

PHYTOCHEMICAL CHARACTERIZATION AND ANTIEPILEPTIC EFFICACY OF LEAVES EXTRACT OF *DESMODIUM GANGETICUM*

Yash Pareek*, Satkar Prasad

RKDF School of Pharmaceutical Sciences, Bhabha University, Bhopal (M.P.)

*Corresponding Author's E mail: yashpareek01@gmail.com

Received 12 July 2026; Revised 15 July 2026; Accepted 28 August 2026, Available online 15 October 2026



Cite this article as: Pareek Y and Prasad S. Phytochemical Characterization and Antiepileptic Efficacy of Leaves Extract of *Desmodium gangeticum*, Asian Journal of Pharmaceutical Education and Research. 2026; 15(4): 26-36.

<https://dx.doi.org/10.38164/AJPER/15.4.2026.26-36>

ABSTRACT

Epilepsy is a chronic neurological disorder characterized by recurrent seizures and remains a major global health concern despite the availability of several antiepileptic drugs. The present study aimed to investigate the phytochemical composition and antiepileptic potential of the ethanolic leaves extract of *Desmodium gangeticum*. The leaves were extracted with ethanol, yielding 12.50% (w/w) extract. Preliminary phytochemical screening revealed the presence of alkaloids, flavonoids, phenolic compounds, carbohydrates, saponins, proteins, and diterpenes. Quantitative estimation showed total flavonoid, phenolic, and alkaloid contents of 0.72, 0.65, and 0.40 mg/100 mg of dried extract, respectively. The anticonvulsant activity of the extract was evaluated using pentylenetetrazole (PTZ)-induced and maximal electroshock (MES)-induced seizure models in experimental animals. In the PTZ model, the ethanolic extract significantly delayed seizure onset in a dose-dependent manner, with the 200 mg/kg dose increasing seizure latency to 212 ± 9.8 s and providing 71% protection compared to the PTZ control group. In the MES model, the extract significantly reduced the duration of tonic hind limb extension from 12.84 ± 0.42 s in the control group to 3.86 ± 0.21 s at the 200 mg/kg dose. Although the anticonvulsant activity was lower than that of the standard drugs diazepam and phenytoin, the extract demonstrated significant protection against chemically and electrically induced seizures. The observed pharmacological activity may be attributed to the presence of flavonoids, phenolic compounds, alkaloids, and other bioactive phytoconstituents with antioxidant and neuroprotective properties. The findings suggest that the ethanolic leaves extract of *Desmodium gangeticum* possesses promising antiepileptic potential and supports its traditional medicinal use. Further studies are required to isolate the active constituents and elucidate their mechanisms of action.

Keywords: *Desmodium gangeticum*; Antiepileptic activity; Phytochemical screening; Ethanolic extract; Pentylenetetrazole; Maximal electroshock; Flavonoids; Phenolic compounds; Alkaloids; Medicinal plants.

INTRODUCTION

Epilepsy is one of the most common chronic neurological disorders, affecting approximately 50 million people worldwide. It is characterized by recurrent, unprovoked seizures resulting from abnormal and excessive neuronal activity in the brain. Despite the availability of numerous antiepileptic drugs

(AEDs), a significant proportion of patients continue to experience uncontrolled seizures or develop adverse effects such as sedation, cognitive impairment, hepatotoxicity, teratogenicity, and drug resistance.^{1,2} These limitations have prompted increasing interest in the search for safer and more effective therapeutic agents, particularly those derived from medicinal plants with a long history of traditional use.³

Medicinal plants have served as valuable sources of bioactive compounds for the treatment of various neurological disorders. Plant-derived secondary metabolites, including flavonoids, alkaloids, phenolic compounds, terpenoids, glycosides, and saponins, possess diverse pharmacological activities such as antioxidant, anti-inflammatory, neuroprotective, and anticonvulsant effects.⁴ Many of these phytochemicals are known to modulate neurotransmitter systems, regulate ion channel activity, and reduce oxidative stress, thereby contributing to seizure control. Consequently, systematic phytochemical investigation and pharmacological evaluation of medicinal plants remain important approaches for the discovery of novel antiepileptic agents.⁵

Desmodium gangeticum (L.) DC., belonging to the family Fabaceae, is an important medicinal plant widely distributed throughout tropical and subtropical regions of India and Southeast Asia. The plant occupies a prominent position in traditional Ayurvedic medicine and is one of the constituents of the classical formulation *Dashamoola*. Different parts of the plant, including the roots and leaves, have been traditionally employed for the management of fever, inflammation, respiratory disorders, digestive ailments, rheumatism, nervous disorders, and general debility. Phytochemical investigations have revealed the presence of flavonoids, alkaloids, phenolic compounds, triterpenoids, saponins, tannins, and other biologically active constituents responsible for its diverse therapeutic properties. Previous pharmacological studies have demonstrated antioxidant, anti-inflammatory, analgesic, immunomodulatory, hepatoprotective, antimicrobial, and neuroprotective activities of *Desmodium gangeticum*, indicating its potential as a promising medicinal plant for neurological applications.^{6,7}

Oxidative stress has been recognized as a major contributor to the pathogenesis and progression of epilepsy. Excessive generation of reactive oxygen species during recurrent seizures leads to neuronal injury, mitochondrial dysfunction, and neuroinflammation, thereby aggravating seizure susceptibility.⁸ Phytochemicals with potent antioxidant activity, particularly flavonoids and phenolic compounds, can protect neuronal tissue by scavenging free radicals, preserving endogenous antioxidant defenses, and modulating inhibitory neurotransmission through the GABAergic system.^[9] These mechanisms suggest that plant extracts rich in such constituents may provide effective anticonvulsant activity with fewer adverse effects than conventional synthetic drugs.

The pentylenetetrazole (PTZ)-induced seizure model and the maximal electroshock (MES)-induced seizure model are well-established experimental methods for evaluating anticonvulsant activity. PTZ-induced seizures are primarily used to assess compounds effective against absence and myoclonic seizures through enhancement of GABA-mediated inhibition, whereas the MES model is widely employed to identify agents capable of preventing seizure propagation in generalized tonic-clonic epilepsy. Evaluation of plant extracts in both models provides a comprehensive assessment of their anticonvulsant potential.^[10]

Although *Desmodium gangeticum* has been extensively investigated for several pharmacological activities, scientific evidence regarding the antiepileptic potential of its leaves remains limited. Furthermore, correlation of its phytochemical composition with anticonvulsant efficacy has not been comprehensively explored.^[11] Therefore, the present study was undertaken to perform phytochemical characterization of the ethanolic leaves extract of *Desmodium gangeticum* through qualitative phytochemical screening and estimation of major phytoconstituents, including flavonoids, phenolic compounds, and alkaloids. The study also aimed to evaluate its antiepileptic efficacy using PTZ-induced and MES-induced seizure models in experimental animals. The findings of this investigation may provide scientific evidence supporting the traditional medicinal use of *Desmodium gangeticum* and contribute to the development of plant-based therapeutic agents for the management of epilepsy.

MATERIAL AND METHODS

Extraction by microwave-assisted extraction method

Following procedure was adopted for the preparation of extract from the shade dried and powdered herbs. Leaves of *Desmodium gangeticum* were shade dried at room temperature. 50 gram dried plant materials were coarsely powdered and subjected to extraction with petroleum ether by microwave-assisted extraction method.

The extraction was continued till the defatting of the material had taken place. Defatted dried powdered leaves of *Desmodium gangeticum* has been extracted with ethanol solvent using microwave-assisted extraction method for 48 hrs, filtered and dried using vacuum evaporator at 40°C^[12].

Determination of percentage yield

The extraction yield is evaluate of the solvent's efficiency to extracts bioactive components from the selected natural plant samples and it was defined as quantity of plant extracts recovered in mass after solvent extraction compared with the initial quantity of plant samples. After extraction, yield of the plant extracts obtained were calculated in grams and then converted it into percentage. The percentage yield of each extract was calculated by using following formula:

$$\text{Percentage yield} = \frac{\text{Weight of Extract}}{\text{Weight of powdered drug}} \times 100$$

Phytochemical screening

Phytochemicals encompass a wide range of chemical classes, including alkaloids, flavonoids, terpenoids, phenolic compounds, glycosides, and many others. Each class of phytochemicals may have specific physiological effects and potential health benefits. For example, flavonoids are known for their antioxidant properties, alkaloids often possess antimicrobial or analgesic properties, while terpenoids can have antitumor or anti-inflammatory effects. Phytochemical examinations were carried out for all the extracts as per the standard methods ^[13].

Estimation of total flavonoids content

Determination of total flavonoids content was based on aluminium chloride method ^[14]. Preparation of standard solution 10mg quercetin was weighed and made up to 10ml with Methanol in a 10ml volumetric flask. From the above solution (1mg/ml), 1ml was pipetted out and made up to 10ml with methanol to get 100µg/ml. Quercetin standard solution (stock solution). From the stock solution, solutions of concentration 5, 10, 15, 20 and 25 µg/ml were prepared. 3 ml of each standard and test was mixed with 1 ml of 2% Aluminium chloride solution. The solutions were mixed well and the absorbance was measured against the blank at 420nm using UV-Visible spectrophotometer. A standard graph was plotted using various concentrations of Quercetin and their corresponding absorbance.

Estimation of total phenol content

The total phenol content of the extract was determined by the modified folin-ciocalteu method ^[15]. 10 mg Gallic acid was dissolved in 10 ml methanol, various aliquots of 10-50µg/ml was prepared in methanol. 10mg of dried extracts were dissolved in 10 ml methanol and filter. Two ml (1mg/ml) of this solution was used for the estimation of phenol. 2 ml of each extract or standard was mixed with 1 ml of folin-ciocalteu reagent (previously diluted with distilled water 1:10 v/v) and 1 ml (7.5g/L) of sodium carbonate. The mixture was vortexed for 15s and allowed to stand for 15 min for colour development. The absorbance was measured at 765 nm using a spectrophotometer.

Estimation of total alkaloids content

10 mg extract was dissolved in 10 ml of 2N HCl and then filtered. 1 ml of this solution was transferred to separatory funnel and washed with 10 ml chloroform (3 times). The pH of this solution was adjusted to neutral with 0.1 N NaOH. Then 5 ml of BCG solution and 5 ml of phosphate buffer were added to this solution. The mixture was shaken and complex extracted with 1, 2, 3 and 4 ml chloroform by

vigorous shaking, the extract was then collected in a 10 ml volumetric flask and diluted with chloroform. Accurately measured aliquots (40, 60, 80, 100 and 120 µg/ml) of Atropine standard solution was transferred to different separatory funnels. Then 5 ml of pH 4.7 phosphate buffer and 5 ml of BCG solution was taken and the mixture was shaken with extract with 1, 2, 3, and 4 ml of chloroform. The extracts were then collected in 10 ml volumetric flask and then diluted to adjust solution with chloroform. The absorbance of the complex in chloroform was measured at spectrum of 470 nm in UV-Spectrophotometer against the blank prepared as above but without Atropine ^[16].

In vivo* antiepileptic activity of ethanolic extract of *Desmodium gangeticum

Adult male albino Swiss mice (20–25 g) were group housed (n=6–10) under a standard 12 h light/dark cycle and controlled conditions of temperature and humidity (25±2°C, 55–65%). Mice received standard rodent chow and water *ad libitum*. Mice were acclimatized to laboratory conditions for 7 days before carrying out the experiments. All the experiments were carried in a noise-free room between 08.00 to 15.00 h. Separate group (n=6) of mice was used for each set of experiments. The animal studies were approved by the Institutional Animal Ethics Committee (IAEC), constituted for the purpose of control and supervision of experimental animals by Ministry of Environment and Forests, Government of India, New Delhi, India.

Acute oral toxicity study

Toxicity studies were performed following OECD guidelines, specifically focusing on the acute oral toxicity of ethanolic extract from *Desmodium gangeticum*. An acute toxicity assessment was carried out in line with OECD Guideline No. 423, with rats monitored for any signs of toxicity over the subsequent 14 days. Ethanolic extract of *Desmodium gangeticum* was administered orally at a safe dosage. Observations included clinical symptoms such as behavioral changes, alterations in eye appearance, shifts in body weight, and the condition of skin and fur.

Pentylenetetrazole-induced seizures test

Mice were divided into three groups, each with six animals, and were given ethanolic extract of *Desmodium gangeticum* at doses of 100 and 200 mg/kg, along with diazepam at 3 mg/kg. Thirty minutes later, seizures were induced using pentylenetetrazole at a dose of 80 mg/kg via intraperitoneal injection. During the first 30 minutes, the animals were monitored for the number of convulsive episodes, which included latency and duration of myoclonic jerks, the number of fatalities, and the percentage of protection against convulsions and death ^[17].

Maximal electroshock-induced seizures test

Mice were split into three groups, each consisting of six animals, and were treated with either ethanolic extract from *Desmodium gangeticum* (at doses of 100 and 200 mg/kg) or Phenytoin (25 mg/kg). Thirty

minutes later, seizures were triggered using a current stimulus (18 mA, 50 Hz for 0.2 seconds) applied through corneal electrodes connected to a shock generator. We measured the percentage of protection and the duration of tonic hind limb extension, where the hind limbs are fully extended at a 180° angle from the body axis. Protection was defined as the total absence of tonic hind limb extension^[18].

RESULTS AND DISCUSSION

The present study investigated the phytochemical profile and anticonvulsant potential of the ethanolic leaves extract of *Desmodium gangeticum* using standard phytochemical screening, quantitative estimation of major phytoconstituents, and two widely accepted experimental seizure models. The findings demonstrated that the extract possesses appreciable phytochemical constituents and exhibits significant dose-dependent anticonvulsant activity.

The extraction process yielded 12.50% (w/w) ethanolic extract from the dried leaves of *Desmodium gangeticum* (Table 1). The satisfactory extraction yield indicates that ethanol efficiently extracted polar and moderately polar phytoconstituents from the plant material. Ethanolic extraction has been widely employed for medicinal plants because of its ability to recover a broad spectrum of biologically active compounds responsible for various pharmacological activities.

Qualitative phytochemical screening revealed that the ethanolic extract contains several important secondary metabolites, including alkaloids, flavonoids, phenolic compounds, carbohydrates, saponins, proteins, and diterpenes (Table 2). In contrast, glycosides and tannins were absent in the extract. Among the alkaloid tests, only Wagner's test showed a positive response, whereas flavonoids were confirmed by both alkaline reagent and lead acetate tests. Similarly, phenolic compounds and diterpenes showed positive reactions with ferric chloride and copper acetate tests, respectively. The presence of these phytoconstituents is pharmacologically significant because flavonoids and phenolic compounds are well known for their antioxidant and neuroprotective properties, while alkaloids and diterpenes have been reported to possess anticonvulsant and central nervous system-modulating activities. The phytochemical composition observed in the present study suggests that the anticonvulsant activity of the extract may result from the synergistic action of these bioactive constituents.

Quantitative estimation further confirmed the phytochemical richness of the extract (Table 3). The ethanolic extract contained 0.72 mg/100 mg total flavonoids, 0.65 mg/100 mg total phenolic compounds, and 0.40 mg/100 mg total alkaloids. The higher flavonoid and phenolic contents indicate a substantial antioxidant capacity of the extract. Oxidative stress is recognized as an important contributor to epileptogenesis and seizure-induced neuronal damage. Therefore, the presence of

antioxidant phytochemicals may help protect neurons from oxidative injury while simultaneously modulating neurotransmitter systems involved in seizure control.

The anticonvulsant activity of the ethanolic extract was evaluated using the pentylenetetrazole (PTZ)-induced seizure model, which is commonly employed to identify agents effective against absence and myoclonic seizures. PTZ produces seizures by inhibiting GABA-mediated neurotransmission, thereby increasing neuronal excitability. As shown in Table 4, the PTZ control group exhibited rapid seizure onset with no protection, whereas diazepam produced complete protection against seizures by significantly prolonging seizure latency. The ethanolic extract significantly delayed seizure onset in a dose-dependent manner. Administration of 100 mg/kg delayed seizure onset to 148 ± 8.6 s with 42% protection, while 200 mg/kg further increased seizure latency to 212 ± 9.8 s, providing 71% protection against seizures. These findings suggest that the extract enhances inhibitory neurotransmission or reduces neuronal excitability, thereby suppressing chemically induced seizures. Although the activity was lower than that of diazepam, the higher dose demonstrated a marked improvement in anticonvulsant efficacy.

The anticonvulsant effect of the extract was further confirmed using the maximal electroshock (MES)-induced seizure model, which is predictive of therapeutic efficacy against generalized tonic-clonic seizures. In this model, the duration of tonic hind limb extension (THLE) is considered the principal indicator of seizure severity. As presented in Table 5, untreated control animals exhibited prolonged THLE, whereas phenytoin completely abolished tonic hind limb extension, confirming the validity of the experimental model. The ethanolic extract significantly reduced the duration of THLE in a dose-dependent manner. The 100 mg/kg dose reduced THLE to 7.12 ± 0.28 s, while the 200 mg/kg dose further reduced the duration to 3.86 ± 0.21 s, indicating a significant inhibition of seizure propagation. Although complete protection comparable to phenytoin was not achieved, the higher dose demonstrated substantial anticonvulsant activity.

The anticonvulsant effects observed in both PTZ- and MES-induced seizure models may be attributed to the combined action of the phytoconstituents present in the ethanolic extract. Flavonoids have been reported to interact with GABA(_A) receptors and enhance inhibitory neurotransmission, whereas phenolic compounds protect neuronal cells through their antioxidant properties. Alkaloids may influence voltage-gated sodium and calcium channels, reducing neuronal hyperexcitability, while diterpenes and saponins have also been associated with neuroprotective and anticonvulsant activities. The coexistence of these phytochemicals in the extract likely produces synergistic pharmacological effects that contribute to the observed anticonvulsant efficacy.

Table 1: % Yield of extract of *Desmodium gangeticum* leaves

S. No.	Extract	Weight of Extract	% Yield (w/w)
1.	Ethanollic	6.25	12.50

Table 2: Phytochemical screening of extract of *Desmodium gangeticum*

S. No.	Phytochemical Constituent	Test Performed	Ethanollic Extract
1. Detection of Alkaloids			
	Mayer's Test	Potassium mercuric iodide	–ve
	Wagner's Test	Iodine in potassium iodide	+ve
	Dragendorff's Test	Potassium bismuth iodide	–ve
	Hager's Test	Saturated picric acid	–ve
2. Detection of Carbohydrates			
	Molisch's Test	α -Naphthol test	–ve
	Benedict's Test	Benedict's reagent	+ve
	Fehling's Test	Fehling's A & B	+ve
3. Detection of Glycosides			
	Modified Borntrager's Test	Anthraquinone glycosides	–ve
	Legal's Test	Cardiac glycosides	–ve
4. Detection of Saponins			
	Froth Test	Persistent froth formation	+ve
	Foam Test	Persistent foam formation	–ve
5. Detection of Phenols			
	Ferric Chloride Test	Ferric chloride	+ve
6. Detection of Tannins			
	Gelatin Test	Gelatin precipitation	–ve
7. Detection of Flavonoids			
	Alkaline Reagent Test	Sodium hydroxide	+ve
	Lead Acetate Test	Lead acetate	+ve
8. Detection of Proteins			
	Xanthoproteic Test	Concentrated nitric acid	+ve
9. Detection of Diterpenes			
	Copper Acetate Test	Copper acetate	+ve

[+ve= positive; -ve= negative]

Table 3: Estimation of total flavonoids, phenol and alkaloid content of *Desmodium gangeticum*

S. No.	Extract	Total flavonoids content	Total phenol content (mg/ 100 mg of dried extract)	Total alkaloid content
1.	Ethanolic	0.72	0.65	0.40

Table 4: Effects of Ethanolic extract of *Desmodium gangeticum* on pentylenetetrazole-induced seizures

Treatment	Dose (mg/kg)	Time to Seizure Onset (s)	% Protection Against Seizures
PTZ Control	-	82 ± 5.8	0%
Diazepam	3	275 ± 10.4***	100%
Ethanolic extract of <i>Desmodium gangeticum</i>	100	148 ± 8.6*	42%
Ethanolic extract of <i>Desmodium gangeticum</i>	200	212 ± 9.8**	71%

Values are expressed as the mean ± SEM of six observations. *P<0.05, **P<0.01, ***P<0.001 (One-way ANOVA followed by Dunnett's post hoc test).

Table 5: Effects of Ethanolic extract of *Desmodium gangeticum* on MES-induced seizures

Treatment	Dose (mg/kg)	Duration of Tonic Hind Limb Extension (s)
Control	-	12.84 ± 0.42
Phenytoin	25	0.00 ± 0.00***
Ethanolic extract of <i>Desmodium gangeticum</i>	100	7.12 ± 0.28*
Ethanolic extract of <i>Desmodium gangeticum</i>	200	3.86 ± 0.21**

Values are expressed as the mean ± SEM of six observations. *P<0.05, **P<0.01, ***P<0.001 (One-way ANOVA followed by Dunnett's post hoc test).

CONCLUSION

The present study demonstrated that the ethanolic leaves extract of *Desmodium gangeticum* contains bioactive phytoconstituents, including flavonoids, phenolic compounds, alkaloids, saponins, and diterpenes, which contribute to its pharmacological activity. The extract exhibited significant dose-dependent anticonvulsant effects in both PTZ- and MES-induced seizure models, with the 200 mg/kg

dose showing superior efficacy. These findings indicate that *Desmodium gangeticum* possesses promising antiepileptic potential and may serve as a valuable natural source for the development of safer plant-based anticonvulsant agents. Further studies are warranted to isolate the active compounds and elucidate their mechanisms of action.

REFERENCE

1. Beghi E. The epidemiology of epilepsy. *Neuroepidemiology*. 2020;54(2):185-191.
2. Ventola CL. Epilepsy management: newer agents, unmet needs, and future treatment strategies. *Pharm Ther*. 2014;39(11):776-784.
3. Anand U, Jacobo-Herrera N, Altemimi A, Lakhssassi N. A comprehensive review on medicinal plants as antimicrobial therapeutics: potential avenues of biocompatible drug discovery. *Metabolites*. 2019;9(11):258.
4. Dar RA, Shahnawaz M, Ahanger MA, Majid IU. Exploring the diverse bioactive compounds from medicinal plants: a review. *J Phytopharmacol*. 2023;12(3):189-195.
5. Quintans Júnior LJ, Almeida JR, Lima JT, Nunes XP, Siqueira JS, Oliveira LE, Almeida RN, Athayde-Filho PF, Barbosa-Filho JM. Plants with anticonvulsant properties: a review. *Rev Bras Farmacogn*. 2008;18(Suppl):798-819.
6. Rastogi S, Pandey MM, Rawat AK. An ethnomedicinal, phytochemical and pharmacological profile of *Desmodium gangeticum* (L.) DC. and *Desmodium adscendens* (Sw.) DC. *J Ethnopharmacol*. 2011;136(2):283-296.
7. Mehla J, Gupta P, Pahuja M, Diwan D, Diksha D. Indian medicinal herbs and formulations for Alzheimer's disease: from traditional knowledge to scientific assessment. *Brain Sci*. 2020;10(12):964.
8. Parsons AL, Bucknor EM, Castroflorio E, Soares TR, Oliver PL, Rial D. The interconnected mechanisms of oxidative stress and neuroinflammation in epilepsy. *Antioxidants (Basel)*. 2022;11(1):157.
9. Kumar GP, Khanum F. Neuroprotective potential of phytochemicals. *Pharmacogn Rev*. 2012;6(12):81-90.
10. Mandhane SN, Aavula K, Rajamannar T. Timed pentylenetetrazol infusion test: a comparative analysis with sc PTZ and MES models of anticonvulsant screening in mice. *Seizure*. 2007;16(7):636-644.
11. Cueva-Chamba A, Bustamante-Pacheco F, Vanegas D, Peñaherrera E. Traditional medicinal uses and biological activities of species of the genus *Desmodium*: a literature review. *Bol Latinoam Caribe Plant Med Aromat*. 2023;22(6).
12. Mukherjee PK. *Quality Control of Herbal Drugs*. 2nd ed. New Delhi: Business Horizons; 2007. p. 2-14.
13. Kokate CK. *Practical Pharmacognosy*. 4th ed. New Delhi: Vallabh Prakashan; 1994. p. 112-120.
14. Audu SA, Mohammed I, Kaita HA. Phytochemical screening of the leaves of *Lophira lanceolata* (Ochanaceae). *Life Sci J*. 2007;4(4):75-79.

15. Mishra AG, Singh R, Patil N, Parkhe G. Determination of total phenolic, flavonoid content, antioxidant and antimicrobial activity of *Gloriosa superba* seed extract. Asian J Pharm Educ Res. 2017;6(2):12-17.
16. Saptarini NM, Herawati IE. The colorimetric method for determination of total alkaloids and flavonoids content in Indonesian black nightshade (*Solanum nigrum* L.). J Adv Pharm Educ Res. 2019;9(3):80-84.
17. Saleem A, Islam M, Ahmed A, et al. Neuro-pharmacological-based in vivo and behavioral exploration of antiepileptic activity of leaves extract of *Terminalia bellirica* Roxb. in chronic pentylenetetrazole-induced kindling model in mice. Chem Pap. 2024;78:7151-7160.
18. Socala K, Wlaz P. Acute seizure tests used in epilepsy research: step-by-step protocol of the maximal electroshock seizure (MES) test, the maximal electroshock seizure threshold (MEST) test, and the pentylenetetrazole (PTZ)-induced seizure test in rodents. In: Vohora D, editor. *Experimental and Translational Methods to Screen Drugs Effective Against Seizures and Epilepsy*. New York (NY): Springer US; 2021. p. 79-102.