Evaluation of Memory Enhancing Activity of Methanolic Extract of *Oxalis corniculata Linn* on Dementia in Experimental Animals

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Abstract—Dementia, a known mental disorder , characterized by loss of intellectual ability and thereby interfering with one's social and occupational activities; resulting in impairment of memory. Since the allopathic system of medicine is yet to provide a radical cure, the use of plants possessing nootropic activity have been practiced since ancient times in order to counteract the memory loss in many ways. Hence the present study aims to evaluate the memory enhancing activities of Methanolic extract of *Oxalis corniculata Linn* on dementia in experimental models.

Keywords — *Oxalis corniculata Linn*, dementia, memory, Morris water maze, Elevated Plus maze.

1 INTRODUCTION

DEMENTIA is defined as an acquired deterioration in cognitive abilities that impairs the successful performance of activities of daily living. Memory is the most common cognitive ability lost with dementia. In addition to memory, other mental faculties may be affected; these include language, visuospatial ability, calculation, judgement, and problem solving. Neuropsychiatric and social deficits also arise in many dementia syndromes, resulting in depression, apathy, hallucinations, delusions, agitation, insomnia, and inhibition. The single strongest risk factor for dementia is increasing age. There are many causes of dementia. The most common causes of dementia are Alzheimer's disease, Alcoholism, Parkinson's disease, Vascular dementia(multi infarct, diffuse white matter disease), drug/ medication intoxication [1].

Dementia represents a syndrome of deterioration of intellectual functions along with failing memory with little or no disturbances in the consciousness. It leads to the deterioration of the quality of life in elderly. A greater research in the early diagnosis of the condition and newer approaches to the development of drugs to prevent or halt the progression of the disease is of utmost importance[2]. Drugs and natural remedies have been tried to enhance memory in people. Thus it is important to explore new directions that would help to minimize the memory loss in dementia patients. Since the allopathic system of medicine is yet to provide a radical cure, the use of plants possessing nootropic activity have been practiced since ancient times in order to counteract the memory loss in many ways[3].

Oxalis corniculata Linn, a subtropical annual herb is well known for its traditional medicinal uses[4]. Oxalis corniculata linn is commonly known as creeping woodsorrel belonging to the family Oxalidaceae and genus Oxalis. It is commonly known as Indian sorrel in English, Tinpatiya in Hindi and saru Tengesi in Assamese. It is used traditionally as anti-inflammatory, digestive, diuretic, antibacterial, antiseptic, in cardiopathy, hepatopathy, dysentery, diarrhea and skin diseases. It is also used in dyspepsia, wound healing, cancer, piles, dementia and convulsions[5].

The study of the review of literature indicated that Oxalis coniculata linn has been used traditionally in the treatment of dementia and the presence of flavanoids, tannins, saponins, phenolic compounds etc. may have neuroprotective propensity[6]. But no study has been done till date. Hence the present study has been undertaken to study the neuroprotective and memory enhancing activities of MEOC. Piracetam was taken as the standard drug to compare the effects.

2 METHODOLOGY

The study was conducted in the Department of Pharmacology at Assam Medical College & Hospital , Dibrugarh after taking due approval from the Institutional Animal Ethics Committee.

2.1 Drugs and Chemicals Used In The Study

1) The drug Piracetam used in our study was obtained from Shine pharmaceuticals, Baroda Gujarat.
2) The drug scopolamine used in our study was obtained from Acme lifesciences, Ahmedabad India.
3) The drug corticosterone used in our study was obtained from Samrat Life Sciences Pvt Ltd, Mumbai,India.
4) Vehicle : Normal Saline (0.9% NaCl)
5) Methanolic extract of Oxalis corniculata Linn (MEOC): Methanol was obtained from HiMedia

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6) Distilled water.

2.2 Instruments Used In The Study

- Oxalis corniculata linn
- Methanol
- Soxhlet apparatus
- Electrical grinder
- Vacuum desiccators
- Glass petridishes
- Flask
- Air tight containers
- Elevated plus maze apparatus
- Morris water maze apparatus
- Stop watch
- Beakers
- Syringes
- Feeding needles

3 Experimental Animals Used In Teh Study

The study was carried out in healthy adult albino mice (Mus musculus) of either sex weighing 20-30 grams. The total number of animals used in our study was ninety. The animals were procured from Central Animal House, Assam Medical College. The animals were housed in standard cages under normal temperature and were maintained on balanced diet (consisting of Bengal gram, wheat, maize and powdered soya bean in sufficient quantity) and water was provided ad libitum during the entire period of the experiment.

The animals were housed in standard conditions with natural light and dark cycles. The study was duly permitted by the Institutional Animal Ethics Committee (IAEC) of Assam Medical College, Dibrugarh, Assam-786002 (Regd no 634/02/a/CPCSEA dated 19.05.2002) vide approval number (IAEC/AMC/02 dated 23/11/15). The study was conducted keeping in view with the CPCSEA (Committee for The Purpose of Control and Supervision of Experiments on Animals) guidelines.

The animals were allowed to acclimatize to the laboratory environment for 2 weeks and were provided water and food ad libitum.

4 Collection Of The Plant Material

The animals were allowed to acclimatize to the laboratory environment for 2 weeks and were provided water and food ad libitum.

5 Method Of Extraction Of The Methanolic Extract Of The Whole Plant Of Oxalis corniculata Linn [7]

The extract was prepared by using the Soxhlet apparatus and distillation apparatus .The whole plant of Oxalis corniculata linn was collected and dried in a drier table at room temperature. The dried plants were then grounded into powder in an electrical grinder. The finely grounded powder approximately 1450gm was extracted in 500ml of 99.8% methanol and then placed in a porous bag or "thimble" made of strong filter paper, which is then placed in a chamber of the Soxhlet apparatus for 16 hrs. The crude extract obtained was filtered through the whatman paper and the filtrate was evaporated. The extract was collected in glass petridishes, further dried in a vacuum desiccator and finally stored in air tight glass containers. In this way the procedure is repeated several times to yield 262 gm of methanolic extract of Oxalis corniculata linn (MEOC) which were further preserved in a sterile glass container at 4˚ until further use. The advantage of this method is that large amounts of drug can be extracted with a much smaller quantity of solvent.

6 Acute Oral Toxicity Test

Acute oral toxicity tests for the Methanolic extract of the whole plant of Oxalis corniculata Linn was carried out as per OECD Guidelines 425[8]. The limit test at 2000 mg/kg which required a total of 5 albino mice was used. The mice were fasted overnight prior to the experiment and their body weights were measured.A single dose of MEOC (2000 mg/kg body weight) was dissolved as 1ml/100 gm of body weight in Normal Saline and administered orally to the first animal with the help of a feeding tube. Food was withheld for further 3-4 hours. Based on its mortality or appearance of toxic signs and symptoms, the other four animals were dosed sequentially. The animals were observed individually at least once during the first 30 minutes after dosing, periodically during the first 24 hours (with special attention during the first 4 hours), and daily, thereafter, for a period of 14 days. Observations were done daily for changes in skin and fur, eyes and mucus membrane (nasal), respiratory rate, circulatory signs (heart rate and blood pressure), autonomic effects (salivation, lacrimation, perspiration, piloerection, urinary incontinence and defecation) and central nervous system changes (ptosis,drowsiness, tremors and convulsions). Body weights were determined weekly (Organization for Economic Co-operation and Development, 2008).

No sign of toxicity and mortality was recorded among the mice at the dose of 2000mg/kg (for the extract); hence arbitrarily 100mg/kg and 200mg/kg was selected for the study. A total of two doses was taken to see the dose dependent effect.

7 Phytochemical Analysis Of MEOC

Qualitative phytochemical analysis was carried out for MEOC as per the standard methods described by Prashant Tiwari et al[9]

8 EXPERIMENTAL PROCEDURES

8.1 Morris Water Maze Test (MWM)

Spatial memory and learning is analyzed by using the Morris Water Maze test. This paradigm is one of the "gold standards" of behavioural neuroscience. Animals are placed in a circular water pool that is coloured opaque with powdered non – fat milk, where they are allowed to swim to find a hidden escape platform. As they are in the opaque water, the animals cannot see the escape platform to find the escape route. As the animals become more familiar with the task, they are able to find the platform quickly. The Morris Water Maze test relies on distal cues to navigate from start locations around the perimeter of an open swimming pool to locate a submerged escape platform. By repeated trials, spatial memory is assessed and by the preference for the platform area, when the platform is absent, reference memory is determined[10].

Procedure: Morris Water Maze test is designed to evaluate the drugs acting on learning and memory and was devised by Prof Richard Morris[11]. Our experiment will be carried out by the modified procedure from Morris. The test apparatus consists of a circular pool (90 cm in diameter & 45 cm in height). The pool is filled with water to a height of 30 cm at room temperature and some milk was added to it. The pool is divided into four vertical quadrants. A white escape platform (6 cm in diameter & 29 cm in height) will be centered in one of the four quadrants of the pool and submerged 1 cm below the water surface so that it is invisible at water level.The first week of the experiment, the animals will be given a swimming training for 60 secs. All animals will be divided into five groups for 3 weeks treatment. In these days the mice will be given one session of two trials each for 21 days. In each training trial animals will be placed in into the pool and allowed to swim freely until they find the escape platform. During each trial, the mouse's escape latency will be measured with a stop watch and it will be recorded and will be used as a measure of the acquisition of the task. The parameter will be averaged for each session of trials and for each mouse. Once the mouse located the platform, it will be permitted to remain on it for 10 sec. If the mouse does not locate the platform within 120 sec, it will be placed on the platform for 10sec. The mice will be then turned to their home cage until the series of trials are completed.In the last day of training, mice will be given a probe trial which will consist of removing the platform from the pool and allowing the mice to swim for 60 sec in search of it. A record will be kept of the swimming time in the pool quadrant where the platform had previously been placed.

For all the test groups, MEOC was administered at doses of 100mg/kg and 200mg/kg per orally 30 min before corticosterone administration. The inducing drug Corticosterone was given at the dose of 5mg/kg injection subcutaneously. Piracetam (standard drug) was given 100mg/kg per orally, 30 min before corticosterone administration.

8.2 Groping And Treatment Schedule For Morris Water Maze Test

25 albino mice of either sex will be divided into 4 groups of 5 mice each. They will be treated as follows:

Group	Number of animals	Treatment
Group A (Normal control)	5	2 ml/kg Normal saline
Group B (Experimental Control)	5	5mg/kg Corticosterone
Group C(Test drug 1)	5	5mg/kg Corticosterone + MEOC 100 mg/kg
Group D(Test drug 2)	5	5mg/kg Corticosterone + MEOC 200 mg/kg
Group E (Standard drug)	5	5mg/kg Corticosterone + Piracetam 100 mg/kg

8.3 Elevated Plus Maze Test:

Principle: The Elevated Plus Maze test served as an exteroceptive behavioral model to evaluate memory and learning in mice[12].

Procedure: The Elevated Plus Maze test, developed by Pellow& File (1986) and modified by Kulkarni anxiogenic and anxiolytic drug effects in rodents. Furthermore, several investigators have attempted to use the influence of approach-avoidance conflict on time taken in their exploration of animals from open to closed arms, referred to as transfer latency(TL), as a parameter to assess consolidation or retrieval mechanisms of learning and memory. This approach was tested and validated for the study of nootropic and memory modulatory actions of drugs in animals. The Elevated Plus Maze test for mice consists of two open arms(16cm×5cm) and two covered arms (16cm×5cm×12cm) extended from a central platform (5cm×5cm), and the maze was elevated to a height of 25cm from the floor[13].

Mice will be divided into 5 groups consisting of 5 animals per group. Group 1 animals will be administered normal saline 10ml/kg and they will be treated as the normal control group. Group 2, animals will be administered with Scopolamine (0.4mg/kg ip)[14] and served as the experimental control group. Groups 3,4 will be treated with 1st and 2nd dose of MEOC mg/kg per orally respectively along with Scopolamine and it will be served as test groups. Group 5 will receive Piracetam (100mg/kg p.o)[14] with scopolamine and will be treated as standard group. All the extract & standard drug treated animals were subjected to scopolamine, 60 minutes after administration of extract & Piracetam, except the first group which served as normal control[15].

On the first day (i.e 8th day of drug treatment), each mouse will be placed at the end of an open arm, facing away from the central platform. Transfer latency (TL) is defined as the time taken by the animal to move from the open arm into one of the closed arms with all its four legs. TL will be recorded on the first day(training session) for

each animal. The mouse will be allowed to explore the maze for another 2 min and then to return to its home cage. Retention of this learned –task (memory) will be examined 24 hrs after the first day trial (i.e, 9th day, 24 hrs after last dose). Significant reduction in the TL value of retention will indicate improvement in memory[16].

8.4 Gruouping And Treatment Schedule For Eleveted Plus Maze Test:

25 albino mice of either sex will be divided into 4 groups of 5 mice each. They will be treated as follows:

Group	Number of animals	Treatment
Group A(Normal control)	5	10 ml/kg Normal saline
Group B(Experimental control)	5	0.4mg/kg Scopolamine
Group C(Test drug 1)	5	0.4mg/kg Scopolamine + MEOC 100 mg/kg
Group D(Test drug 2)	5	0.4mg/kg Scopolamine + MEOC 200 mg/kg
Group E (Standard drug)	5	0.4mg/kg Scopolamine + Piracetam 100 mg/kg

9 Statistical Analysis

The results were expressed as mean± S.E.M. The data were statistically analysed by using one way ANOVA followed by Dunnett's multiple comparison test using the graph pad prism and a P< 0.05 is considered significant.

10 Results

The phytochemical analysis of the MEOC revealed the presence of alkaloids, flavanoids, tannins, phenolic compounds, saponins, sterols, carbohydrates, proteins and amino acids.

TABLE 1
PHTOCHEMICAL ANALYSIS OF MEOC

PHYTOCHEMICALS	MEOC
ALKALOIDS	PRESENT
FLAVANOIDS	PRESENT
TANNINS/PHENOLS	PRESENT
SAPONINS	PRESENT
STEROLS	PRESENT
CARBOHYDRATES	PRESENT
GLYCOSIDES	PRESENT
PROTEINS	PRESENT
AMINO ACIDS	PRESENT

TABLE 2
MORRIS WATER MAZE TEST

GROUPS	ESCAPE LATENCY							
	0	3	6	9	12	15	18	21
GROUP A-Control (Normal saline 2ml/kg)	28.01±0.01	27.71±0.44	27.68±0.01	27.26±0.01	26.98±0.05	26.62±0.18	26.46±0.20	24.40±0.19
GROUP B-Experimental control (Corticosterone 5mg/kg)	35.01±0.01a	36.57±0.01a	37.14±0.23a	47.61 ±0.02a	48.08 ±0.02a	49.08±0.02a	49.32±0.04a	53.29±0.60a
GROUP C- TEST DRUG 1 (Corticosterone + MEOC 100mg/kg)	32.67±0.01	32.18±0.18	32.06±0.53	31.96 ±0.01b	31.63 ±0.10b	30.83 ±0.22b	30.53 ±0.11b	29.02±0.01b
GROUP D- TEST DRUG 2 (Corticosterone + MEOC 200mg/kg)	31.86±0.01	31.71±0.40	31.07±0.18	29.37 ±0.01b	29.14 ±0.03b	29.10 ±0.08b	28.50 ±0.23b	26.69±0.10b
GROUP E- STANDARD DRUG (Corticosterone + Piracetam 100 mg/kg)	29.61±0.01	29.54±0.01	29.24±0.07	29.08 ±0.00b	29.02 ±0.01b	28.72 ±0.01b	28.11 ±0.22b	26.41±0.02b
ONE WAY ANOVA F	9000	8959	8757	7800	3640	3335	3592	503.3
ONE WAY ANOVA Df	24	24	24	24	24	24	24	24
ONE WAY ANOVA P	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Values are expressed as MEAN ± SEM (n=5). One Way ANOVA followed by Dunnett's Multiple Comparison test is done between the groups. P < 0.05 is considered significant.

ap<0.05, when compared with the control group

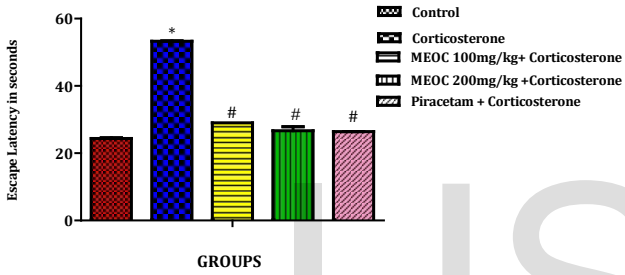
bp<0.05, when compared with the experimental control group(group B)

The Morris Water Maze test(MWMT), represents a versatile tool in which a number of different tasks can be measured. The simplest measure of performance is the latency to escape from the water onto the hidden platform[17]. The time taken to find the hidden platform i.e escape latency was measured with a stop watch and recorded during each trial. The parameter was averaged for each session of trials and for each mouse.

It can be seen from table 2 that the saline treated normal group mice rapidly learned the location of the submerged platform at 21st day than the zero day. In the corticosterone (5mg/kg subcutaneously) treated group, mouse's escape latency significantly increased($p<0.05$) from 0 to 21st day as compared to the control group indicating impairment of memory. MEOC (100 & 200mg/kg) showed significant decrease($p<0.05$) in the mouse's escape

latency in the 21 days study as compared to the corticosterone treated group suggesting improvement of memory. The standard drug piracetam also showed significant decrease($p<0.05$) in the escape latency when compared with the experimental control group. The mice treated with both the doses of MEOC, significantly found the platform earlier than the corticosterone treated group. However with the higher dose of the extract (200mg/kg), there was more decrease in the escape latency suggesting increased memory improvement as can be seen from the above table.

Figur-1 Shows the Escape Latency on the 21st day in MWMT



*p<0.05, when compared with the control group
#p<0.05, when compared with the corticosterone treated group

TABLE 3
ELEVATED PLUS MAZE TEST

Groups		Transfer latency in secs	
		Acquisition day 1	Retention after 24 hrs
GROUP A- Control (Normal Saline 10ml/kg)		42.55±0.10	38.80±0.16
GROUP B-Experimental control (Scopolamine 0.4mg/kg)		68.53±1.73a	68.26±0.22a
GROUP C-Test drug 1 (MEOC 100mg/kg + Scopolamine)		48.17±0.12b	41.09±0.01bc
GROUP D- Test drug 2 (MEOC 200mg/kg + Scopolamine)		47.51±0.09b	40.09±0.02bc
GROUP E-Standard drug (Piracetam 100mg/kg+ Scopolamine)		45.55±0.86b	39.39±0.24bc
ONE WAY ANOVA	F	170.4	269.1
	Df	24	24
	P	<0.05	<0.05

Values are expressed as MEAN ± SEM (n=5). One Way ANOVA followed by Dunnett's Multiple Comparison test is done between the groups. $p< 0.05$ is considered significant.

ap<0.05, when compared with the control group

bp<0.05, when compared with the experimental control group(group B)

cp<0.05, Paired t test done within the groups.

In the elevated plus maze test (EPM), the transfer latency time (TLT) taken by the mouse to move from the open arm to the covered arm with all its four legs in the elevated plus maze was noted. The mouse was allowed to explore the maze for another two minutes and then return to its home cage. After 24 hrs of acquisition trials, the transfer latency was again noted as an index of retrieval[18].

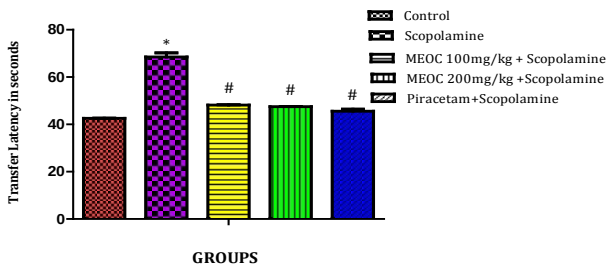
The effect of the vehicle, scopolamine (0.4mg/kg), MEOC(in the doses of 100mg/kg & 200mg/kg) and the standard drug piracetam, were evaluated on the 1st day and thereby after 24 hrs of administration of the drugs.

It can be seen from table 3 that the mean transfer latency for the control group, scopolamine treated, MEOC(100mg/kg) + scopolamine, MEOC (200 mg/kg) + scopolamine, and (Piracetam + scopolamine) treated groups were 42.55±0.10, 68.53±1.73, 48.17±0.12, 47.51±0.09 and 45.55±0.86 for the day 1 i.e in the day of acquisition of the trial, whereas after 24 hrs i.e in the day of retrieval the transfer latency was 38.80±0.16, 68.26±0.22, 41.09±0.01, 40.09±0.02 and 39.39±0.24 for the respective groups.

The transfer latency time (TLT) on the 1st day reflected the learning and behaviour of the animals, whereas the TLT on the 2nd day i.e after 24 hrs, reflected the retention of information and memory. Scopolamine treated group showed significant increase($p<0.05$) in the transfer latency values as compared with the control group indicating impairment of memory and learning in both the days. It can be seen from table 5.5 that MEOC at the doses of 100mg/kg and 200mg/kg orally demonstrated significant decrease ($p<0.05$) in transfer latency on acquisition as well as on retention of memory when compared to scopolamine treated group. Also it is seen that piracetam 100mg/kg showed significant decrease ($p<0.05$) in escape latency when compared to the amnesia induced by scopolamine. The mice treated with both the doses of MEOC, and the piracetam treated group showed significant retention of memory ($p<0.05$) after 24 hrs as compared to the first day.

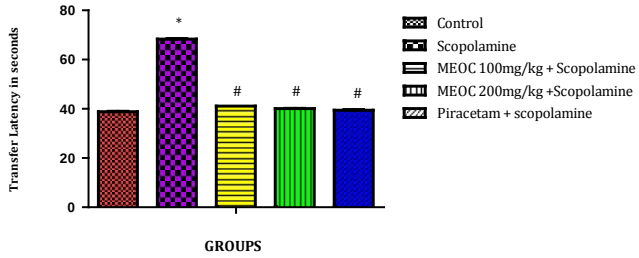
All the animals were healthy after the experiment and there were no deaths.

Figure 2 Shows Transfer Latency on day 1



*p<0.05,when compared with the control group
#p<0.5, when compared with the scopolamine treated group

Figure 3 Shows the Transfer Latency after 24hrs



*p<0.05, when compared with the control group
#p<0.05, when compared with the scopolamine treated group

11 DISCUSSION

The Morris water maze test is broadly used to evaluate the impact of medicines on memory and learning. The Morris water maze task was introduced as a spatial localization or navigation task. This task has been used widely to study the neurobiological mechanisms that underlie spatial learning and memory, age associated changes in spatial navigation and the ability of nootropic agents to influence the cognitive processes. In this model, a reduction in the escape latency (EL) and an increase in the time spent in the quadrant where the escape platform was kept show change of learning and memory i.e acquisition of the task and thereby its retention[19].

In the Morris water maze test, MEOC in both the doses showed significant decrease ($p<0.05$) in the escape latency from 0 day to 21st day to find the hidden platform as compared to the amnesia induced by corticosterone treated group. . In the corticosterone (5mg/kg subcutaneously) treated group, memory impairment increased from 0 to 21st day as compared to the control group. MEOC (100 & 200mg/kg) showed significant decrease ($p<0.05$) in the mouse's escape latency in the 21 days study as compared to the corticosterone treated group.. The standard drug piracetam also showed significant decrease ($p<0.05$) in the escape latency on corticosterone induced dementia. The mice treated with both the doses of MEOC, significantly found the platform earlier than the corticosterone treated group.

In the EPM test, the transfer latency is measured. MEOC at the doses of 100 & 200 mg/kg demonstrated significant decrease in the transfer latency ($p<0.05$) on acquisition as well as on retention, as compared to scopolamine treated group. Scopolamine treated group showed significant increase($p<0.05$) in the transfer latency values as compared with the control group indicating impairment of memory and learning in both the days. It can be seen from table 3 that MEOC at the doses of 100mg/kg and 200mg/kg orally demonstrated significant decrease($p<0.05$) in transfer latency on acquisition as well as on retention of memory when compared to scopolamine treated group. Also it is seen that piracetam 100mg/kg showed significant decrease ($p<0.05$) in escape latency when compared to the amnesia induced by scopolamine. The mice treated with both the doses of MEOC, and the piracetam treated group showed significant retention of memory ($p<0.05$) after 24 hrs as compared to the first day. Phytochemical analysis of the plant revealed the presence of flavonoids, saponins, tannins, phenolic compounds, glycosides, alkaloids, phytosterols, volatile oils, proteins and amino acids .

The probable mechanism of action which may be responsible for the above drug effect and also the phytochemicals responsible for the effect are discussed here under.

In the Morris water maze test and the Elevated plus maze test, the two groups of Methanolic extract of Oxalis corniculata linn (100 & 200 mg/kg) showed significant activity ($p < 0.05$) on memory impairment on corticosterone and scopolamine induced dementia as compared to the control group and only corticosterone/ scopolamine treated group. Also the standard drug piracetam showed significant ($p<0.05$) activity on corticosterone/scopolamine induced dementia.

As suggested from the phytochemical analysis, Oxalis corniculata linn is rich in flavonoids. Also methanolic extract of Oxalis corniculata Linn showed potent antioxidant activity as compared to the reference standard ascorbic acid[20]. Products of oxidative metabolism and other oxygen free radicals have shown to be neurotoxic. Flavonoids can effect the neurotransmitters and acetylcholinesterase activity in the brain of rodents treated with corticosterone and scopolamine[21]. The protective effect of MEOC may be attributed to the antioxidant property due to rich in flavonoids by virtue of which susceptible brain cells get exposed to less oxidative stress and thereby less brain damage leading to improvement in neuronal function which ultimately leads to enhancement of memory.

Thus it can be seen that methanolic extract of Oxalis corniculata Linn possesses significant memory enhancing activity and may prove to be effective in dementia and other related cognitive disorders.

12 CONCLUSION

Oxalis corniculata Linn was used traditionally as anti-inflammatory, digestive, diuretic, antibacterial, antiseptic, in cardiopathy, hepatopathy, dysentery, diarrhea and skin diseases. It is also used in dyspepsia, wound healing, cancer, piles, dementia and convulsions. It was also reported that Oxalis corniculata linn have hypoglycemic, antihypertensive, antipsychotic, nervous system stimulant & have chronotropic and inotropic effect.

Some phytochemical constituents present in Oxalis corniculata Linn like flavonoids, saponins, tannins, phenolic compounds and phytosterols were found to be responsible for the medicinal property of the plant. However, further research is necessary to gain a better understanding of its potential therapeutic action by isolating and identifying the phytochemicals responsible for the observed beneficial activities. There is also a need for fur-

ther studies on a molecular level for the evaluation of neuroprotective effect on depression and memory enhancing activities of Oxalis corniculata Linn on other animals and human beings that may provide definite data for its safety, efficacy, cost and also therapeutic use.

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