2.5.1 Drugs

Scopolamine served as the negative control. Piracetam was used as a positive control. The analytical grade compounds employed in the current investigation were all obtained from Merck and Sigma Chemical Co.

2.5.2 Animals used in the study.

The experimental protocol was approved by the Institutional Animal Ethical Committee (IAEC) of Raj Kumar Goel Institute of technology (Pharmacy) (Reg. no- 992/PO/RE/S/06/CCSEA) in accordance with the national guidelines on the use of laboratory animals with the protocol number: RKGIT/IAEC/2024/13.

A total number of 24 healthy Swiss albino mice weighing 30±5g grams were divided randomly into four groups. They were housed and kept in a controlled room temperature environment (22± 20C) and light with alternate 12-hour light/dark cycles. The animals had free access to rat pellets and water ad libitum.

2.5.3 Experimental design

For acclimatization, the animals were kept in a laboratory room for a week.4 groups of six animals each (n=06 animals) were formed from the animals. Amnesia was induced by intraperitoneal administration of scopolamine (0.3 mg/kg body weight) [40.] Piracetam (150 mg/kg body weight)[41] was used as the standard drug.

2.5.4Selection of Doses

The dose selection of various extracts was based on the data obtained by acute toxicity study according to OECD (423) guidelines, that is, 200mg/kg p.o. of both extracts. Scopolamine, piracetam and experimental drug solutions were prepared in distilled water.

2.5.5Model I: Morris water maze test:

Experiment set up: The Morris water maze (MWM) is a ring-shaped circular swimming pool. The water in the pool is opaque. The purpose of the extra-maze visual cues is to help rats or mice locate the concealed platform that is located just beneath the opaque water's surface and provides them with an escape route[42]. The MWM is used to assess spatial memory, which is susceptible to hippocampus loss, but the hidden platform variant of the MWM is a non-hippocampal task that is impacted by dorsal striatum lesions[43]. Additionally, there was anxiety that mice in the water maze may experience anxiety, indicating that the hippocampus and amygdala may both be involved[44]. The MWM test was used to measure the animals' capacity for memory and learning.

Four equally sized quadrants were created in the pool, and a platform (10.5 cm2) was submerged. In the middle of one of the quadrants, there was a circular pool with a diameter of 65 cm and a depth of 25 cm. The water in the pool was milky-opaque and about 20 cm deep. The pool was located in a test room, and the mice could use the exterior cues (such as images, fans, chairs, etc.) that were visible from the pool to help them navigate the maze. All of the study's animals were acclimated to the pool twenty-four hours before the start of training by allowing them to swim for 60 seconds without the platform.

On the first day of the experiment, animals engaged in 60 seconds of platform-free swimming practice. The mice underwent two trial sessions daily for the next five days on the following days. A single researcher who was unaware of the experimental settings recorded the swimming paths in all testing procedures on a map of the pool. Mouse escape latencies were timed for each experiment using a stopwatch, and the results were recorded. After locating the platform, the mouse was allowed to remain there for at least ten seconds. If the mouse did not find the platform within 90 seconds, it was gently placed there for 10 seconds before being taken out of the water. For a total of five days, the mouse had two daily trials with a 20-minute inter- trial break. The location of the platform for escape and the

mouse's point of entry into the maze changed every day, however they stayed the same between trials first and second. The mice were given test samples and standard each day. After 60 min, scopolamine (0.3 mg/kg body weight) was given intraperitoneally to induce amnesia in mice. Spatial memory was tested after 30 min of injection of scopolamine.

2.5.6 Model II: Passive avoidance test

Experiment set up: The apparatus was a perplex cage with a shock-free zone (SFZ, 2 x 3 x 1 cm) in the center that encircled the whole electrical grid. Individual animals have been transferred to the electric grid and given a minute to explore on day 7 after 20 minutes of treatment. The time it took (delay) to get to the shock-free zone (SFZ) was measured 3 times in a row after a stimulus of 20 V with an AC current of 5 mA and was taken as the baseline value. Scopolamine (0.3mg/kg) was administered to all groups after 30 min of drug treatment on the 7th day. Every animal was repositioned on the electrical grid, following the first trial, the animal's time to enter the shock-free zone (SFZ) and the mistakes (descents) it made within 15 minutes were noted and used as acquisition and retention criteria, respectively[45].

3 RESULTS

3.1 Qualitative Phytochemical Estimation of Extracts:

3.1.1 Qualitative Phytochemical Analysis of *Prunus armeniaca* (PA) extracts

The methanolic extract contains flavonoids, terpenoids, tannins, phenolic compounds, alkaloids, and saponins. Table No. 1 indicates that phenolic compounds, tannins, and flavonoids are present in ethyl acetate extract.

3.1.2 Qualitative Phytochemical Analysis of *Murraya paniculata* (MP) extracts

Carbohydrates, Alkaloids, terpenoids, Flavonoids, tannins and Phenolic Compounds, protein, and amino acids, glycosides present in the methanolic extract. Ethyl Acetate extract shows the presence of alkaloids, flavonoids, tannins, and phenolic Compounds as shown in table 1.

Table 1. Qualitative Phytochemical Analysis of *Prunus armeniaca* (PA) and *Murraya paniculata* (MP) extracts

S. No.	Experiment	Result					
		Pet. Ether Extract		Ethyl Acetate		Methanol	
		PA	MP	PA	MP	PA	MP
1.	Carbohydrates	-	-	-	-	-	+
2.	Alkaloids	-	-	-	+	+	+
3.	Flavonoids	-	-	+	+	+	+
4.	Terpenoids	-	-	-	_	+	+
5.	Tannins and Phenolic Compounds	-	-	+	+	+	+
6.	Protein and Amino acids	-	+	-	-	-	-
7.	Glycosides	+	-	+	-	+	+

3.2Quantitative Phytochemical Analysis of Extracts:

Extraction yield:

The percentages of yield for the leaf and kernel crude extracts of *M. paniculata* and *P. armeniaca* are shown in Table 2 for the three consecutive solvents (petroleum ether (C6H14), ethyl acetate (CH3CO2CH2CH3), and methanol (CH3OH), respectively). The *M. paniculata* leaf extracts in methanolic form yielded a greater percentage (6.027%) than the extract in ethyl acetate (2.57%). The leaf extract from Pet. Ether had the lowest yield, at 0.549 percent. The *P. armeniaca* ether extracts from kernels showed the highest yield (15.44%), while the ethyl acetate extract (11.48%) came in second. The extract from methanol kernels had the lowest yield, 4.43 percent.

Table No. 2 Percentage yield of *Murraya paniculata* and *Prunus armeniaca*

S. No.	Solvent used	Extract colour		Theoretical wt. in gms		Yield (gms)		Yield (%)	
		MP	PA	MP	PA	MP	PA	MP	PA
1.	Pet. Ether	Green	Yellow	262.19	402.17	1.44	62.12	0.549	15.44
2.	Ethyl Acetate	Green	Yellow	248.63	378.33	6.45	43.44	2.57	11.48
3.	Methanol	Green	Yellow	234.44	353.95	14.13	15.70	6.027	4.43

Total phenolic content (TPC)

The total phenolic content of the various *M. paniculata* leaf extracts ranged widely, from 18 to 124.0 mg GAE/100 g extract (Table 3). The methanolic leaf extract produced a higher total phenolic content (88 mg GAE/100 g extract) as compared to the other solvent extracts. The total phenolic content of the different *P. armeniaca* kernel extracts varied greatly, ranging from 127 to 430 mg GAE/100 g extract (Table No. 3). Compared to the other solvent extracts, the methanolic extract of the leaves and kernels showed a greater total phenolic content (400 mg GAE/100 g extract).

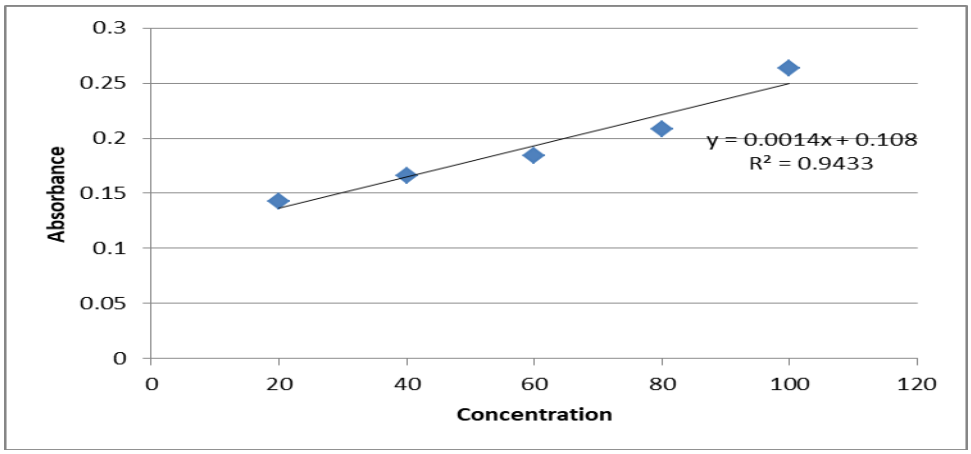


Figure 3: Graph depicting the Gallic acid standard curve.

Total flavonoids content (TFC): *P. armeniaca's* methanolic kernel extract had the highest concentration of total flavonoids (400 mg RE/100 g extract), followed by kernel ethyl acetate extracts (195 mg RE/100 g extract) (Table 3). It has also been noticed that the flavonoids content in methanolic and ethyl acetate extract of leaf extracts of *M. paniculata* was found to be 88.0 and 9.0 RE/100 g extract respectively.

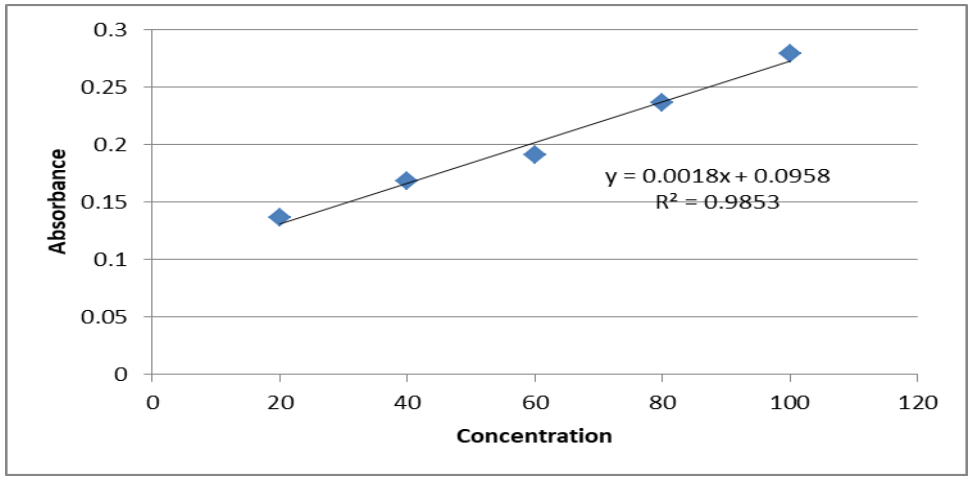


Figure 4. Graph depicting the standard curve of rutin.

Table 3. Total Phenolic Content (TPC) and Total Flavonoid (TFC) Estimation

Plant	Extract	Total phenolics (mg gallic acid equivalent/g)	Total flavonoid (mg rutin equivalent/g)
Murraya paniculata	**Ethyl acetate**	18.00	9.00
	Methanolic	124.00	88.00
Prunus armeniaca	**Ethyl acetate**	127.00	195.00
	Methanolic	430.00	400.00

1. Cholinesterase inhibition assay: Ellman's assay was used to test all substances for AChE inhibitory activity. Table 4 summarises the cholinesterase inhibitory activity of the synthesised compounds. Methanolic extract of *Murraya paniculata* showed inhibitory activity against the AChE in the range of 39.85 to 85.14% (Figure 4) while methanolic extract of *Prunus armeniaca* shows much better inhibitory activity against the AChE in the range of 46.78 to 90.47% (Figure5).

Determination of IC50

Extract of *Prunus armeniaca* shows most promising AChE inhibitory activity tested with IC_{50} value of 20.14 µg/ml (Table4)

Table 4. Acetylcholinesterase inhibitory activity of methanolic extract of selected plants.

Treatment	IC_{50} Values (µg/ml)
Galanthamine	7.63
Murraya paniculata	68.43
Prunus armeniaca	20.14

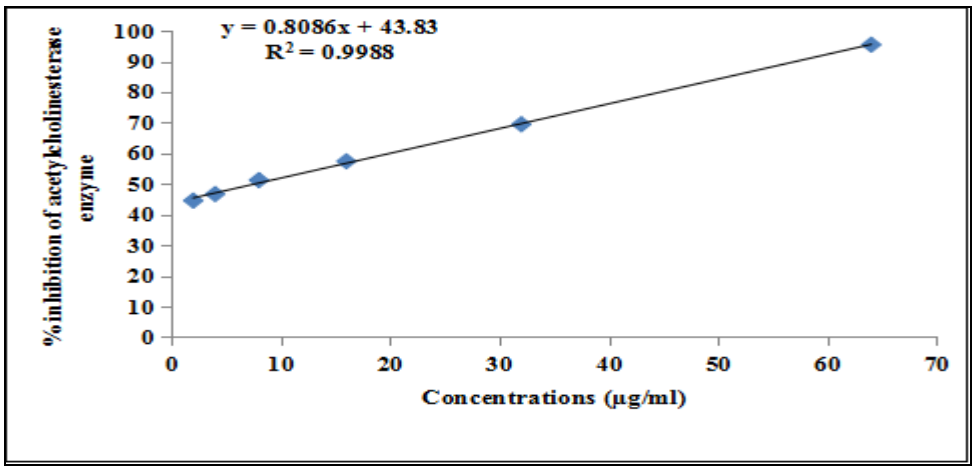


Figure 3. Percentage inhibition of acetylcholinesterase using galanthamine enzyme.

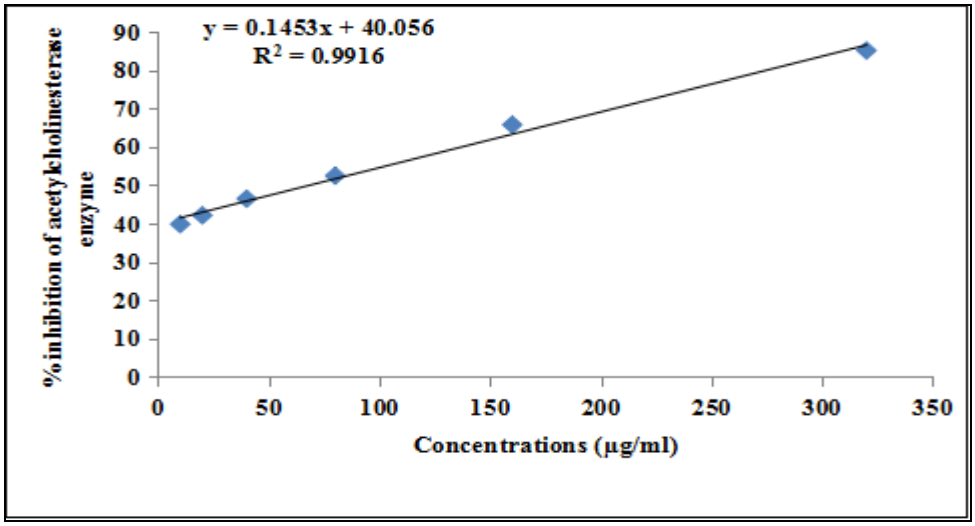


Figure 5. Percentage inhibition of acetylcholinesterase enzyme using methanolic extract of *Murraya paniculata.*

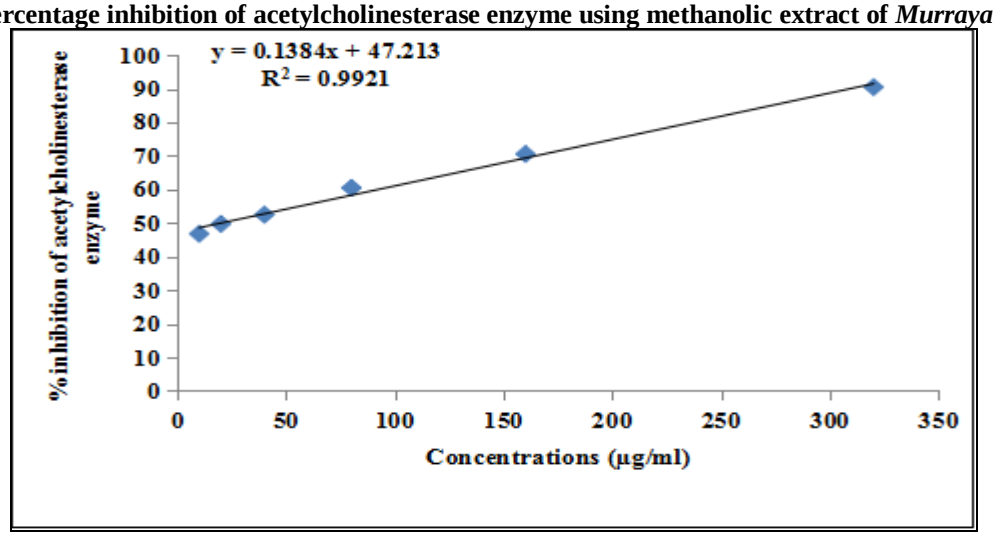


Figure 6. Percentage inhibition of acetylcholinesterase enzyme using methanolic extract of *Prunus armeniaca*

Assessment of learning and memory:

1. Morris water maze test: In the current study, the group administered with scopolamine showed escape latency for five more days in comparison to the control group. The extract-treated groups (PA and MP) shown in Table 5 decreased the escape latency time of mice (43.0±6.000 and 29.8±4.167) in MP and PA treatment prolonged by scopolamine administration. Piracetam, positive control, also significantly reduced escape latency time (18.5±3.271) on the 5th day. The current study demonstrates that PA treatment enhances memory consolidation and raises the possibility that it can potentially enhance memory retrieval in a task designed especially for the memory system (Figure 9).

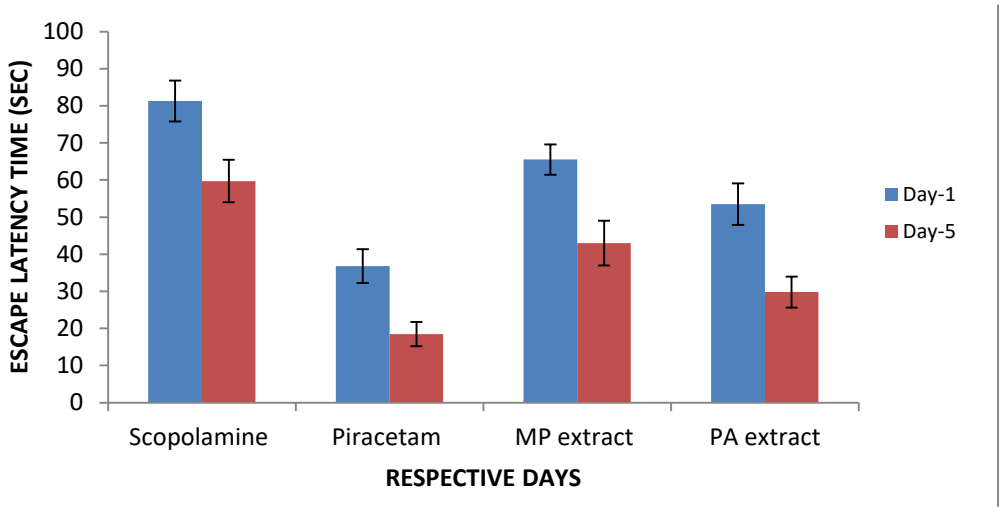


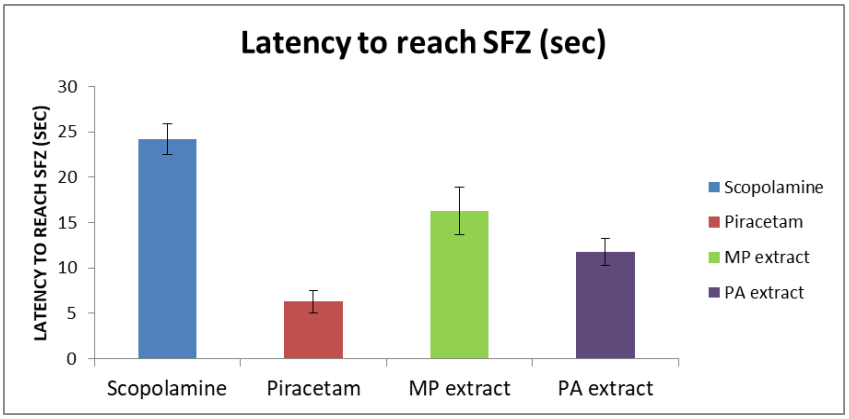
Figure 7. Morris water maze study of MP and PA treated sample in Scopolamine induced mice.
Values are in Mean±SD (n=6). *p<0.05 as compared to scopolamine-treated groups

Table 5. Morris water maze test of MP and PA treated sample in Scopolamine induced mice

Group	Treatment	Dose	Latency time (Sec.)	
			Day-1	Day-5
I	Scopolamine	0.3 mg/kg i.p.	81.3±5.502	59.7±5.715
II	Standard drug Piracetam	150 mg/kg p.o.	36.8±4.579*	18.5±3.271*
III	MP extract	200 mg/kg p.o.	65.5±4.087*	43.0±6.000*
IV	PA extract	200 mg/kg p.o.	53.5±5.612*	29.8±4.167*

Values are in Mean±SD, (n=6). *p<0.05 as compared to scopolamine-treated groups

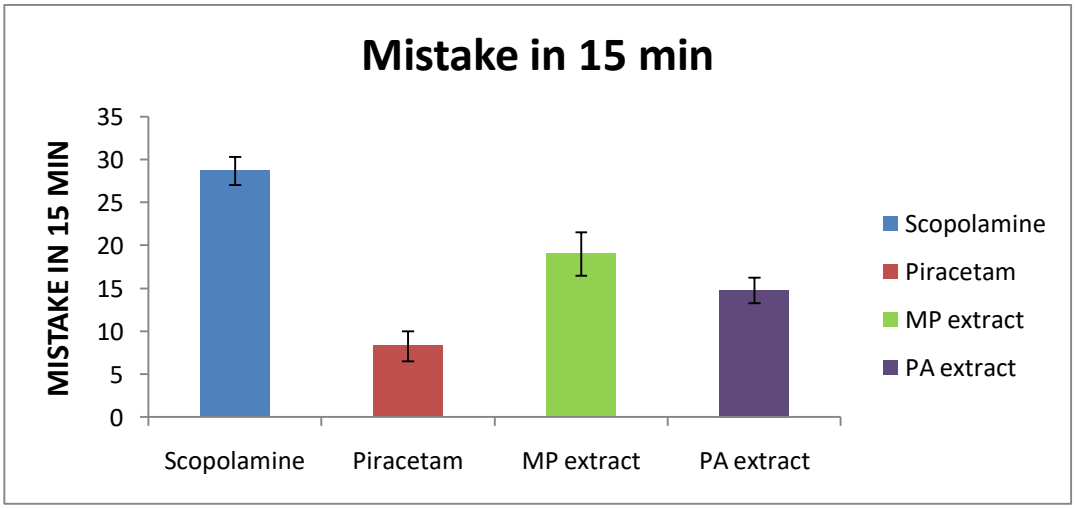
2. Passive avoidance test (PAT):
Latency to reach SFZ (sec): In the current investigation, it turned out that i.p. scopolamine considerably lengthened the latency to reach SFZ in the passive avoidance test (PAT) at a 0.3 mg/kg dosage, and this was taken as evidence of amnesia in mice. In comparison to scopolamine-treated mice, MP, and PA latency to reach SFZ was shown to be lower in both treatment groups of extracts (Table 6). Therefore, it was thought that extracts with a 200 mg/kg dosage would lessen cognitive impairment brought on by scopolamine injection. In the treatment groups using PA and MP extract, PA was discovered to be more efficient as shown in Figure 10, since latency to reach shock free zone (SFZ) was dramatically reduced contrasted to animals receiving MP.



Values are in Mean±SD (n=6). * p<0.05 as compared to scopolamine-treated groups

Figure8. Passive avoidance test (Latency to reach SFZ (sec) of MP and PA treated sample in Scopolamine induced mice.

Mistake in 15 minutes: In the current study, as discovered scopolamine considerably elevated mistakes in the passive avoidance test after 15 minutes at 0.3 mg/kg, intraperitoneally, and this was interpreted as a marker of cognitive dysfunction in mice. From tables and figures it is observed that in both treatment groups of extracts MP and PA, the mistake in 15 min. was found to decrease compared to animals given scopolamine. As a result, it was assumed that the extract would lessen cognitive impairment brought on by scopolamine injection. In PA and MP extract-treated groups, PA was found to be most effective (Figure 11) in mistake in 15 min. was considerably lower than in animals treated with MP; comparing Piracetam to the Scopolamine group, there was also a noticeable difference.



Values are in Mean±SD (n=6). * p<0.05 as compared to scopolamine-treated groups

Figure9.: Passive avoidance test Mistakes in 15 minutes (sec) of MP and PA treated sample in Scopolamine induced mice

Table 6. Passive avoidance test of MP and PA treated sample in Scopolamine induced mice

Group	Treatment	Dose	Latency to reach SFZ (sec)	Mistake in 15 min
I	Scopolamine	0.3 mg/kg i.p.	24.2±1.722	28.7±1.633
II	Standard drug Piracetam	150 mg/kg p.o.	6.3±1.211*	8.3±1.751*
III	MP extract	200 mg/kg p.o.	16.3±2.658*	19.0±2.53*
IV	PA extract	200 mg/kg p.o.	11.8±1.472*	14.8±1.472*

Values are in Mean±SD (n=6). * p<0.05 as compared to scopolamine-treated groups

2. DISCUSSION

To find and choose herbs for further experimentation and study, traditional medicinal literature might be consulted. Results demonstrated that extracts from *Prunus armeniaca* and *Murraya paniculata* exert significant memory enhancement activity against scopolamine-induced amnesia. Improvement in memory is a sign of structural and functional changes

in the hippocampus plastic, including the presence of phenolic and flavonoid content[46]. To confirm the role of phenolic and flavonoid content in memory enhancement activity, qualitative analysis estimation of total phenolic content or TPC and total flavonoid content or TFC by Folin-Ciocalteu Assay and Aluminium chloride method respectively has been performed. Exposure to scopolamine causes neuronal cell death. Scopolamine is a muscarinic ACh receptor antagonist by disrupting cholinergic neurotransmission, which can cause learning and memory deficits[47]**.** Acetylcholine is responsible for the regulation of cognitive functions by Couples by Gq/11 to activate the PLC-IP3-Ca2+-PKC pathway. The cholinergic system, which has a central action and is crucial for memory and learning, is kept at a constant level[48.] In previous research it is observed that *Prunus armeniaca* and *Murraya paniculata* shows acetylcholinesterase (AChE) inhibitory activity[49, 50]. The current study demonstrates that PA therapy enhances memory consolidation and provides evidence that it may potentially enhance memory retrieval in a task designed especially to test the memory system. Furthermore, it was discovered that *Prunus armeniaca*

worked best, as evidenced by a substantial decrease in latency to reach the SFZ when compared to mice treated with *Murraya paniculata* extract. *Prunus armeniaca* was also found to be most effective as the mistake in 15 min. was significantly decreased as compared to *Murraya paniculata* treated animals in the Passive avoidance test. The therapeutic efficacy of *Murraya paniculata*, in memory enhancement refers to its potential to improve cognitive functions, particularly memory, through its bioactive compounds such as flavonoids and polyphenols. *Murraya paniculata* contains various bioactive compounds, such as alkaloids, flavonoids, and essential oils, which have antioxidant and neuroprotective properties. These compounds could help protect neurons from oxidative stress and inflammation, two factors linked to cognitive decline and memory impairment. Study suggests that *Murraya paniculata* also influence the cholinergic system, which is crucial for memory and learning. The cholinergic system involves neurotransmitters like acetylcholine, which plays a central role in memory consolidation and retrieval. Enhancing acetylcholine levels could improve memory function. Studies on animal models have shown that extracts of *Murraya paniculata* may improve performance in memory-related tasks, suggesting that it may enhance short-term and long-term memory. For example, it could improve recall, recognition, and learning ability. *Prunus armeniaca* has better therapeutic efficacy as compare to *Murraya paniculata*. The higher values of bioactive compounds in prunus armeniaca, including flavonoids (TFC) and polyphenols (TPC), have neuroprotective effects that can help maintain brain health and enhance memory. These compounds may protect neurons from damage and promote the regeneration of brain cells. Also, *Prunus armeniaca* influence the cholinergic system much better as compared to other plant extract has better IC50 values. Thus, we suggest that *Prunus armeniaca* has better therapeutic efficacy than *Murraya armeniaca* in memory enhancement.

This study has some limitations *Prunus armeniaca* and *Murraya paniculata* extracts highlights their potential in memory enhancement but has several limitations. It primarily uses animal models, limiting the generalizability to humans. Overall, while preliminary studies and traditional uses suggest that these extracts may have therapeutic efficacy in enhancing memory and cognitive function, further clinical trials and research are needed to confirm these effects and understand the precise mechanisms involved. Long-term effects and dosage variations were not explored. The scopolamine-induced amnesia model may not fully reflect other forms of memory impairment, such as Alzheimer's disease. The study doesn't address confounding factors like environmental or genetic influences. Additionally, a small sample size may limit statistical robustness.

3. SUMMARY AND CONCLUSION

AChE is primarily linked to cognitive and memory deficits and scopolamine induction caused amnesia by raising the level of AChE. As compared to *Murraya paniculata*, *Prunus armeniaca* reversed scopolamine-mediated changes much better which were observed in terms of Escape latency time (ELT), latency to reach shock-free zone (SFZ), and Mistakes in 15 minutes in the Morris water maze (MWM) and Passive avoidance test (PAT) respectively. Therefore, *Prunus armeniaca* may be a viable option for treating amnesia and cognitive impairment.

4. DECLARATION OF INTEREST: None

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