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Research Article

Evaluation of *Abelmoschus moschatus* seed extract in psychiatric and neurological disorders

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ABSTRACT

Background: *Abelmoschus moschatus* is an aromatic and medicinal plant, used as traditional medicine in the Thirunelveli district and distributed in many parts of Asia, including India. The present study was aimed to evaluate central nervous system (CNS) activities of ethanolic seed extract of *A. moschatus* (AEAM).
Methods: Oral administration of AEAM at doses of 200 and 400 mg/kg on various behavioral models forced swim, tail suspension, light-dark box, hole-board, elevated-plus-maze, locomotor, strychnine, maximal electroshock induced seizure, pentylenetetrazole (PTZ), rotarod, climbing an inclined screen models were utilized.
Results: In the open field test, AEAM (200 and 400 mg/kg) increased the numbers of rearing. However, the number of central motor and ambulation were reduced. The number of entries and the time spent in the open arm were increased, whereas the number of locomotion was decreased ($p<0.001$) in elevated-plus-maze and actophotometer test, respectively. AEAM (200 and 400 mg/kg) protected the mice against the PTZ and strychnine-induced convulsions; it causes significant dose-dependent increase in latency of convulsion. Treatment with AEAM reduced the duration of the tonic hind limb extension, increased the hypnotics time and decreased motor co-ordination of experimental animals.
Conclusion: This study concludes *A. moschatus* is an alternative source for CNS drug development.

Keywords: Anti-depressant, *Abelmoschus moschatus,* Muscle relaxant, Rotarod, Pentylenetetrazole

INTRODUCTION

In the world, 450 million people suffered from mental disorders also the particular global burden will be increased from 12.3 to 15% by 2020.[1] Depression are extremely dramatic and debilitating multifacetic disorders, which ranked as the fourth leading cause of mortality, disability and life threatening disease, characterized by a downcast mood, loss of pleasure, negative thoughts, disturbed sleep or appetite, low energy and suicidal ideations.[2] Several anti-depressant therapies aimed for enhance the neurotransmitter level and normalize the transmission.[3] Although majority of commercially available anti-depressant drugs have proven to be effective, but they caused adverse side-effects such as tiredness, blurred vision, weight gain, nausea, dry mouth, agitation fatigue and sexual dysfunction.[4] Anxiety is a high prevalent physiological state characterized by sympathetic hyperactivity, psychomotor tension, and vigilance syndrome.[5] Benzodiazepines, diazepam are used to treat anxiety disorders and causes adverse side-effects such as amnesia, sedation, changes in body weight and physical dependence.[6] Commercial drug benzodiazepines for insomnia have adverse effect viz., hangover, addiction and subsequent drug resistance. Even though, zolpidem, zopiclone and zaleplon are non-benzodiazepine, which is most recently permitted for the short-term executive of insomnia, also have side-effects such as headache, anxiety and wooziness.[7] Epilepsy associated with high rhythmic high frequency of impulses discharges by a group of neurons in the central nervous system (CNS). Researchers focused

their interest towards development of lesser side-effect drugs using plant system to overcome the above-mentioned problems. Currently used anti-convulsant drugs encompass the voltage triggered sodium and calcium channels, GABA transporters, GABA transaminase and $GAGA_A$ and glutamate receptors.[8] Therefore, there is a need for more efficacious and safer neurological disorder drugs.

Abelmoschus moschatus (L.) Medik syn. (Family: Malvaceae) is a prostate herb widely cultivated for its seeds and essential oil along the tropical regions of Asia, Africa and South America. The seeds traditionally used to treat neurodegenerative diseases, rheumatism, cystitis and diuretic.[9] Earlier, seeds of the study plant have been reported on anti-hysteric, hepato-protective, anti-oxidant, anti-spasmodic and anti-diabetic effect.[10] Phytochemical studies showed the presence of flavonoids, phenols, saponins, carbohydrates, terpenoids, myricetin, alkaloids and steroids.[11] Based on the issues, the present study aimed to evaluate anti-depressant, anti-convulsant, anxiolytic, hypnotic and muscle relaxant effect of *A. moschatus* seed extract using animal models.

METHODS

Plant material

Seeds of *A. moschatus* were collected from Thirunelveli district of Tamil Nadu, India during the month of January 2012. The plant was identified and authenticated by Botanical Survey of India, Tamil Nadu, Agricultural University Campus, Southern Regional Center, Coimbatore and (Voucher No.: BSI/SRC/562/23/2012-13/Tech) has been deposited in the herbarium for future references.

Extraction

The seeds were washed with double distilled water, shade dried and powered. 500 g of the powdered material of *A. moschatus* was extracted with 80% ethanol for 72 hr in a cold percolation method. After that the solvent was evaporated under pressure using rota vapour. Final dark gray residue was used to further experiment.

Drugs and chemicals

The experimental drugs imipramine, strychnine, pentalenetetrazole were obtained from Loba Chemie (Mumbai, India), diazepam (Roche, Mumbai, India) and pentobarbitone (Rhone-Poulenec, Mumbai, India). All other chemicals used were of analytical grade obtained from (Sigma Aldrich, USA).

Experimental animals

Swiss albino mice (18-22 g) and Wistar albino rats (180-220 g) were used for this study. The animals were procured from Central Animal House, I.R.T. Perundurai Medical College, Tamil Nadu, India. Animals were housed at a temperature of 24±2°C and relative humidity of 30-70% at 12:12 light:Dark cycle was followed. All animals were permitted to free access to water and pellet fed (M/s. Hindustan Lever Limited. Mumbai). The experimental events and protocols used in this study were followed by NIN and approved by the Institutional Animal Ethics Committee (Reg.No.:688/02/NCP/CPCSEA) of Nandha College of Pharmacy and Research Institute, Tamil Nadu, India.

Acute toxicity study

Acute toxicity of ethanolic extract of *A. moschatus* (AEAM) was evaluated according to the method described by an Organization of Economic Cooperation and Development Guideline 423.[12] The animals were kept fasting overnight. AEAM was administered orally at a dose of 5 mg/kg (0.5% carboxy methyl cellulose [CMC]) initially to separate groups of mice and mortality was observed for 3 days. If mortality was observed in 4/6 or 6/6 animals, then the dose administered was considered as a toxic dose. However, if the mortality was found in single mice out of six animals, then the dose was repeated with higher 50, 300, 500, 1000, and 2000 mg/kg b. wt. Control mice were given 10 ml/kg of water. Behavioral changes and mortality of experimental mice were observed for 24 hr. After that, continued observations were composed to the 14th day.

Treatment schedule

Twenty-four animals were subdivided into four groups of six animals each. Group 1, served as control, treated with 0.5% CMC solution (10 ml/kg); Group 2 treated with diazepam (1 mg/kg); Group 3 and 4 treated with AEAM by doses of 200 and 400 mg/kg respectively. The drugs were administered orally by suspend in 0.5% CMC 30 mins before the initiation of the experiment. Forced swim test (FST), imipramine (20 mg/kg) was used as the standard drug.

Anti-depressant activity

FST

FST is most widely used pharmacological model for assessing anti-depressant effect. The test was carried out according to a modification of the traditional method described by Porsolt et al. for rats.[13] The apparatus consisted of an opaque plexiglas cylinder (50 cm high×20 cm wide) filled with a 30 cm depth of water at room temperature. In the pre-test, female and male rats were placed in the cylinder for 15 mins, 24 hr prior to the 5 mins swim test. AEAM (200 and 400 mg/kg), imipramine (20 mg/kg) was administered i.p. 3 times: Immediately after the initial 15 mins pre-test, 6 and 0.5 hr prior to the swimming test. Increases in active responses, such as climbing or swimming, and reduction in immobility,

are thought as behavioral profiles consistent with an anti-depressant-like action.[14]

Tail suspension test

The tail suspension test was conducted in accordance with the method described by Steru et al.[15] The principle of this test is that suspending mice suspended upside down leads to characteristic behavior immobility, which resembles human depression. After oral administration of AEAM (200 and 400 mg/kg) mice were suspended on the edge of the table 58 cm above the table top by adhesive tape placed approximately 1 cm from the tip of the tail. Immobility duration was recorded for the last 6 mins period. Mice were considered immobile when they hanged passively and completely motionless. The decrease in immobility time priority with respect to vehicle-treated group was calculated.

Anxiolytic activity

Light-dark box test

The light/dark method, testing apparatus consist of the box (48 cm×28 cm×27 cm) was separated into two compartments with one-third of the box. The box constructs of black plexiglass with a bright fluorescent lighting. Mice can travel between compartments through an opening (7.5 cm) located at floor level in the center of the partition involving two compartments. The testing was initiated by placing the mouse into the white, aversive partition to increasing aversion to the light partition and to increase the sensitivity of measuring anxiety behavior and the time spent in the compartments were monitored for 5 mins.[16]

Elevated plus maze

The elevated plus maze test is the most extensively used of all currently accessible animal models of anxiety that depend upon the study of spontaneous behavior. The equipment comprised of two open arms (25 cm×10 cm) and two closed arms (25 cm×10 cm×20 cm) that extend from a familiar central platform (10 cm×10 cm) the entire maze was elevated to a height of 90 cm above the floor height. After treatment with AEAM (200 and 400 mg/kg), the animals were placed in the center of the elevated plus maze and noticed a number of open and closed arm entries and time spent on open- and closed-arm in the mice.[17]

Locomotor activity

The locomotor test is usually involved forced confrontation of a rodent with the situation. The testing apparatus consist of the box (48 cm×28 cm×27 cm) was separated into two compartments with one-third of the box. The box constructs of black plexiglass with a bright fluorescent lighting. Mice can travel between compartments through an opening (7.5 cm×7.5 cm) located at floor level in the center of the partition involving two compartments. The testing was initiated by placing the mouse into the white, aversive partition to increasing aversion to the light partition and to increase the sensitivity of measuring anxiety behavior and the time spent in the compartments was monitored for 5 mins.[16]

Hole-board test

The poking of the nose into a hole is the usual behavior of mice indicating the definite degree of curiosity. The equipment composed of a gray box (50 cm×50 cm×50 cm) with four equidistant holes 3 cm in diameter in the floor. The center of each hole was 10 cm from the adjacent wall of the box. The floor of the box was situated 15 cm above the ground and separated into squares of 10 cm×10 cm with a water challenging matter. After treatment with AEAM (200 and 400 mg/kg) animals were located in the center of the hole-board and allowed freely to explore the equipment for 5 mins. The number of heads dipping was recorded by visual examination. Head dip was scored if both eyes disappeared keen on the hole.[18]

Anti-convulsant activity

Pentylenetetrazole (PTZ) induced convulsions

PTZ induced seizure brushwood in rodents was considered a model of human absence epilepsy and myoclonic seizure. PTZ (95 mg/kg) was administered subcutaneously to induce a convulsion. AEAM (200 and 400 mg/kg) was given orally 30 mins prior to the administration of PTZ. After treatment, the animals were noticed for the duration of convulsion induced by PTZ were recorded.[19]

Strychnine induced convulsions

The convulsing exploitation of strychnine is due to interfering with post-synaptic inhibition mediated by glycine. The extract has quash the action of strychnine and exposed to have an anxiolytic property.[20] Strychnine (2 mg/kg) was administered intramuscularly to induce a convulsion. AEAM (200 and 400 mg/kg) was given orally 30 mins prior to the administration of strychnine. After treatment, the animals were observed for a period of convulsion induced by strychnine was recorded.[21]

Electro-shock induced seizure model

The electroshock attempt in mice is primarily used as a sign for extracts in grand mall epilepsy. AEAM (200 and 400 mg/kg) was administered orally to the animal 60 mins prior to the electro shock. The electroshock induced in

animals through passing a current of 45 mA for 0.2 sec duration through electro convulsion meter (Techno, India) using corneal electrodes. Followed by the treatment animals were noticed for the incidence and duration of extensor tonus was noted.[22]

Hypnotic activity

Pentobarbitone induced sleeping time

The test was used to reveal CNS active properties of extracts. Not only hypnotics, sedatives and tranquillizers but also anti-depressant in high doses is recognized to prolong barbiturates induced sleep following a single dose of pentobarbitone. The loss of righting reflexes was measured as a decisive factor for the duration of pentobarbitone induced sleeping time.[20] After treatment, the effects of AEAM (200 and 400 mg/kg) was recorded as follows: time beyond among the administration of pentobarbitone until loss righting reflex the sedative action was recorded as the time from the loss to its revival was measured as the duration of sleep.

Muscle relaxant activity

Rota-rod method

The test is used to evaluate the activity of AEAM (200 and 400 mg/kg) interfere with motor coordination. The equipment consists of a horizontal metal rod covered with rubber to 3 cm diameter attached to a motor with speed accustomed to 2 rotations/mins. The rod is 75 cm in length and is separated into six sections by plastic discs. This was allowed the concurrent test of six mice. The rod is at a height of about 50 cm above the table top in order to dispirit the animals from jumping off the roller. Cages below the sections provide to restrict the movements of the animals when they fall from the roller. The number of animals falling from the roller during this time was counted.[22]

Climbing test

The mice were formerly was formed to climb a chain of (6 cm long) floating from a clamp of a retort stand (100 cm above ground). Only those mice that climb the chain within 10 sec were selected for the test. After treatment with AEAM (200 and 400 mg/kg), experimentation took place for 10 mins, the climbing capability was observed.[23]

Inclined screen test

The inclined plane test is to determine the skeletal muscle relaxant activity. The plane consists of transparent glass were left on an inclined at 30°C. The mice, try to move out of the plane glass without sliding off, were used for the test. The investigation was made at 15-30 mins intervals, subsequent to the oral administration of AEAM (200 and 400 mg/kg). The mice were kept in the superior part of the inclined plane and are given 30 sec to hang on or to fall off.[23]

RESULTS

Acute toxicity studies

The AEAM did not produce any mortality orally up to 2000 mg/kg was observed for 5 hr after administration. There were not any visible signs of delayed toxicity and mortality observed for 14 days.

Anti-depressant studies

The effect of AEAM and imipramine was on active behaviors in the FST of rats. Treatment with AEAM (200 and 400 mg/kg) significantly shortened the immobility time in comparison to control values. This effect was associated with a significant increase in climbing behavior after AEAM administration of 200 and 400 mg/kg. Imipramine, a selective serotonin re-uptake inhibitor, markedly decreased the immobility time during the 5 mins test session while inducing a corresponding increase in swimming behavior. There was slight significant difference between the effects of AEAM and imipramine on the immobility time. The result of tail suspension test was shown in Table 1. A significant ($p<0.01$) decrease in the duration of immobility was seen with the standard drug imipramine and AEAM in all the tested doses as opposed to the control. AEAM in doses of 200 and 400 mg/kg produced a greater decrease in the

Table 1: Anti-depressant activity of AEAM using FST and tail suspension test.

Group	FST			Tail suspension test
	Immobilization time (sec)	Swimming time (sec)	Climbing counts (numbers)	Immobility time (seconds)
Control (0.5% CMC)	240.57±1.46	129.96±0.89	8.25±0.06	171.87±1.68
Diazepam (1 mg/kg)	178.93±1.63*	219.61±1.79*	4.11±0.05*	106.12±0.23*
AEAM (200 mg/kg)	250.60±1.31**	151.55±0.87**	8.12±0.05**	182.27±1.14**
AEAM (400 mg/kg)	238.35±0.77***	161.27±1.01***	7.78±0.10***	174.94±1.92***

The data represent the mean±SD (n=6). *p<0.05, **p<0.01 and ***p<0.001 significantly different compared to normal control. CMC: Carboxy methyl cellulose, AEAM: Activities of ethanolic seed extract of *Abelmoschu moschatus*. SD: Standard deviation, FST: Forced swim test

duration of immobility when compared to the standard drug imipramine.

Anxiolytic studies

Light-dark test measures were summarized in Table 2. Diazepam (1 mg/kg) and AEAM (200 and 400 mg/kg) significantly increased time spent in light arena 166.17±3.45 and 174.67±2.66, in dark 133.83±3.48 and 125.33±2.66. The number of crossings was considerably increased in diazepam (1 mg/kg), AEAM (400 mg/kg) compared to control group ($p<0.001$). Treatment with AEAM (200 and 400 mg/kg) to the rats causes the significant ($p<0.01$ and $p<0.001$) increases in the frequency of the open arm entries (Table 2). Significant and dose-dependent increase in the duration of time spent in the open arm were observed in AEAM (200 and 400 mg/kg) treated rats. Extract at doses of 200 and 400 mg/kg produce a low number of entries in the closed arm, whereas control (10 ml/kg) had the highest closed arm entry value of 11.38±0.29. The effects of AEAM (200 and 400 mg/kg) and diazepam resulted in significant increases in the total number of entries into the two arms ($p<0.01$ and $p<0.001$). In the hole board test, there was a significant decrease in the number of head dips 13.12±0.04 of diazepam (1 mg/kg), AEAM (400 mg/kg) compared with control group 2.07±0.03 to 6.25±0.07 ($p<0.001$) (Table 3).

Anti-convulsant studies

PTZ produced tonic seizures in the entire animals used. A dose of 100 mg/kg of AEAM protected 33.33% of the animals against seizures and did not affect the onset (latency) of seizures to any significant extent. AEAM the dose of 200 and 400 mg/kg protected 22.84±0.41 and 20.30±0.17 of the mice against seizures, and highly significant ($p<0.001$) increased the latency of the seizures. Strychnine elicited clonic convulsions in experimental animals. The normal control group produced convulsion and showed latency of 21.57±0.08 sec. AEAM (200 and 400 mg/kg) highly significant ($p<0.001$) delayed the duration of strychnine induced seizures from 50.75±0.25 sec in control to 22.55±0.32 and 20.23±0.10 sec, respectively and showed dose-dependent increase in the anti-convulsant activity. Similarly, diazepam 5 mg/kg pre-treatment increased the latency of strychnine induced seizures from 55.25±0.50 sec to 14.28 ±0.20 with 100% protection. Maximal electroshock produced hind limb tonic extension in all the animals. The vehicle-treated rats showed tonic hindlimb extension for the duration of 15.16±0.22 sec. Administration of AEAM (200-400 mg/kg) showed a dose-dependent increase in the delay of the onset time of seizures induced by maximal electroshock induced convulsion and also decreased duration of tonic hindlimb extension (Figure 1).

Table 2: Anxiolytic activity of AEAM (a) light-dark box test and elevated plus maze.

Group	Light-dark box test		Elevated plus maze			
	Time spent in light (sec)	Time spent in dark (sec)	Entries in open arm (sec)	Time spent in open arm (sec)	Entries in closed arm (sec)	Time spent in closed arm (sec)
Control (0.5% CMC)	110.33±1.37	189.67±1.37	3.07±0.03	71.07±0.70	11.38±0.29	219.73±9085
Diazepam (1 mg/kg)	180.33±1.63*	119.67±1.63*	12.09±0.08*	272.62±4.212*	2.11±0.05*	50.12±0.22*
AEAM (200 mg/kg)	146.33±2.94**	153.67±2.94**	6.88±0.08**	183.66±3.14**	5.51±0.06**	120.40±1.16**
AEAM (400 mg/kg)	150.83±1.47***	149.17±1.47***	7.10±0.03***	191.40±0.70***	5.13±0.04***	99.07±1.33***

The data represent the mean±SD (n=6). *$p<0.05$, **$p<0.01$ and ***$p<0.001$ significantly different compared to normal control.
CMC: Carboxy methyl cellulose, AEAM: Activities of ethanolic seed extract of *Abelmoschu moschatus*. SD: Standard deviation

Table 3: Anxiolytic activity of AEAM using locomotor and hole board test.

Group	Locomotor		Hole board	
	Rearing (numbers)	Crossing (numbers)	Head dips (numbers)	
			(30 mins)	(60 mins)
Control (0.5% CMC)	19.57±0.07	47.24±0.42	3.11±0.03	2.07±0.03
Diazepam (1 mg/kg)	26.30±0.42*	59.04±0.31*	11.10±0.04*	13.12±0.04*
AEAM (200 mg/kg)	19.62±0.10**	48.46±0.33**	8.15±0.13**	8.63±0.06**
AEAM (400 mg/kg)	20.23±0.11***	49.07±0.17***	9.10±0.02***	9.50±0.11***

The data represent the mean±SD (n=6). *$p<0.05$, **$p<0.01$ and ***$p<0.001$ significantly different compared to normal control.
CMC: Carboxy methyl cellulose, AEAM: Activities of ethanolic seed extract of *Abelmoschu. moschatus*. SD: Standard deviation

Hypnotic studies

The oral treatment of mice with AEAM (200-400 mg/kg) 1hr before the sodium pentobarbital injection did not modify the latency to induce sleep, but this treatment significantly increased duration of the hypnosis induced by the drug as described in Figure 2.

Muscle relaxant studies

Treatment with AEAM (200 and 400 mg/kg) showed highly significant reduction in the time spent on the rota rod test by the animals on revolving rod when compared with control ($p<0.001$). Diazepam also showed a highly significant effect when compared with control ($p<0.001$). Low dose of AEAM (200 mg/kg) was showed significant effect ($p<0.05$). The results of climbing test indicated the time taken to climb the chain was also found to be delayed in the AEAM treated groups ($p<0.01$ at 200 mg/kg and $p<0.001$ at 400 mg/kg) than the control (Table 4). Treatment with AEAM and diazepam decreased sliding time of experimental animals. The result obtained from both standard and AEAM treated groups was compared with the control group. The result from the rota rod, climbing and inclined test showed that the AEAM significantly reduced the motor co-ordination of the tested animals (Table 5).

DISCUSSION

Majority of the research concerned about the usage of plant secondary metabolites for therapeutic evaluation.[24] Owing to search for neurological and psychiatric pharmacotherapy towards plants has advancement due to their less side effect and tolerability.[25] In the present study, the AEAM has been investigated the central nervous disorders using experimental animals. The FST and tail suspension test model reduced the immobility time directly reflects the anti-depressant activity of the study plant in the experimental animal. Saba et al.[26] pointed the magnitude of anti-depressant effect of *Cassia occidentails* compared

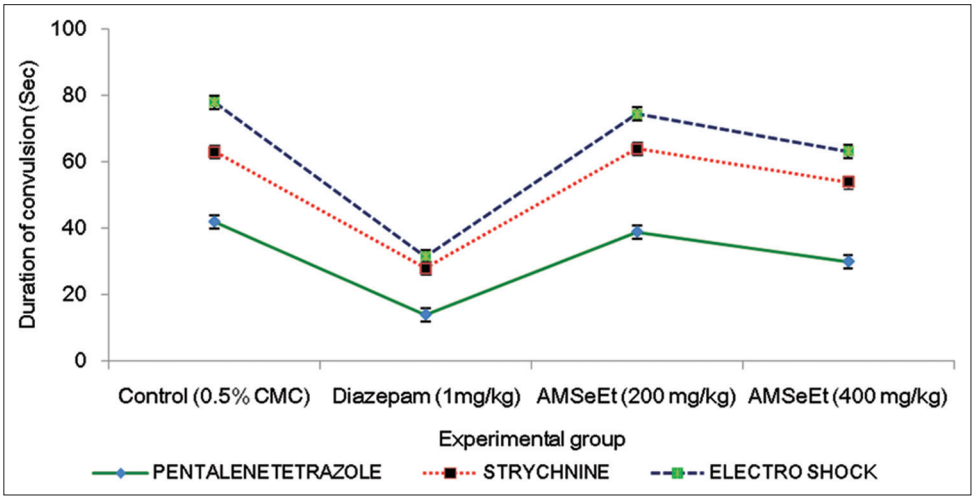

Figure 1: Effect of oral administration of activities of ethanolic seed extract of *Abelmoschus moschatus* on convulsion time in experimental animals. *p<0.05, **p<0.01 and ***p<0.001 indicate significant difference from control.

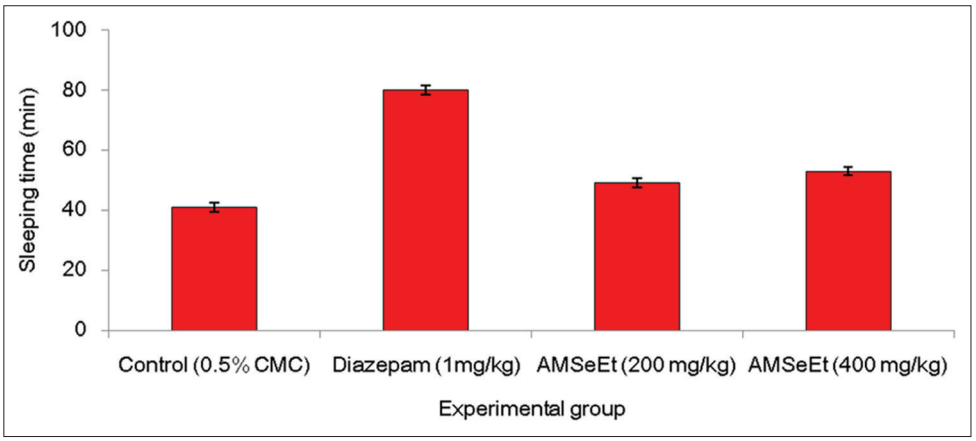

Figure 2: Effect of oral administration of activities of ethanolic seed extract of *Abelmoschus moschatus* on sleeping time in experimental animals. *p<0.05, **p<0.01 and ***p<0.001 indicate significant difference from control.

Table 4: Muscle relaxant activity of AEAM by rota rod method.

Group	Time taken to fall (min)				
	0 mins	30 mins	60 mins	90 mins	120 mins
Control (0.5% CMC)	178.16±0.19	178.15±0.29	177.65±0.42	177.47±0.09	175.41±0.11
Diazepam (1 mg/kg)	177.30±0.28*	35.16±1.26*	50.34±0.05*	92.34±0.22*	98.58±0.34*
AEAM (200 mg/kg)	174.40±0.11**	168.21±0.12**	180.64±0.48**	228.90±0.34**	239.98±0.45**
AEAM (400 mg/kg)	174.58±0.51***	160.59±0.50***	174.08±0.25***	212.31±0.13***	220.22±0.36***

The data represent the mean±SD (n=6). *p<0.05, **p<0.01 and ***p<0.001 significantly different compared to normal control.
CMC: Carboxy methyl cellulose, AEAM: Activities of ethanolic seed extract of *Abelmoschu moschatus*. SD: Standard deviation

Table 5: Muscle relaxant activity of AEAM by climbing and inclined screen test.

Group	Time taken for climbing (sec)		
	Climbing test		Inclined screen test
	30 mins	60 mins	
Control (0.5% CMC)	8.09±0.02	33.02±0.24	8.22±0.02
Diazepam (1 mg/kg)	18.19±0.12*	20.17±0.08*	21.20±0.44*
AEAM (200 mg/kg)	10.48±0.11**	9.16±0.06**	44.17±0.27**
AEAM (400 mg/kg)	11.40±0.11***	10.18±0.14***	39.13±0.06***

The data represent the mean±SD (n=6). *p<0.05, **p<0.01 and ***p<0.001 significantly different compared to normal control.
CMC: Carboxy methyl cellulose, AEAM: Activities of ethanolic seed extract of *Abelmoschu moschatus*. SD: Standard deviation

with fluoxetine treated group. In the present study, 400 mg/kg of AEAM was effectively reduced the immobility time without modifying swimming duration compared to the normal control.

The clear anxiolytic effect of AEAM extract has been observed by light-dark box test, locomotor, hole board and elevated plus maze model that has been frequently used to evaluate the anxiolytic properties of drugs. De Almeida et al.[27] observed the frequency and time spent in open arms were the major indexes of anxiety in plus maze model, given the fact that rodents are extremely aversive to an open area. In the present study, diazepam increased the number of entries and time spent in the open arms demonstrating the characteristic of synthetic anxiolytic drug benzodiazepines. AEAM has a selective anxiolytic effect with significantly modifying the locomotor activity. Similar results were observed in *Xeromphis niclotica*, *Palisota hirsute* extracts.[28,29] Engel speculated the sufferings of people with epilepsy and experienced seizure. 80% of the seizure could be controlled, fortunately millions of people have uncontrolled epilepsy.[30] PTZ, strychnine and electro-shock induced seizure model are effective to evaluate the anti-convulsant activity of plants and secondary metabolites. PTZ interacted with GABA neurotransmitters and its receptor complex to raise the seizure. The anti-convulsant activity of AEAM protect and significantly prolonged the onset of the seizure in mice against PTZ induced seizure by modifying excitatory and inhibitory neurotransmission through voltage gated ion channels, GABA (A) receptors and glutamate-mediated excitatory neurotransmission.[31] Selective competitive antagonist strychnine, blocks the inhibitory effect of glycine amino acids at all receptors.[32] AEAM treated animals increased the seizures onset significantly in a dose dependent manner which reflects its anti-convulsant activity. Similarly, ethanolic extracts were reported to reduce the hind limb extension and duration of convulsion compared to standard drug phenytoin and diazepam.[33] AEAM nearer to the action of diazepam which belongs to benzodiazepine group, it has a binding site on the GABA receptor type ionophore complex and decreases the activity.[34] The frequently employed prognostic test for asses the sedative-hypnotic properties is phenobarbitone-induced sleeping assays.[35]

Pre-treatment of experimental mice with AEAM showed dose-dependent reduction in latency time and effective sleeping duration in phenobarbitone induced sleeping time test. The reduction in the amplitude of motion might be attributed to sedative action of AEAM.[36] The whole part extract of *Boerhaavia diffusa* posed significant hypnotic activity through the GABAA-chloride ion channel complex prolongs pentobarbital induced sleep duration.[37] Therefore, an involvement of GABAergic system might be suggest for the drug development process.[38] Kumar mentioned diazepam act as an anxiolytic, anti-convulsant, produce sedation and myorelaxant effect.[39] It showed significant muscle relaxant activity in animals when treated with aqueous extract of *Sapindus trifoliatus*.[40] In the present study, the 1 mg/kg of diazepam were employed. Muscle relaxation effects of AEAM could be due to the interaction of flavonoids with the GABA/benzodiazepine receptor complex in the brain system.

CONCLUSION

AEAM possesses anti-depressant, anxiolytic, anti-convulsant, hypnotic and muscle relaxant activity.

Furthermore, the potential active components of AEAM will be isolated to determine the mode of action of *A. moschatus*.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Animal Ethics Committee

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